CURRICULUM BOOKLET

Manav Rachna International Institute of Research and Studies

(Deemed to be university under section 3 of the UGC Act 1956)

B.TECH

IN

MECHANICAL ENGINEERING

SPECIALIZATION IN MECHATRONICS

SPECIALIZATION IN ELECTRIC VEHICLE

2021-2025

Faculty of Engineering & Technology

Departmentof Mechanical Engineering

Faridabad-121006, Haryana.

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FOREWORD

This is to certify that this booklet contains the entire Curriculum and Scheme of Examination of B.Tech in Mechanical Engineering being offered at Faculty of Engineering and Technology of this University. This has been duly vetted and finally approved by the Academic Council of the University vide **38th Academic Council** held on **26.10.2021** and changes, if any deemed appropriate, shall be duly incorporated after the necessary approval by the Academic Council.

This Curriculum and Scheme of Examination of B.Tech in Mechanical Engineering shall be implemented w.e.f. AY 2020-21.

Date:

Prof. (Dr.) Naresh Grover
Dean-Academics

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Index

Title of Content	Page No.
About the Department	1
Vision and Mission of the Department	2
PEOs and PSOs	2
POs	3-4
Mapping of PEOs with POs and PSOs	4
Semester System and Choice Based Credit System	5
Study Scheme	6-26
Details/Contents	27-300
Appendix A – Courses related to national, regional and global importance	301-305
Appendix B – Courses related to employability, skill development, entrepreneurship	306-311
Appendix C – Courses related to environmental sustainability, gender equality, professional ethics and human values	312

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About the Department:

Professional opportunities are vast in numbers for a mechanical engineer in generation and distribution of energy, material processing, industrial automation and control of manufacturing systems, design and development of mechanisms and machines. Ever since its inception in 1997, Department of Mechanical Engineering has grown in stature over the years considering its performance and achievements. The B.Tech-Mechanical Engineering programme offered by the department has been accredited by NBA in 2004, 2007 and 2018. Mechanical Engineering, being a very versatile branch, remains the most preferred programme for admission seekers. The department takes pride in its highly qualified faculty members who are actively involved in research and innovation. A large number of research papers have been published by faculty members in reputed journals. The department has labs on Mechatronics, CIM, Thermal Engineering, Fluid Mechanics, Fluid Machines and Turbo Machinery, Applied Mechanics, Strength of Material, Metrology etc. which are at par with the institutes of academic excellence. Mechanical Engineering Department is a continuously evolving department possessing several newer trends and opportunities to offer. Recently the department has procured several versatile software licenses including CREO, ALTAIR, MATLAB, etc. which are installed in CAD lab and design center. Also, the labs are consistently upgraded with the addition of major equipment like Fatigue test rig, Torsion Test rig, HMT Precision Lathe, Cylindrical grinding machine, Tool maker's microscope, Gear Roller tester (Parkinson's type), Autocollimeter, EDM, etc. along with already existing state of the art equipment.

The Institute of Indian Foundrymen (IIF) and Mechanical Engineering Department from Manav Rachna International Institute of Research (MRIIRS) have joined hands to establish the Faridabad Chapter of IIF Northern Region at the Manav Rachna campus.

The student chapter of Mechanical Engineering Department from Manav Rachna International Institute of Research and Studies is responsible for organizing many events in Collaboration with ISHRAE (Indian Society of Heating, Refrigeration & Air conditioning Engineers) such as job junction, expert lectures, technical quiz etc.

The department has signed memorandum of understanding with more than 50 companies including Miniratna Government of India enterprises like National Small Industries Corporation (NSIC), Ministry of Micro, Small & Medium Enterprises (MSME)*, etc. A MoU has also been signed with Orient Electric Ltd, Faridabad to carry out consultancy projects.

The department offers following programmes at Graduate/ Post Graduate level apart from Ph.D. degree. At graduate levels, there are options of core Mechanical Engineering and Mechanical Engineering with specialization in Mechatronics and specialization in Electric Vehicle. B.Tech Mechanical engineering with Mechatronics and Electric Vehicle offers multidisciplinary courses of engineering among mechanical, electrical, electronics, automobile and computer science engineering. At post graduate level, the specialization is in Industrial Engineering. At doctoral level, there is an entire plethora of domains available due to versatility of extremely competent team of faculty members.

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Vision and Mission of the Department Of Mechanical Engineering

Vision of the Department:

To develop the department into an advance center of learning by synergizing teaching, learning and research to produce competent Mechanical Engineers with an exposure to interdisciplinary engineering knowledge.

Mission of the Department:

The Mechanical Engineering Department is committed to:

M1 Produce job ready engineers in the field of production, design, thermal, industrial and automation engineering by imparting basic sciences and engineering education.

M2 Nurture students with creativeness, innovativeness and to develop ability to think out-of-the-box and respond effectively to the needs of the industry and the ever changing world scenario.

M3 Conduct high quality research, provide industrial consultancy and offer state-of-art undergraduate, postgraduate and doctoral programmes.

Program Educational Objectives (PEOs)

PEO1- To prepare mechanical engineering graduates with an outstanding knowledge of mathematical, scientific, engineering, technology, management, humanities and various other interdisciplinary subjects for a successful career.

PEO2- To equip students with modern tools/technology and advanced software for deliberating engineering solutions.

PEO3- To equip students with broad based knowledge to support the service industries, economic development and to address social and engineering challenges of the nation.

PEO4- To inculcate students with managerial/leadership skills with high level of integrity and ethical values for team building and team work.

Programme Specific Outcomes for Mechanical Engineering Programme

PSO1	To develop the ability to understand the basic concepts and principles of mechanical engineering formultidisciplinary projects/fields.
PSO2	To develop the ability to accept global challenges and apply knowledge of thermal, manufacturing,and design in interdisciplinary fields using the latest software/hardware tools
PSO3	To develop an understanding of social awareness and ethical responsibility towards society with insights on industrial management skills/interdisciplinary technologies to be successful entrepreneurs/professionals.

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PO for B.Tech

POs	Engineering Graduates Program Outcomes
PO1	**Engineering Knowledge:** Apply knowledge of mathematics, science and engineering fundamentals and Production and Industrial Engineering specialization to the solution of complex Production and Industrial Engineering problems.
PO2	**Problem Analysis:** Identify, formulate, research literature and analyze complex Production and Industrial Engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
PO3	**Design/ Development of Solutions:** Design solutions for complex Production and Industrial Engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.
PO4	**Conduct investigations of complex Production and Industrial Engineering problems** using research-based knowledge and research methods including analysis, interpretation of data and synthesis of information to provide valid conclusions.
PO5	**Modern Tool Usage:** To apply appropriate techniques, resources and engineering and IT tools for modeling of different Production and Industrial Engineering problems with an understanding of the limitations.
PO6	**The Engineer and Society:** Apply contextual knowledge to assess societal, health, safety, legal andcultural issues and the consequent responsibilities relevant to professional engineering practice.
PO7	**Environment and Sustainability:** Understand the impact of professional Production and Industrial Engineering solutions in societal and environmental contexts and demonstrate knowledge of and needfor sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and normsof Production and Industrial Engineering practice.
PO9	**Individual and Team Work:** Function effectively as an individual, and as a member or leader indiverse teams and in multi-disciplinary settings.
PO10	**Communication:** Communicate effectively on complex Production and Industrial Engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations and give and receive clear instructions.

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PO11	**Project Management and Finance:** Demonstrate knowledge and understanding of Production and Industrial Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments
PO12	**Life-long Learning:** Recognize the need for and have the preparation and ability to engage inindependent and life- long learning in the broadest context of technological change.

PEOs Statements	**M1**	**M2**	**M3**
PEO1: To prepare mechanical engineering graduates with an outstanding knowledge of mathematical, scientific, engineering, technology, management, humanities and variousother interdisciplinary subjects for a successful career.	**3**	**3**	**3**
PEO2: To equip students with modern tools/technology and advanced software's for deliberating engineering solutions.	**3**	**3**	**3**
PEO3: To equip students with broad based knowledge to support the service industries, economic development and to address social and engineering challenges of the nation.	**3**	**3**	**2**
PEO4: To inculcate students with managerial/leadership skills with high level of integrity and ethical values for team building and team work.	**3**	**3**	**1**

MAPPING OF PEO WITH PO AND PSO

PEOs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	3	3	2	2	1	1	1	1	-	-	1	-	3	1	-
2	2	2	2	1	3	-	1	-	-	-	-	-	2	2	-
3	1	1	-	-	3	2	3	1	-	2	3	3	3	3	3
4	-	-	-	1	3	3	3	2	2	-	3	3	3	-	3

MITS

Semester & Choice Based Credit System

Credit based system of study and student's performance/progress is measured by the number of credits that he/she has earned, i.e. completed satisfactorily. Based on the course credits and grade obtained by the student, grade point average is calculated

(a) Course credits assignment

Each course has a certain number of credits assigned to it depending upon its duration in periods for lecture, tutorial and laboratory/clinical practice in a week. A few courses/activities are without credit (s) and are referred to as Audit Pass Courses (APC) but are mandatory to pass as a partial fulfillment of award of degree.

(b) Earning of credits

At the end of every course, a letter "Grade" shall be awarded in each course for which a student has registered. On obtaining a minimum Pass Grade, student shall accumulate the course credits as Earned Credits. A student's performance shall be measured by the number of credits that he/she has earned and by the weighted grade point average. Grades obtained in the audit courses shall not be counted for computation of grade point average, however shall be mandatory to pass as a partial fulfillment of award of degree. For award of Degree of a programme B.Tech in Mechanical Engineering with specialization in Mechatronics or Electric Vehicles, he/she has to earn minimum 180 credits during the four year duration of the course. The total credits required to be earned have been further classified under two baskets of courses: "Compusory Courses Basket" and " Elective Courses Basket". The total 123 credits required to be earned under "Compusory Courses Basket" and 37 credits under "Elective Courses Basket". A separate "20" credits from specialization basket for Mechatronics and Electric Vehicles.

All courses under "Compulsory Courses Basket", are required to be qualified and cleared/pass by each and every students enrolled under the programme and are semester-wise listed in the study scheme along with credits assigned to each course.

Under Elective Courses Basket, there will be three types of courses:

- Semester-wise courses offered by the department itself
- Open/Inter-disciplinary courses offered at the Institute/University level notified from the office of Dean- Academics.
- Massive Open Online Courses (MOOCs) available on SWAYAM Platform or any other platform as recommended by UGC/AICTE and notified from the office of Dean-Academics.

Each course shall have credits assigned to it. Student shall be required to register courses every semester for as many courses/credits specified under "Elective Courses Basket" depending upon his/her interest, capability/pace of learning and availability of time slot (without any clash in time table) so as to earn all required total credits under the"Elective Courses Basket" during the entire programme duration.

However, for registration of courses [including courses under "Compulsory Courses Basket", "Elective Courses Basket" and Previous Semester Courses (wherein he/she was declared in-eligible on the basis of attendance or he/she could not clear the course within permissible given chances)], if any, the

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maximum limit in a semester shallbe 30 credits.

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Study Scheme at a Glance

B.Tech In

Mechanical Engineering

(Specialization in Mechatronics;

Specialization in Electric Vehicle)

2021-2025

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Study Scheme

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MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

FACULTY OF ENGINEERING & TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

B.Tech in Mechanical Engineering

B.Tech in Mechanical with specialization in Mechatronics : 2021-25 BATCH

B.Tech in Mechanical with specialization in Electric Vehicles : 2021-25 BATCH

(Common for All B.Tech. Programmes) B.Tech (Non-CSE branches and CSE N): Group A & B.Tech CSE (SPL): GroupB

SEMESTER-I

Course Type	Course Code	Title of Course	Pre-requisite Course, if any		Periods/Week				Marks			Duration of Exam	Credits
			Title	Code	L	T	P	Total	Int/ Con	End Sem	Total		
BSC	BPH-106	Physics for Engineers (GroupA)	NA	NA	3+ 1#	0	0	4	100	100	200	3 hrs	3
BSC	BCH-106	Chemistry for Engineers (Group B)	NA	NA	2+ 1 #	0	0	3					2
BSC	BMA-101/ BMA-102/ BMA-103	Mathematics-I (ForCSE only)/ Mathematics-1(All Branches except CSE & BT)/ Mathematics for Biotechnology-I (ForBT only)	NA	NA	3+ 1#	1	0	5	100	100	200	3 hrs	4
ESC	BEE-101	Basic Electrical Engineering (GroupA)	NA	NA	3	0	0	3	100	100	200	3 hrs	3
ESC	BCS-101	Programming for Problem Solving(Group B)	NA	NA									

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ESC	BCS-100	AI for Engineers	NA	NA	2	0	0	2	100	100	200	3 hrs	2
ESC	BME-101A/ BME-102	Engg Graphics & Design(Group A)/ Workshop/Manufacturing Practices(Group B)	NA	NA	0	0	4	4	100	100	200	3 hrs	2
BSC	BPH-151A/ BCH-151A	Physics lab (Group A)/ Chemistry lab (Group B)	NA	NA	0	0	2	2	50	50	100	2 hrs	1
ESC	BEE-151A/ BCS-151	Basic Electrical Engg lab (Group A)/ Programming for Problem Solving lab (Group B)	NA	NA	0	0	2	2	50	50	100	2 hrs	1
HSMC	BHM-201	English	NA	NA	2	0	0	2	50	50	100	2 hrs	2
HSMC	BHM-MC-001/ BCH-MC-002	Constitution of India* (Group A)/ EVS** (Group B)	NA	NA	1*	1**	0	1	50	50	100	2 hrs	AP
		Total (Group A/ Group B)							**700**	**700**	**1400**		**18/17**

 # Contact hours per week have been increased due to bridge course.

SEMESTER-II

Course Type	**Subject Code**	**Subject**	**Pre-requisite Course, if any**		**Periods/Week**				**Marks**			**Duration of Exam**	**Credits**
			Title	**Code**	**L**	**T**	**P**	**Total**	**Int./ Continuous**	**End Sem.**	**Total**		
BSC	BPH-106	Physics for Engineers (Group B)	NA	NA	3+1#	0	0	4	100	100	200	3 hrs	3
BSC	BCH-106	Chemistry for Engineers (Group A)	NA	NA	2+1#	0	0	3					2

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BSC	BMA-201/ BMA-202/ BMA-203	Mathematics-2 (For CSE only)/ Mathematics-2 (All Branches except CSE & BT)/ Mathematics for Biotechnology-II (For BT only)	NA	NA	3	1	0	4	100	100	200	3 hrs	4
ESC	BEE-101	Basic Electrical Engineering (Group B)	NA	NA	3	0	0	3	100	100	200	3 hrs	3
ESC	BCS-101	Programming for Problem Solving (Group A)	NA	NA									
ESC	BME-101A/ BME-102	Engg Graphics & Design(Group A)/ Workshop/Manufacturing Practices(Group B)	NA	NA	0	0	4	4	100	100	200	3 hrs	2
ESC	BBT-100	Biology for Engineers	NA	NA	2	0	0	2	100	100	200	3 hrs	2
BSC	BPH-151A/ BCH-151A	Chemistry lab (Group A)/ Physics lab (Group B)	NA	NA	0	0	2	2	50	50	100	2 hrs	1
ESC	BCS-151/ BEE-151A	Programming for Problem Solving lab (Group A)/ Basic Electrical Engg lab(Group B)	NA	NA	0	0	2	2	50	50	100	2 hrs	1
HSMC	BHM-151	English lab	NA	NA	0	0	2	2	50	50	100	2 hrs	1
HSMC	BHM-MC-001/ BCH-MC-002	EVS** (Group A)/ Constitution of India* (Group B)	NA	NA	1*	1**	0	1	50	50	100	2 hrs	AP
		Total (Group A/ Group B)							**700**	**700**	**1400**		**16/17**
# NOTE: Contact hours per week have been increased due to bridge course.													

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SEMESTER-III														
Course Type	Course Code	Title of Course	Pre-requisite Course, if any		Periods/Week				Marks			Duration of Exam	Credits
			Title	Code	L	T	P	Total	Int/ Con	End Sem	Total		
Compulsory courses													
ESC	BME-DS-301A	Engineering Mechanics	Physics / Mathematics-I	BPH-101 / BMA-102	4	0	0	4	100	100	200	3 hrs	4
CORE#		**Thermodynamics; Code: BME-DS-302//[Electronic Devices; Code: EC-DS-301 (3 credits) and Electronic Devices lab; Code: BEC-DS-351 (1 credit)]**											4
CORE	BME-DS-303	Fluid Mechanics & Machines	Physics / Mathematics-I	BPH-101 / BMA-102	4	0	0	4	100	100	200	3 hrs	4
CORE	BME-DS-304	Manufacturing Processes	Workshop/Manufacturing Practices	BME-102	4	0	0	4	100	100	200	3 hrs	4
ESC	BME-DS-351	Engineering Mechanics Lab			0	0	2	2	50	50	100	2 hrs	1

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CORE	BME-DS-352	Fluid Mechanics & Machines Lab			0	0	2	2	50	50	100	2 hrs	1
CORE	BME-DS-353	CAD Lab	Engineering Graphics & Design	BME-101	0	0	2	2	50	50	100	2 hrs	1
HSMC	BHM-320	Universal Human Values			2	0	0	2	50	50	100	2 hrs	2
HSMC	DTI-300	Design Thinking and Innovation					1	1	50		50		1
HSMC	BHM-MC-004	Quantitative Aptitude					2	2	50	50	100	2 hrs	AP
PROJ	Proj-ME-300A	Summer Internship –I			2 Weeks				50		50		1
Total					**14**	**0**	**9**	**23**	**650**	**550**	**1200**		**23**
B.Tech Mechanical with specialization in Mechatronics													
CORE	BEC-DS-302	Digital Electronics			3	0	0	3	100	100	200	3 hours	3
CORE	BEC-DS-352	Digital Electronics Lab			0	0	2	2	50	50	100	2 hrs	1
B.Tech Mechanical with specialization in Electric Vehicles													
CORE	BME-DS-311	Basics of Automobile Engineering			3	0	0	3	100	100	200	3 hours	3
CORE	BME-DS-312	Basics of Automobile Engineering Lab			0	0	2	2	50	50	100	2 hrs	1

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#NOTE:

1) Stundents of B.Tech Mechanical with specialization in Mechatronics will study Electronics Devices and Electronics Devices Lab in place of Thermodynamics and extra four mandatory credits from Mechatronics basket.

2) Students of B.Tech Mechanical with specialization in Electric Vehicles will study four extra mandatory credits only from Electric Vehicles Basket

***Training undertaken by students during the Summer vacation after second Semester (2 weeks minimum) will be evaluated as a III Semester subject. (Proj-ME-300A)**

Under Elective Courses, Inter-disciplinary, Generic, on-line Courses (MOOCs etc) and other approved courses shall be offered, which shall be notified well before start of the semester. The student shall be required and allowed to opt the courses out of offered courses as per maximum limit for maximum credits and for the category of Elective Courses under University Rules.

AP: Audit Pass (Students should pass these courses for partial fulfillment of the degree.

SEMESTER-IV

Course Type	Course Code	Title of Course	Pre-requisite Course, if any		Periods/Week				Marks			Duration of Exam	Credits
			Title	Code	L	T	P	Total	Int/Con	End Sem	Total		
Compulsory courses													
CORE		**Applied Thermodynamics; Code: BME-DS-401/Thermal Engineering; Code: BME-DS-405;**	Thermodynamics	BME-DS-302	4	0	0	4	100	100	200	3 hrs	4
CORE	BME-DS-402A	Strength of Materials	Engineering Mechanics/ Mathematics-I	BME-DS-301 / BMA-102	4	0	0	4	100	100	200	3 hrs	4
CORE	BME-DS-403A	Manufacturing Technology	Workshop / Manufacturing Processes	BME-102 /	4	0	0	4	100	100	200	3 hrs	4

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				BME-DS-304									
core#		**Material Science Code BME-DS-404 //Programming language; Code: BCS-ID-001**			3	0	0	3	100	100	200	3 hrs	3
CORE	BME-DS-451	Thermal Engineering Lab			0	0	2	2	50	50	100	2 hrs	1
CORE	BME-DS-452	Strength of Material Lab			0	0	2	2	50	50	100	2 hrs	1
CORE	BME-DS-453	Manufacturing Technology Lab			0	0	2	2	50	50	100	2 hrs	1
HSMC	DTI-400	Design Thinking and Innovation-II	Design Thinking and Innovation-I	DTI-300			1	1	50		50		1
HSMC	BHM-MC-006	Quantitative Aptitude and Personality Development-I					2	2	50	50	100	2 hrs	AP
HSMC	BHM-MC-002	Sports & Yoga			2	0	0	2	100	0	100	2 hrs	AP
Total					17	**0**	**9**	**24**	**750**	**600**	**1350**		**19.0**
B.Tech Mechanical with specialization in Mechatronics													
CORE	BEC-DS-403	Microcontrollers			3	0	0	3	100	100	200	3 hours	3
CORE	BEC-DS-453	Microcontrollers Lab			0	0	2	2	50	50	100	2 hrs	1

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		B.Tech Mechanical with specialization in Electric Vehicles											
CORE	BEE-DS-421	Fundamentals of Electric and Hybrid Vehicles			2	0	0	2	100	100	200	3 hours	2
CORE	BME-DS-412	Electric Vehicle Safety and standard			2	0	0	2	100	100	200	3 hours	2

#NOTE: Stundents of B.Tech Mechanical with specialization in Mechatronics will study the following: 1) Thermal Engineering in place of Applied Thermodynamics
2) Programming languages in place of Material Science 3) And and extra four mandatory credits from B.Tech Mechanical with specialization in Mechatronics basket.
4) Students of B.Tech Mechanical with specializationin Electric Vehicles will study four extra mandatory credits only from Electric Vehicles Basket

Under Elective Courses, Inter-disciplinary, Generic, on-line Courses (MOOCs etc) and other approved courses shall be offered, which shall be notified well before start of the semester. The student shall be required and allowed to opt the courses out of offered courses as per maximum limit for maximum credits and for the category of Elective Courses under University Rules.

AP: Audit Pass (Students should pass these courses for partial fulfillment of the degree).

SEMESTER-V

Course Type	**Course Code**	**Title of Course**	**Pre-requisite Course, if any**		**Periods/Week**				**Marks**			**Duration of Exam**	**Credits**
			Title	**Code**	**L**	**T**	**P**	**Total**	**Int/ Con**	**End Sem**	**Total**		
Compulsory courses													
CORE	BME-DS-501A	Theory of Machines	Engineering Mechanics	BME-DS-301	4	0	0	4	100	100	200	3 hrs	4
CORE	BME-DS-551	Theory of Machines Lab			0	0	2	2	50	50	100	2 hrs	1

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HSMC	DTI-500	Design Thinking and Innivation-III	Design Thinking and Innivation-II	DTI-400			1	1	50		50		2
HSMC	BHM-MC-008	Quantitaive Aptitude & Personality Development-II	Quantitative Aptitude and Personality Development-I	BHM-MC-006	0	0	2	2	50	50	100	2 hrs	AP
PROJ	PROJ-ME-500	Summer Internship-II/ Seminar			(4 WEEKS)				100		100	2 hrs	**2**
CORE	/BME-DS-522A	Mechatronics System Controls			3	0	0	3	100	100	200	3 hrs	3
HSMC	BHM-520	Enterpreneurship & Startup			2	0	2	4	50	50	100	2 hrs	2
Generic Elective-I	HM-506	French-I	NA	NA	2	0	0	2	50	50	100	1.5 hrs	2
	HM-507	German-I	NA	NA									
	HM-508	Spanish-I	NA	NA									
Total					**9**	**0**	**5**	**15**	**450**	**300**	**750**		**16.0**
B.Tech Mechanical with specialization in Mechatronics													
SPL	BEC-DS-510	Digital Signal Processing and its applications			3	0	0	3	100	100	200	3 hours	3
SPL	BEC-DS-551	Digital Signal Processing Lab			0	0	2	2	50	50	100	2 hrs	1
B.Tech Mechanical with specialization in Electric Vehicles													
SPL	BEE-DS-535	Design Architecture and Control of			3	0	0	3	100	100	200	3 hours	3

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		Electric Vehicle											
SPL	BEE-DS-554	Electric Vehicle Simulation lab			0	0	2	2	50	50	100	2 hrs	1

Note:1) A student may register for courses leading to a minimum of 16 credits for B.Tech Mechanical engineering and 20 for students opting for any specialization in Mechatronics/Electric Vehicles and a maximum of 30. 2) Students opting for Specialization in Mechatronics to take Mechatronics Systems and Control (BME-DS-522) as a **mandotory course. 3) And and extra four mandatory credits from B.Tech Mechanical with specialization in Mechatronics basket.**

****Under Elective Courses, beside the mentioned Domain Specific Elective Courses, other Inter-disciplinary, Generic, on-line Courses (MOOCs etc) and other approved courses shall be offered, which shall be notified well before start of the semester. The student shall be required and allowed to opt the courses out of offered courses as per maximum limit for maximum credits and for the category of Elective Courses under University Rules.**

AP: Audit Pass (Students should pass these courses for partial fulfillment of the degree.

***Training undertaken by students during the Summer vacation after fourth Semester (4 weeks minimum) will be evaluated as a V Semester subject (PROJ-ME-500).**

SEMESTER-VI

Course Type	Course Code	Title of Course	Pre-requisite Course, if any		Periods/Week				Marks			Duration of Exam	Credits
			Title	Code	L	T	P	Total	Int/Con	End Sem	Total		
CORE	BME-DS-604	Machine Design	Strength of Materials/ Theory of Machines	BME-DS-402 / BME-DS-501	4	0	0	4	100	100	200	3 hrs	4
CORE#		**Heat Transfer; Code: BME-DS-602//Control System; Code: BEE-DS-502**			4	0	0	4	100	100	200	3 hrs	4

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CORE#		**Heat Transfer Lab; Code: BME-DS-652//Control System Lab; Code: BEE-DS-552**			0	0	2	2	50	50	100	2 hrs	1
PROJ	PROJ-ME-600	Project Phase - I			0	0	2	2	100	0	100	2 hrs	1
HSMC	BHM-MC-009	Quantitaive Aptitude & Personality Development-III			0	0	2	2	50	50	100	2 hrs	AP
Generic Elective-II	HM-606	French-II	French-I	HM-506	2	0	0	2	50	50	100	1.5 hrs	2
	HM-607	German-II	German-I	HM-507									
	HM-608	Spanish-II	Spanish-I	HM-508									
Total					**8**	**0**	**6**	**14**	**400**	**300**	**700**		**12.0**
B.Tech Mechanical with specialization in Mechatronics													
SPL	BME-DS-603	Robotic Analysis			3	0	0	3	100	100	200	3 hrs	3
SPL	BEC-DS-717	Robitics Lab			0	0	2	2	100	0	100	2 hrs	1
B.Tech Mechanical with specialization in Electric Vehicles													
SPL	BEE-DS-635	Energy Storage and Battery Management System			3	0	0	3	100	100	200	3 hrs	3
SPL	BME-DS-612	Electric Vehicle Testing &			0	0	2	2	100	0	10	2 hrs	1

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		Validation Lab								0			

#NOTE: Stundents of B.Tech Mechanical with specialization in Mechatronics will 1) study Control system and Control system Lab in place of Heat Transfer and Heat transfer Lab respectively and extra four credits from specialized basket 2) Stundents of B.Tech Mechanical with specialization in Stundents of B.Tech Mechanical with specializations with Elective Baskets have to study extra four credits from specialized basket

****Under Elective Courses, beside the mentioned Domain Specific Elective Courses, other Inter-disciplinary, Generic, on-line Courses (MOOCs etc) and other approved courses shall be offered, which shall be notified well before start of the semester. The student shall be required and allowed to opt the courses out of offered courses as per maximum limit for maximum credits and for the category of Elective Courses under University Rules.**

AP: Audit Pass (Students should pass these courses for partial fulfillment of the degree.

Note: A student may register for courses leading to a minimum of 12 credits for B.Tech (Mechanical) and 16 for specialization in Mechatronics/Electric Vehicles and a maximum of 30 credits.

SEMESTER-VII

Course Type	Course Code	Title of Course	Pre-requisite Course, if any		Periods/Week				Marks			Duration of Exam	Credits
			Title	Code	L	T	P	Total	Int/ Con	End Sem	Total		
Compulsory courses													
PROJ	PROJ-ME-700	Project Phase - II/Industrial Project			0	0	8	8	**200**	**100**	**300**	**2 hrs**	**5**
DOMAIN SPECIFIC ELECTIVE COURSE (COMPULSORY) #		**Industrial Engineering & Operation Research (BME-DS-703) //Computer Network and Communications (BCS-ID-004) & Mechatronics System Control**			4	0	0	4	100	100	200	3 hrs	4

		Lab (BME-DS-751)											
Total					**4**	**0**	**8**	**12**	**300**	**200**	**500**		**9**
B.Tech Mechanical with specialization in Mechatronics													
SPL	BME-DS-702	Industry Automation	Nil		3	0	0	3	100	100	200	3 hours	3
SPL	BEE-DS-751	Industry Automation Lab	Nil		0	0	2	2	50	50	100	2 hours	1
B.Tech Mechanical with specialization in Electric Vehicles													
	BME-DS-711	Electric Vehicle Charging and Infrastructure			3	0	0	3	100	100	200	3 hours	3
	BME-DS-712	Electric Vehicle Charging Station Lab			0	0	2	2	50	50	100	2 hours	1

NOTE: **Domain Specific Elective Courses (Compusory)** 1) Stundents of B.Tech Mechanical have to opt a courses from Industrial Engineering and Operation Research 2) Stundents of B.Tech Mechanical in Mechatronics have to opt Computer Netwrok and communication and Mechtronics Systems Cnotrol Lab

Note* Computer Network and Communications (BCS-ID-004) is 3 credits & Mechatronics System Control Lab (BME-DS-751) is of one credit.

Project Phase - II/ Industrial Project can be the any one of the following:

(i) an extended part of Minor Project,

(ii) an independent project

(iii) an industrial project in any industry of his/her choice, following which the student has to undergo Summer Internship-III in the same industry.

Any student who has a placement offer and is bound to join the industry/company can undergo the Summer Internship-III(PROJ-ME-800) for a minimum of 20 weeks of 10 credit in the 7th Semester itself and his/her training/probation period will be considered equiavlent to Summer Internship-III. However the student has to attend special classes and appear for the end semester exam for the courses registered in the 7th Semester (as per the notification of the department) .

****Under Elective Courses, beside the mentioned Domain Specific Elective Courses, other Inter-disciplinary, Generic, on-line Courses (MOOCs etc) and other approved courses shall be offered, which shall be notified well before start of the semester. The student shall be required and allowed to opt the courses out of offered courses as per maximum limit**

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for maximum credits and for the category of Elective Courses under University Rules.														
Note:A student may register for courses leading to a minimum of 09 credits for B.Tech (Mechanical) and 13 credits for Specialization in Mechatronics/Electric Vehicle and a maximum of 30 credits.														
SEMESTER-VIII														
Course Type	**Course Code**	**Title of Course**	**Pre-requisite Course, if any**		**Periods/Week**				**Marks**			**Duration of Exam**	**Credits**
			Title	**Code**	**L**	**T**	**P**	**Total**	**Int/ Con**	**End Sem**	**Total**		
Elective courses**													
PROJ	**Proj-ME-800**	**Internship –III**			**16 to 20 weeks**				**200**	**1000**	**300**	**2 hrs**	**10**
OR													
DE/OE/GE		**Electives**											
Total													
****Under Elective Courses, beside the mentioned Domain Specific Elective Courses, other Inter-disciplinary, Generic, on-line Courses (MOOCs etc) and other approved courses shall be offered, which shall be notified well before start of the semester. The student shall be required and allowed to opt the courses out of offered courses as per maximum limit for maximum credits and for the category of Elective Courses under University Rules.** **#Open electives is to be selected from list of Open electives to be floated at the start of the semester**													
Note 1													
A candidate would need to earn a minimum of 160 credits (compulsary courses + elective courses) for the award of UG degree (B.Tech) in Mechanical Engineering.													
Out of the elective courses, the candidate shall be required to choose minimum of eight domain specific electives (24 credits) including MOOC and the balance elective courses could be from Generic electives.													
Note 2													
There shall be a requirement to earn extra 20 credits (Total 180 credits) for Honours degree in Mechanical Engineering in accordance with AICTE norms.													

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TABLE 1: LIST OF DEPARTMENTAL ELECTIVES FOR ENGINEERING (VERICALS)													
Course Type	Course Code	Title of Course	VERTICALS	SEMESTER	Periods/Week				Marks			Duration of Exam	Credits
					L	T	P	Total	Int	Ext	Total		
DE	BME-DS-527	Design Thinking	TD & CAD/CAM	Vth	3	0	0	3	100	100	200	3 hrs	3
DE	BME-DS-529	Tool Engineering & Design	TD & CAD/CAM	Vth	3	0	0	3	100	100	200	3 hrs	3
DE	BME-DS-528	Plastic Technology	TD & CAD/CAM	Vth	3	0	0	3	100	100	200	3 hrs	3
DE	BME-DS-626	Fundamental of Robot	TD & CAD/CAM	Vth	3	0	0	3	100	100	200	3 hrs	3
DE	BME-DS-531	Cooling Towers & Chillers	HVAC	Vth	3	0	0	3	100	100	200	3 hrs	3
DE	BME-DS-532	Refrigeration Systems & Basics of Air-conditioning	HVAC	Vth	3	0	0	3	100	100	200	3 hrs	3
DE	BME-DS-625	Renewable Energy & Resource Utilization	HVAC	Vth	3	0	0	3	100	100	200	3 hrs	3
DE	BME-DS-627	CNC Technology & Programming	TD & CAD/CAM	VIth	3	0	0	3	100	100	200	3 hrs	3
DE	BME-DS-628	Metrology & Quality Assurance	TD & CAD/CAM	VIth	3	0	0	3	100	100	200	3 hrs	3
DE	BME-DS-629	Digital Manufacturing	TD & CAD/CAM	VIth	3	0	0	3	100	100	200	3 hrs	3

DE	BME-DS-603	Robotic Analysis	**TD & CAD/CAM**	**VIth**	3	0	0	3	100	100	200	3 hrs	3
DE	BME-DS-631	Heat Exchangers	**HVAC**	**VIth**	3	0	0	3	100	100	200	3 hrs	3
DE	BME-DS-632	Green Building Technologies	**HVAC**	**VIth**	3	0	0	3	100	100	200	3 hrs	3
DE	BME-DS-633	Heating Ventilation Air Conditioning (HVAC) system	**HVAC**	**VIth**	3	0	0	3	100	100	200	3 hrs	3
DE	BME-DS- 727	Mould and Press Tool Design	**TD & CAD/CAM**	**VIIth**	3	0	0	3	100	100	200	3 hrs	3
DE	BME-DS-728	Product Design & Development	**TD & CAD/CAM**	**VIIth**	3	0	0	3	100	100	200	3 hrs	3
DE	BME-DS-729	Computer Aided Design	**TD & CAD/CAM**	**VIIth**	3	0	0	3	100	100	200	3 hrs	3
DE	BME-DS-702	Industrial Automation	**TD & CAD/CAM**	**VIIth**	3	0	0	3	100	100	200	3 hrs	3
DE	BME-DS-731	Building Safety, Insulation & Accoustic	**HVAC**	**VIIth**	3	0	0	3	100	100	200	3 hrs	3
DE	BME-DS-732	Computational Fluid Dynamics	**HVAC**	**VIIth**	3	0	0	3	100	100	200	3 hrs	3
DE	BME-DS-733	Building Management Systems (BMS) for HVAC	**HVAC**	**VIIth**	3	0	0	3	100	100	200	3 hrs	3
18													
TABLE 2: LIST OF DEPARTMENTAL ELECTIVES FOR Mechanical ENGINEERING (Continued….of previous years)													
DE	BME-DS-521	I C Engine		**Vth**	3	0	0	3	100	10	20	3 hrs	3

										0	0		
DE	BME-DS-523	Welding & Forging Technology		**Vth**	3	0	0	3	100	100	200	3 hrs	3
DE	BME-DS-525	Power Plant Engineering		**Vth**	3	0	0	3	100	100	200	3 hrs	3
DE	BME-DS-526	Production Engineering		**Vth**	3	0	0	3	100	100	200	3 hrs	3
DE	BME-DS-622	CAD/CAM		**VIth**	3	0	0	3	100	100	200	3 hrs	3
DE	BME-DS-623	Advanced Strength of Material		**VIth**	3	0	0	3	100	100	200	3 hrs	3
DE	BME-DS-624	Process Planning and Cost Estimation		**VIth**	3	0	0	3	100	100	200	3 hrs	3
DE	BME-DS-722	Modern Machining Methods		**VIIth**	3	0	0	3	100	100	200	4 hrs	3
DE	**BME-DS-723**	**Gas Dynamics & Jet Propulsion**		**VIIth**	**3**	**0**	**0**	**3**	**100**	**100**	**200**	**3 hrs**	**3**
DE	BME-DS-724	Mechanical Vibrations		**VIIth**	3	0	0	3	100	100	200	3 hrs	3
DE	BME-DS-725	Design of Machine Tools		**VIIth**	3	0	0	3	100	100	200	3 hrs	3
DE	BME-DS-726	Additive Manufacturing		**VIIth**	3	0	0	3	100	100	200	3 hrs	3

Note:4 A student interested in pursuing the courses pertaining to Tool Design & CAD/CAM or Heating Ventilation Air Conditioning VERTICALS as their departmental elective courses, can opt two courses of three credits each in Vth, Vith and VIIth semester and cummiliatvely earn 18 credits from the basket in Table-1 and other from Table-1 or Table-2 as per the courses offered by the department notifications

TABLE 3: LIST OF OPEN ELECTIVES FOR ENGINEERING OTHER THEN MECHANICAL ENGINEERING

Course Type	Course Code	Title of Course	Pre-requisite Course, if any		Periods/Week				Marks			Duration of Exam	Credits
			Title	Code	L	T	P	Total	Int	Ext	Total		
OE	BME-OE-001	Six Sigma Techniques			2	0	0	2	100	100	200	2 Hrs	2
OE	BME-OE-002	Maintenance Management			2	0	0	2	100	100	200	2 Hrs	2
OE	BME-OE-003	Quality Control			2	0	0	2	100	100	200	2 Hrs	2
OE	BME-OE-004	Operations Research			2	0	0	2	100	100	200	2 Hrs	2
OE	BME-OE-005	Robotic Mechanism			2	0	0	2	100	100	200	2 Hrs	2
OE	BME-OE-006	Basics of Mechanical Engineering			2	0	0	2	100	100	200	2 Hrs	2
OE	BME-OE-007	Energy Audit			2	0	0	2	100	100	200	2 Hrs	2
OE	BME-OE-008	Fundamental of MATLAB			2	0	0	2	100	100	200	2 Hrs	2
OE	BME-OE-009	Production Management			2	0	0	2	100	100	200	2 Hrs	2

OE	BME-OE-010	Rapid Prototyping			2	0	0	2	100	100	200	2 Hrs	2

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Course Details/Contents

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Ist Semester

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MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)
NAAC 'A' Grade University

BPH-106: PHYSICS FOR ENGINEERS

Periods/week	Credits	Max. Marks	: 200
L: 3 T:0	3	Continuous Evaluation	: 100
Duration of Examination: 3 Hrs		End Term Examination	: 100

Pre-requisite: Basic knowledge of 10+2 level Physics
Course Type: Basic Sciences

Course Outcomes: The students will be able to:
BPH-106.1 discuss and explain the key concepts and principles of quantum physics, lasers and optical fibres
BPH-106.2 apply the basic concepts of semiconductors and devices based on them
BPH-106.3 analyze the structure, characterization techniques and applications of advanced material.
BPH-106.4 recall the basic concept of electromagnetism and understand their applications to the theoryof electromagnetic waves.

Unit-1 Semiconductors (8 Lectures)
Physical properties of semiconductors, direct and indirect band gap semiconductors, compound semiconductors, organic and inorganic semiconductors, Fermi level and Fermi energy, occupation probability, concentration of charge carriers, generation and recombination, carrier transport: drift and diffusion, energy band diagram of unbiased and biased P N Junction, Light Emitting Diode, Photodetectors - p-n photodiode, PIN, Photoconductivity, Effect of impurity & Traps, Photovoltaic effect and Solar cell.

Unit-2 Quantum Physics (8 Lectures)
Limitations of classical physics, Black-body radiations, Planck's hypothesis, Photo-electric effect, Compton effect, Uncertainty principle, Matter waves, Phase and group velocity, Schrodinger's equations (time dependent and independent), Particle in a box (motion in one dimension), Basics of quantum statistics.

Unit-3Lasers and Optical Fibres (8 Lectures)
Introduction to laser, Spontaneous and stimulated emissions of radiations, Einstein's coefficients and relation among them, Population inversion and laser pumping, Characteristics of lasers, Components of laser, He-Ne laser, Semiconductor laser, Applications of laser.
Introduction to optical fibres, Acceptance angle and acceptance cone, Numerical aperture, Classification of fibres, Attenuation, Losses associated with optical fibres, Merits and applications of optical fibres.

UNIT 4: Advance Material and Synthesis (6 Lectures)
Introduction to nanomaterials, Nano-science and nano-technology, Two main approaches in nanotechnology, Bottom up technique, Top down technique, Quantum dot and graphene, Methods to produce Nanomaterials, Chemical vapour deposition, Sol-gel process, Molecular beam epitaxy, Physical and chemical properties of nanomaterials, Carbon nanotubes: single and multi-walled nanotubes, Synthesis of Nanotubes: carbon arc method, Laser evaporation method, Sputtering, applications of advanced materials.

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UNIT 5: Investigating Techniques (6 Lectures)
Properties of X-Ray,Braggs' Law, Bragg's Spectrometer, Rutherford Back Scattering, Raman effect and Raman spectroscopy, Hall effect, Vander Pauw measurements for carrier density, resistivity, Hot-point probe measurement, AFM, SEM, photoluminescence spectroscopy, band gap by UV-Vis spectroscopy.

Unit-6 Electrodynamics (8 Lectures)
Divergence and curl of electrostatic field, Laplace's and Poisson's equations for electrostatic potential. Solutions of Laplace equation in one dimension, Dielectric Polarization and Dielectric constant, Piezoelectricity, Bio-Savart law and Ampere's circuital theorem, Continuity equation for current densities, Displacement current, Maxwell's equations, Electromagnetic energy – Flow of energy and Poynting vector, The wave equation; Plane electromagnetic waves in vacuum, their transverse nature, Energy carried by electromagnetic waves.

Text Books/ Reference Books:

1. P. Bhattacharya,2017, Semiconductor Optoelectronic Devices, Pearson education.
2. D.J Griffiths, 2015, Introduction to Electrodynamics, Pearson education.
3. Avadhanulu and Kshirsagar,2014, A textbook of Engineering Physics S. Chand.
4. S.P. Taneja,2018, Modern Physics for Engineers, R. Chand & Co.
5. Mark Ratner and Daniel Ratner, 2003,Nanotechnology, Pearson.
6. M.N.O. Sadiku, 2015, Elements of Electromagnetics, Asian Edition, Oxford Higher Education.

Distribution of Continuous Evaluation:

Sessional-I	30%
Sessional-II	30%
Assignment/Tutorial	20%
Class Work/ Quiz	20%

Evaluation Tools:
Assignment/Tutorials
Sessional tests
Surprise questions during lectures/Class Performance
Term end examination

Assignments, Sessional and End Semester Examination paper will consist of various difficulty levels to accommodate the different capabilities of students. Assessment should cover all course outcomes and upper limit for lower order skills will be 40% (for knowledge-oriented questions). However, weightage for different cognitive levels in the question papers can vary.

Instructions for paper setting: The paper setter must ensure the coverage of entire syllabus while setting the question papers and mention the learning outcomes across each section to be measured by the examination. Weightage of the sections may vary as per the number of respective lecture hours mentioned in the syllabus.Action verbs should be used from Bloom's Taxonomy while designing question papers.

Course articulation Matrix

CO Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BPH-106.1	2	2	1	2	3	-	-	-	-	-	2	3
BPH-106.2	3	1	3	-	2	1	1	-	-	-	-	3
BPH-106.3	3	2	2	-	2	2	1	-	-	-	-	2
BPH-106.4	3	3	3	1	1	3	1	-	-	-	-	3

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MANAV RACHNA INTERNATIONAL INSTITUTE OFRESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)

BMA-102: MATHEMATICS-1

(Calculus and Linear Algebra)

Periods/week	Credits	Max. Marks:200	
L: 3 T: 1	4	Continuous Assessment	100
Duration of Examination: 3 Hrs		End Semester Examination	100

Pre-requisites: The students must have the knowledge of mathematical concepts of Intermediate level.
Course Type: Basic Sciences

Course Outcomes:

The objective of this course is to familiarize the prospective engineers with techniques in calculus, multivariate analysis and linear algebra. It aims to equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling more advanced level of mathematics and applications that they would find useful in their disciplines. More precisely, the outcomes are:

BMA-102.1. Students will be able to understand the role of mathematics in engineering.
BMA-102.2. Students will be able to define the terminology of Integration, Differentiation, Matrices and Infinite Series.
BMA-102.3. Students will be able to explain improper integrals, power series, and linear system of equations, convergence of series and physical interpretation of vector function.
BMA-102.4. Students will be able to demonstrate the knowledge of evolutes and involutes, rank of matrices, expansion of functions and diagonalization.
BMA-102.5. Students will be able to interpret the concepts of integration, differentiation, matrices and series to solve real life problems.
BMA-102.6. Students will be able to correlate the surface area, maxima and minima, eigen vectors.

PART-A

Unit 1: Integral Calculus

Evolutes and involutes, Evaluation of definite and improper integrals, Beta and Gamma functions and their properties, Applications of definite integrals to evaluate surface areas and volumes of revolutions.

Unit 2: Differential Calculus

Rolle's Theorem, Mean value theorems, Taylor's and Maclaurin theorems with remainders; indeterminate forms and L'Hospital's rule, Maxima and minima.

Unit 3: Sequences and Series

Convergence of sequence and series, tests for convergence, Power series, Taylor's series, series for exponential, trigonometric and logarithm functions, Fourier series: Half range sine and cosine series, Parseval's theorem

PART-B

Unit 4: Multivariable Calculus (Differentiation)

Limit, continuity and partial derivatives, directional derivatives, total derivative, Tangent plane and normal line, Maxima, minima and saddle points, Method of Lagrange multipliers, gradient, curl and divergence.

Unit 5: Matrices

Inverse and rank of a matrix, rank-nullity theorem, System of linear equations, Symmetric, skew-symmetric and orthogonal matrices, Determinants, Eigenvalues and Eigenvectors, Diagonalization of matrices, Cayley-Hamilton theorem and Orthogonal transformation.

Suggested Text/Reference Books

1. G.B. Thomas and R.L. Finney, 2002, Calculus and Analytic geometry, 9thEdition, Pearson.
2. Erwin kreyszig, 2006, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons.
3. Veerarajan T., 2008, Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi.
4. Ramana B.V., 2010, Higher Engineering Mathematics, Tata McGraw Hill New Delhi.
5. D. Poole, 2005, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole.
6. N.P. Bali and Manish Goyal,2008, A text book of Engineering Mathematics, Laxmi Publications.
7. B.S. Grewal, 2010, Higher Engineering Mathematics, Khanna Publishers, 36th Edition.

Instructions for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each PART-A and PART-B. Student needs to attempt two questions out of three from each part. Each question will be of 20 marks.

Distribution of Continuous Assessment:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Assessment Tools:

Assignment/Tutorials.
Sessional tests.
Surprise questions during lectures/Class Performance.
End Term Examination.

MITS

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH & STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)
BEE-101A: BASIC ELECTRICAL ENGINEERING

Periods/week Credits	Max. Marks 200
L: 3 T: 3	Continuous Evaluation 100
Duration of Examination: 3 Hours	End Semester Exam 100

Pre-requisites
Course Type: Engineering Science

Course Outcomes: After completion of this course the students will be able to
BEE-101A.1 understand the components of electrical network, low voltage electrical installation, earthing and working of batteries.
BEE-101A.2 apply the basic theorems and laws for solving both dc and ac networks.
BEE-101A.3 differentiatebetween single phase series and parallel circuits and three phase system.
BEE-101A.4 explain the construction and working of transformers, electrical machines and power converters

Unit 1: DC CIRCUITS (8 hours)
1.1 Electrical circuit elements (R, L and C), voltage and current sources,
1,2Kirchoff Voltage and Current Laws,
Analysis of simple circuits (two loops) with dc excitation ,
Superposition Theorem,
Thevenin's Theorem,
Norton's Theorem,
Time domain analysis of first order system- RL circuit,
Time domain analysis of first order system- RC circuit.

Unit 2: AC CIRCUITS (8 hours)
Single Phase-AC Generation,
Sinusoidal Waveform- peak value average and rms values
Phasor representation, L, C, RL, RC circuit
RLC Series Circuits
Power factor, Real power, Reactive power and Apparent power
RLC parallel circuits
Resonance
Three Phase Emf Generation, Delta and Star Connections
Voltage and current relation in star and delta connections

Unit 3: TRANSFORMERS (6 hours)
Magnetic materials
BH characteristics,
Working Principle and Emf Equation of transformer,
Ideal and Practical transformer,
Equivalent circuit Losses in transformer,
Efficiency and regulation of transformer
Auto transformer
Three phase transformer connections.

Unit 4: DC MACHINES (5 hours)
Construction and working of DC motor,
Torque-speed characteristic and speed control of separately excited dc motor,

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Construction and working of DC generator,
EMF equation of DC generator,
Introduction to power converters/power switching devices.

Unit 5: AC MACHINES (6 hours)

Generation of rotating magnetic fields,
Construction and working of a three-phase induction motor
Significance of torque-slip characteristic,
Loss components and efficiency of three phase induction motor
Starting and speed control of induction motor,
Single-phase induction motor working and types
Construction and working of synchronous generators.

Unit 6: ELECTRICAL INSTALLATIONS (6hours)

Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB,
Types of Wires and Cables,
Earthing,
Types of Batteries, Important Characteristics for Batteries,
Elementary calculations for energy consumption,
Power factor improvement and battery backup.

Text Books/ Reference Books:

1. I. J. Nagrath, D. P. Kothari ,2007, Basic Electrical Engineering, TMH.
2. S. NathChakrabarti, C. K. Chanda , 2009, Basic Electrical Engineering, TMH,2009.
3. B. L. Thereja , 2005, Electrical Technology Vol.1, S Chand.
4. V. N. Mittal, Aravind Mittal, 2007, Basic Electrical Engineering,TMH 2007.
5. S N Singh , 2011, Basic Electrical Engineering, PHI.
6. D. C. Kulshreshtha , 2009, Basic Electrical Engineering, McGrawHill.
7. Leonard S Bobrow,2011,Fundamentals of Electrical Engineering, 2nd edition, Oxford University Press.
8. E. Hughes ,2010, Basic Electrical Engineering, Pearson.
9. S K Sahadev ,2015, Basic Electrical Engineering, Pearson India.

Software required/Weblinks

http://nptel.ac.in/courses/108105053/
https://nptel.ac.in/courses/108108076/

Instructions for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each PART-A and PART-B. Student needs to attempt two questions out of three from each part. Each question will be of 20 marks.

Se Sessional- I	3 30%
Se Sessional- II	3 330%
A Assignment	2 20%
C Class Performance	1 10%
At Attendance	1 10%

MRITS

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
BEE-101A.1	3	3	2	1	1	-	-	-	-	-	-	2	3	1	1	1
BEE-101A.2	3	3	3	1	1	-	-	-	-	-	-	2	3	1	1	1
BEE-101A.3	3	3	3	1	1	-	-	-	-	-	-	2	3	3	1	1
BEE-101A.4	3	3	3	1	1	-	-	-	-	-	-	2	3	1	1	1

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MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH & STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

BME-101A: ENGINEERING GRAPHICS & DESIGN

Periods/week CreditsMax. Marks: 200

L: 0 T: 0 P: 4 2 Internal/Continuous Assessment : 100

Duration of Examination: 3 Hrs End Semester Exam : 100

Prerequisites:

Course Type: Engineering Science Course

Course Outcomes:

After completion of this course the students will be able to

BME-101A.1 understand the role and importance of Engineering Graphics, design/drafting in cognitive development.

BME-101A.2 conceptualize engineering drawing and descriptive geometry to understand different components and machineries.

BME-101A.3 visualize objects with the help of engineering principles, projectiontheories including their applications to solve problems related to engineering and production.

BME-101A.4 develop capability of understanding engineering drawing problems and implementation of respective solution.

BME-101A.5 develop capability of selection of solutions for a given designproblem.

BME-101A.6 develop of capability of designing a product or assembly with its variouscomponentswith a systematic design approach

Theory (Detailed Content)

Traditional Engineering Graphics:

Principles of Engineering Graphics; Orthographic Projection; Descriptive Geometry; Drawing Principles;Isometric Projection;Surface Development;Perspective;Reading a Drawing; SectionalViews;Dimensioning&Tolerances; TrueLength,Angle;intersection, Shortest Distance.

(**Except the basic essential concepts, most of the teaching part can happen concurrently in the laboratory**)

Part-A

Unit 1: Introduction to Engineering Drawing, Orthographic Projections

Principles of Engineering Graphics and their significance, usage of drawing instruments,lettering, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid and Involute; Scales – Plain, Diagonal and Vernier Scales;Principles of Orthographic Projections-Conventions - Projections of Points and lines inclined to both planes; Projections of planes inclined Planes - Auxiliary Planes;

Unit 2: Projections of Regular Solids & Sections and Sectional Views of Right Angular Solids

Inclined to both the Planes- Auxiliary Views; Draw simple annotation, dimensioning and scale. Floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc.

Prism, Cylinder, Pyramid, Cone – Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone; draw the sectional orthographic views of geometrical solids, objects from industry and dwellings (foundation to slab only).

Unit 3: Isometric Projections

Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric
Views to Orthographic Views and Vice-versa, Conventions;

Theory (Detailed Content)

Computer Graphics

Engineering Graphics Software; -Spatial Transformations; Orthographic Projections; ModelViewing; Co-ordinate Systems; Multi-view Projection; Exploded Assembly; Model Viewing;Animation; Spatial Manipulation; Surface Modelling; Solid Modelling; Introduction to Building Information Modelling (BIM)
(**Except the basic essential concepts, most of the teaching part can happen concurrently in the laboratory**)

Part-B

Unit 4: Overview of Computer Graphics, Customization & CAD Drawing

Listing the computer technologies that impact on graphical communication, Demonstratingknowledge of the theory of CAD software [such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.; Isometric Views of lines, Planes, Simple and compound Solids;consisting of set up of the drawing page and the printer, including scale settings, Setting up of units and drawing limits; ISO and ANSI standards for coordinate dimensioning andtolerancing; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines,Applying various ways of drawing circles;

Unit 5: Annotations, layering, other functions

Applying dimensions to objects, applying annotations to drawings; Setting up and use ofLayers, layers to create drawings, Create, edit and use customized layers; Changing line lengths through modifying existing lines (extend/lengthen); Printing documents to paper using the print command; orthographic projection techniques; Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface; Drawing annotation, Computer-aided design (CAD) software modeling of parts and assemblies. Parametric and non-parametric solid, surface, and wireframe models. Part editing and two-dimensional documentation of models. Planar projection theory, including sketching of perspective, isometric, multiview, auxiliary, and section views. Spatial visualization exercises. Dimensioning guidelines, tolerancing techniques; dimensioning and scale multi views of dwelling;

Unit 6: Demonstration of a simple team design project

Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; meshed topologies for engineering analysis and tool-path generation for component manufacture; geometric dimensioning and tolerancing; Use of solid-modeling software for creating associative models at the component and assembly levels; floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc. Applying color coding according to building drawing practice; Drawing sectional elevation showing foundation to ceiling; Introduction to Building Information Modelling (BIM).

Text Books:

1. Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House
2. Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education
3. (Corresponding set of) CAD Software Theory and User Manuals

Reference Books:

1. Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication
2. Narayana, K.L.&P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers

Weblinks:

https://nptel.ac.in/courses/112103019/

NITTTR

https://nptel.ac.in/courses/112104172/

Assessment Tools:
Surprise questions during lab/Class Performance
Term end examination/viva

Course Articulation Matrix

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 11	PSO 12	PSO 13
BME-101A.1	2	1	1	1	1	2	1	2	1	1	2	3	3	3	2
BME-101A.2	2	2	3	1	1	2	2	2	2	2	3	2	3	3	1
BME-101A.3	2	2	2	2	2	1	2	1	3	2	2	2	3	3	2
BME-101A.4	3	3	2	3	2	1	2	2	1	1	2	1	3	3	1
BME-101A.5	3	3	2	3	2	1	2	1	1	1	2	1	3	-	-
BME-101A.6	2	1	3	2	3	2	2	2	3	2	2	1	-	-	3

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BME-102: WORKSHOP/MANUFACTURING PRACTICES

Periods/week Credits		Max. Marks	200
L: 0 T: 0 P: 4	2	Continuous Assessment	100
Duration of Examination: 3 Hrs		End Semester Exam	100

Prerequisites: basic knowledge of Science and Mathematics
Course Type: Engineering Science Course

Course Outcomes:
After completion of this course the students will be able to

BME-102.1 Learn the basic manufacturing/fabrication processes and develop skills to fabricate with their own hand.

BME-102.2 Understand how to operate various traditional and modern machine tools used in industries.

BME-102.3 Apply knowledge of the dimensional accuracies and dimensional tolerances, basics of various measuring instruments, hand tools and cutting tools.

BME-102.4 Acquire knowledge of safety measurements

BME-102.5 Understand the impact of manufacturing engineering solution.

BME-102.6 Assemble different mechanical component/parts

Lectures & Videos (10 Hrs)

(i) Detailed Content

1. Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods (3 lectures).
2. CNC machining, Additive manufacturing (1 lecture)
3. Fitting operations & power tools (1 lecture)
4. Electrical &Electronics (1 lecture)
5. Carpentry (1 lecture)
6. Plastic moulding, glass cutting (1 lecture)
7. Metal casting (1 lecture)
8. Welding (arc welding & gas welding), brazing (1 lecture)

(ii) Workshop Practice: (60 hours)

1. Machine shop (10 hours)
2. Fitting shop (8 hours)
3. Carpentry (6 hours)
4. Electrical & Electronics (8 hours)

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5. Welding shop (8 hours) (Arc welding 4 hrs + gas welding 4 hrs)
6. Casting (8 hours)
7. Smithy (6 hours)
8. Plastic moulding & Glass Cutting (6 hours)

Students Project Fabrication

Students have to fabricate product from the assigned list with their own hands. They will also get practical knowledge of the dimensional accuracies and dimensional tolerances possible with different workshop processes. The final product should be assembly of different components fabricated by different workshop practices.

For e.g. Tack-hammer; Project Display Stand; Pen stand, Screw Driver, Variable size Spanner, Electrical Extension Board with electronic circuits or any other product which should involve multiple workshop practices to fabricate a single product.

Each student will be issued the drawings of the product assembly along with the drawing of the sub-part assembly, mentioning the dimensions, tolerance, sub-products used.

Students should follow the process planning sheet of the product and get involved in different workshop practices to complete the jobs for final submission.

Note: Each student should do more than one product to get hands on experience of all the workshop practices.

Text Books:

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of Workshop Technology", Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai.
2. Kalpakjian S. And Steven S. Schmid, "Manufacturing Engineering and Technology", 4th edition, Pearson Education India Edition, 2002.
3. Gowri P. Hariharan and A. Suresh Babu," Manufacturing Technology – I" Pearson Education, 2008.

Reference Books:

1. Roy A. Lindberg, " Processes and Materials of Manufacture" , 4th edition, Prentice Hall India, 1998.
2. Rao P.N., " Manufacturing Technology" , Vol. I and Vol. II, Tata McGrawHill House, 2017.

Weblinks:

https://nptel.ac.in/noc/courses/noc17/SEM2/noc17-me21/

Instructions for setting of Paper Seven questions are to set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each part A

and part B (one from each unit). Student needs to attempt two questions out of three questions fromeach part. Each question will be of 20 marks.

Assessment Tools:

Surprise questions during lab/Class PerformanceTerm end examination/viva

Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
BME-102.1	3	3	3	3	2	1	1	2	2	2	2	3	1	-	1
BME-102.2	3	3	3	3	3	2	1	2	2	2	2	2	1	1	1
BME-102.3	3	3	3	3	3	2	2	1	2	2	1	2	1	1	1
BME-102.4	2	2	2	2	3	2	1	1	2	1	2	2	1	1	1
BME-102.5	3	2	2	2	2	3	3	2	2	2	2	2	-	2	-
BME-102.6	3	3	3	2	2	1	2	2	2	3	2	2	-	-	2

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NAAC 'A' Grade University
BPH-151A: PHYSICS LAB

Periods/week	Credits	Max. Marks	100
P: 2	1	Internal	50
Duration of Examination: 2 Hrs		External	50

Pre-requisite: Basic knowledge of 10+2 level Physics
Course Type: Basic Sciences Courses

Course Outcomes: The students will be able to:

BPH-151A.1 calculate zero error, least count, maximum percentage error, percentage error and understand their importance
BPH-151A.2 understand the principle, concept and working of the experiments
BPH-151A.3 rearrange/assemble the different components of a device or a circuit
BPH-151A.4 describe the methodology of science and the relationship between observation and theory

List of Experiments:

1. To calculate the hysteresis loss and magnetic susceptibility by tracingB- H curve.
2. To determine the value of Planck's constant h by a photo cell.
3. To determine the grating element of a given grating by using LASER.
4. To study Hall Effect in a semiconductor and to find (i) Hall voltage and Hall coefficient (ii) number of charge carriers per unit volume (iii) mobility.
5. To draw the characteristics of a solar cell and to find the fill factor.
6. To find the band gap of an intrinsic semiconductor using four probe method.
7. To draw the V-I characteristics of a PIN diode.
8. To determine numerical aperture of an optical fibre.
9. Todetermine the volume magnetic susceptibility of manganese sulphatesolution at different concentrations.
10. To find the charge to mass (e/m) ratio of an electron.
11. To study the resonance phenomena in LCR circuits.
12. To study the variation of magnetic field from Helmholtz coil.
13. To determine the moment of inertia of a flywheel.
14. To determine the Young's modulus of the material of a given beamsupported on two knife-edges and loaded at the middle point.
15. To determine the Modulus of Rigidity of a wire by Maxwell's Needle.

Text Books/References:
1. S. L. Gupta & V. Kumar, Practical Physics, 2018, Pragati Prakashan.
2. S.L. Arora, B.SC, Practical Physics, 2010, S. Chand.
3. NPTEL video lectures for Experimental Physics.

Instructions for Exam: One experiment out of 10 given randomly needs to be performed in exams.

Distribution of Continuous Evaluation:

Viva-I	30%
Viva-II	30%
File/Records	20%
Class Work/ Performance	20%

Evaluation Tools:
Experiments in lab
File work/Class Performance
Viva (Question and answers in lab)
End Term Practical Exam

Course articulation Matrix

CO Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BPH-151A.1	3	1		1				1	1	1		3
BPH-151A.2	2		2		2				1	1		2
BPH-151A.3	2	3	2	3	3				3		1	3
BPH-151A.4	3	1	2		1		1	1	1	1		3

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NAAC 'A' Grade University

BEE-151A: BASIC ELECTRICAL ENGINEERING LAB

Periods/week Credits	Max. Marks 100
P: 2 1	Internal/Continuous Evaluation: 50
Duration of Examination: 2 Hours	End Semester Exam 50

Course Outcomes

After completion of this course the students will be able to

BEE-151A.1 familiarize with the measuring instruments, breadboard, CRO, components of LT installation

BEE-151A.2 understand the transformers connection both single and three phase.

BEE-151A.3 study the working principles of electric machines and power converters

BEE-151A.4design a simple PCB with software.

LIST OF EXPERIMENTS:

1. Introduction and use of measuring instruments – voltmeter, ammeter, multi-meter, oscilloscope. Real-life resistors, capacitors and inductors and verification of basic laws.
2. To measure the steady-state and transient time-response of R-L/R-L circuits to a step change in voltage (transient may be observed on a storage oscilloscope).
3. To examine sinusoidal steady state response of R-L, and R-C circuits – impedance calculation and verification. Observation of phase differences between current and voltage.
4. To find the resonance frequency inR-L-C circuits..
5. To observe the no-load current waveform of transformer on an oscilloscope (non- sinusoidal wave-shape due to B-H curve nonlinearity should be shown along with a discussion about harmonics).
6. To perform Load test on a transformer: measurement of primary and secondary voltages and currents, and power.
7. To connect Three-phase transformers in Star and Delta and verify voltage and current relationships (line-line voltage, phase-to-neutral voltage, line and phase currents). Phase-shifts between the primary and secondary side and to measure three-phase power in balanced three-phase circuits.
8. Identification of various types of Printed Circuit Boards (PCB) and soldering techniques.
9. Introduction to PCB design software.
10. PCB Lab a) Artwork & printing of simple PCB b) Etching & drilling of PCB.
11. Demonstration of cut-out sections of machines: dc machine (commutator-brush arrangement), induction machine (squirrel cage rotor), synchronous machine (field winding - slip ring arrangement) and single-phase induction machine.
12. To draw Torque -Speed Characteristic of dc motor.
13. To find Synchronous speed of two and four-pole three-phase induction motors, check Direction reversal by change of phase-sequence of connections and to draw Torque-Slip Characteristic of an induction motor.
14. To Study components of LT, switchgear- MCB, ELCB, MCCB.
15. To Study DC-DC Converter.

Text Books:

Dr. N K Jain ,2010, A text book of Practicals in Electrical Engineering, Dhanpatrai Publishing Co.

Instructions for Exam: Every student needs to complete 10 experiments in a semester. One experiment out of 10 given randomly needs to be performed in exams.

Parameter	Weightage

Two Mid-Term Viva	60%
File/Record Keeping	20%
Class Performance	10%
Class Attendance	10%

Assessment Tools:
Experiments in lab
File work/Class Performance
Viva (Question and answers in lab)
End Term Practical Examination

COURSE ARTICULATION MATRIX

CO Statement (BEE-151A)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
BEE-151A.1	3	3	2	1	1	-	-	-	-	-	-	2	3	1	1	1
BEE-151A.2	3	3	3	1	1	-	-	-	-	-	-	2	3	1	1	1
BEE-151A.3	3	3	3	1	1	-	-	-	-	-	-	2	3	3	1	1
BEE-151A.4	3	3	3	1	1	-	-	-	-	-	-	2	3	1	1	1

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NAAC 'A' Grade University
BCS-100A: Artificial Intelligence for Engineers

Periods/week Credits	Max. Marks 200
L :2 T: 0 2.0	Continuous Assessment 100
Duration of Exam: 3 Hrs	End Term Examination : 100

Pre-Requisite: Nil
Course Type: Engineering Science Course

Course Outcomes: The Students will be able-
BCS-100A.1 To understand evolution of Artificial Intelligence.
BCS-100A.2 To familiarize with artificial intelligence problems and their formulations.
BCS-100A.3 To Understand Intelligent system, Agents & its environment.
BCS-100A.4 To understand applications of artificial intelligence.

Unit-1: AI Introduction, Background and History
Introduction to AI
Foundations of AI
AI Evolution
Introduction to AI programming languages

Unit-2: AI Problem Formulation
AI problem formulation
Problem characteristics
Production System
Production System characteristics

Unit 3: Intelligent System & Agents
Introduction to intelligence system
Types of Intelligence
Difference between Human and Machine learning
Introduction to Agent & environment
Structure of Intelligent Agent
Nature and Properties of Environment.

Unit-4: AI Applications
Robotics
Natural Language Processing
4.3Computer Vision
Health Care
Education
Expert System

Text Books / Reference Books:

1. Elain Rich and Kevin Knight (2009), Artificial Intelligence, 3rdedition, Tata McGraw Hill.
2. Stuart J.Russel and Peter Norvig (2009), Artificial Intelligence-A modern approach: 3rd edition, Pearson.
3. Patrick Henry Winston (1992), Artificial Intelligence , 3rdedition, , Pearson.

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4. George F Luger, (2009), Artificial Intelligence :Structures and Strategies for Complex Problem Solving , University of New Mexico,6th edition, Pearson.
5. V S Janakiraman, Parerback (2005), Foundations of Artificial Intelligence And Expert Systems : 3rd edition, Macmillan India Limited

Software required/Weblinks:
http://artint.info/html/ArtInt_351.html
http://www.tutorialspoint.com/artificial_intelligence/
http://www.compinfo-center.com/tpai-t.htm

Instructions for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each Part A and Part B (one from each unit) Student needs to attempt two questions out of three from each part. Each question will be of 20 marks.

Assessment Tools:
Assignment/Tutorials
Sessional tests
Surprise questions during lectures/Class Performance
Term end examination

COURSE ARTICULATION MATRIX:

CO Statement (BCS-100A)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
BCS-100A.1	2	2	1	2									2	2	3
BCS-100A.2	2	3	2	3									2	2	3
BCS-100A.3	3	2	2	2									3	3	3
BCS-100A.4	3	3	2	3									2	3	3

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BHM-MC-001: CONSTITUTION OF INDIA

Periods/week Credits	Max. Marks 100
L:0 T:1 P: 0 AP	Continuous Assessment : 50
Duration of Examination: 2 Hrs	End Semester Examination: 50

Course Type: HSMC

1. Background: India's struggle for independence, Formation of the Constituent Assembly, The Union and its Territory : Nomenclature, Formation of New States and Alteration of Areas, Citizenship : Citizenship at the Commencement of the Constitution, Rights of Citizenship of certain persons, Rights of Citizenship of certain persons of Indian origin residing outside India, Continuance of the rights of Citizenship, Parliament to regulate the right of the Citizenship by law.

2. Fundamental Rights and Directive Principles : Definition, Laws inconsistent with or in derogation of the Fundamental Rights, Equality before law, Prohibition of discrimination on grounds of religion, race, caste, sex or place of birth, Equality of opportunity in matters of public employment, Abolition of untouchability, Abolition of Titles- Right to Freedom, Right against Exploitation, Right to freedom of religion, Cultural and Educational rights, Right to constitutional remedies, Directive principles of State Policy : Definition, Right to work, Right to education and to public assistance in certain cases, provisions for just and humane condition of work and maternity relief, uniform civil code for the citizens, protection and improvement of environment and safeguarding of forests and wildlife, protection of monuments and places and objects of national importance, separation of judiciary from executive, promotion of international peace and security and Fundamental Duties.

3. The Union: The executive, The President and Vice President of India, Council of Ministers, Attorney General for India, Parliament, Legislative procedure, The Union Judiciary: Establishment and constitution of Supreme Court, Powers and Functions of Supreme Court, Original Jurisdiction of the Supreme Court, The States : Definition, The Governor, Council of Ministers, The Advocate General for the State, The State Legislature, Legislative Procedure, High Courts in the State, The Union Territories, The Panchayats, Municipalities, Relations between the Union and the States.

4. Services under the Union and the States: Services, Public Service Commissions, Elections: Election Commission of India, Emergency Provisions : Proclamation of Emergency, Amendment of the Constitution, Temporary, Transitional and Special Provisions, Schedules : First to Tenth Schedule and Miscellaneous.

Distribution of Continuous Assessment:

Sessional- I	30%
Sessional- II	30%
Class Work/ Performance	20%
Attendance	20%

IInd Semester

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BCH-106: CHEMISTRY FOR ENGINEERS

Periods/week	Credits	Max. Marks	: 200
L: 2 T: 0	2	Continuous Evaluation	: 100
Duration of Examination: 3 Hrs		End Term Examination	: 100

Pre-requisite: Basic knowledge of 10+2 level Chemistry
Course Type: Basic Sciences

Course Outcomes: The course will enable the student to-

BCH-106.1. Apply fundamental principles to predict the structure, stereochemistry, bonding and general properties of materials.

BCH-106.2.Predict potential applications and practical utility of chemistry in different areas and propose suitable analytical techniques for practical applications.

BCH-106.3. Develop the understanding of water treatment techniques, electrochemical cells and combustion technology.

Unit 1: Water Treatment Chemistry (5 Lectures)
Impurities in water, Drinking Water quality standards, Hardness, types and its determination by EDTA method, Alkalinity and its determination, numerical problems based on hardness & alkalinity, Water softening methods: zeolite, ion-exchange process, Desalination of water: Reverse osmosis (RO) & Electro-dialysis process

Unit 2: Electrochemical cells and Fuels (5 Lectures)
Basic concepts of cells, Primary cells, Secondary cells and batteries, Fuel cells, Fuels and their types, Combustion technology

Unit 3: Phase Rule and its applications (4 Lectures)
3.1 Terminology of Gibb's phase rule and problems based on phase rule equation, One component system (water), Two component Eutectic system (Pb-Ag), Industrial applications of phase diagrams

Unit 4: Atomic and molecular structure (5 Lectures)
Limitations of classical mechanics in treating atomic and molecular phenomena, Schrodinger equation, Particle in a box solution and their applications for conjugated molecules and nanoparticles, Molecular orbital treatment for homo-nuclear diatomic molecules, Bonding in Coordination Compounds: Crystal field theory

Unit-5: Stereochemistry (4 Lectures)
Structural isomers and stereoisomers, Representations of 3 dimensional structures, Enantiomers, diastereomers, Absolute configurations and conformational analysis

Unit6: Analytical Techniques(5 Lectures)
Basic Principles of spectroscopy, UV- VIS spectroscopy and its applications, IR spectroscopy and its applications, Principle and analytical applications of Atomic Absorption spectroscopy, brief overview of Inductively coupled plasma mass spectrometry

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Text Books/ Reference books/Web references:

1. P. C. Jain and Monica Jain, Engineering Chemistry, 2017, Dhanpat Rai Publishing Company.
2. Prasanta Rath, SubhenduChakroborty, Chemistry, 2018, Cengage Learning Publishers.
3. B. H. Mahan,2010, University Chemistry, Pearson Education.
4. C. N. Banwell, 2008, Fundamentals of Molecular Spectroscopy, McGraw Hill Education India.
5. GourkrishnaDasmohapatra, 2019, Chemistry-I, Vikas Publishing.
6. https://nptel.ac.in/courses/103/108/103108138/
7. https://nptel.ac.in/courses/122/101/122101001/

Distribution of Continuous Evaluation:

Sessional-I	30%
Sessional-II	30%
Assignment/Tutorial	20%
Class Work/ Quiz	20%

Evaluation Tools:

Assignment/Tutorials
Sessional tests
Surprise questions during lectures/Class Performance
Term end examination

Assignments, Sessional and End Semester Examination paper will consist of various difficulty levels to accommodate the different capabilities of students. Assessment should cover all course outcomes and upper limit for lower order skills will be 40% (for knowledge-oriented questions). However, weightage for different cognitive levels in the question papers can vary.

Instructions for paper setting: The paper setter must ensure the coverage of entire syllabus while setting the question papers and mention the learning outcomes across each section to be measured by the examination. Weightage of the sections may vary as per the number of respective lecture hours mentioned in the syllabus.Action verbs should be used from Bloom's Taxonomy while designing question papers.

Course articulation Matrix

CO Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BCH-106.1	3	3	1	-	1	-	-	-	-	-	-	2
BCH-106.2	3	3	2	-	2	2	2	-	-	-	-	2
BCH-106.3	3	3	2	-	2	2	2	-	-	-	-	2

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BMA-202: MATHEMATICS-2

(Calculus, ordinary Differential Equations and Complex variables)

Periods/week	Credits	Max. Marks	200
L: 3 T: 1	4	Continuous Assessment :	100
Duration of Examination: 3 Hrs		End Semester Examination:	100

Pre-requisites: The students must have the knowledge of mathematical concepts of Intermediate level and Mathematics-1.

Course Type: Basic Sciences

Course Outcomes:

The objective of this course is to familiarize the prospective engineers with techniques in multivariate integration, ordinary and partial differential equations and complex variables. It aims to equip the students to deal with advanced level of mathematics and applications that would be essential for their disciplines. More precisely, the outcomes are:

BMA-202.1 Students will be able to recognize the application of mathematics in engineering.

BMA-202.2 Students will be able to describe the knowledge of multiple Integration and Differentiation in the field of complex functions.

BMA-202.3 Students will be able to demonstrate the concepts of differential equations of higher order.

BMA-202.4 Students will be able to distinguish between real and complex functions.

BMA-202.5 Students will be able to interpret the concept of complex integration for those functions which are not defined on real line.

BMA-202.6 Students will be able to evaluate improper integrals using complex integration.

PART-A

Unit 1: Multivariable Calculus (Integration)

Multiple Integration: Double integrals (Cartesian), change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: areas and volumes, Center of mass and Gravity (constant and variable densities), Triple integrals (Cartesian), orthogonal curvilinear coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds, Scalar line integrals, vector line integrals, scalar surface integrals, vector surface integrals, theorems of Green, Gauss and Stokes.

Unit 2: First Order Ordinary Differential Equations

Exact, linear and Bernoulli's equations, Euler's equations, Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type.

Unit 3: Ordinary Differential Equations of Higher Orders

Second order linear differential equations with variable coefficients, method of variation of parameters, Cauchy-Euler equation, Power series solutions; Legendre polynomials, Bessel functions of the first kind and their properties.

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PART-B

Unit 4: Complex Variable – Differentiation

Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate, elementary analytic functions (exponential, trigonometric, logarithm) and their properties, Conformal mappings, Mobius transformations and their properties.

Unit 5: Complex Variable – Integration

Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy Integral formula (without proof), Liouville's theorem and Maximum-Modulus theorem (without proof), Taylor's series, zeros of analytic functions, singularities, Laurent's series, Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral involving sine and cosine, Evaluation of certain improper integrals using the Bromwich contour.

Suggested Text/Reference Books

1. G.B. Thomas and R.L. Finney, 2002, Calculus and Analytic geometry, 9th Edition, Pearson.
2. Erwin kreyszig, 2006, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons.
3. W. E. Boyce and R. C. DiPrima, 2009, Elementary Differential Equations and Boundary Value Problems, 9th Edn., Wiley India.
4. S. L. Ross, 1984, Differential Equations, 3rd Ed., Wiley India.
5. E. A. Coddington, 1995, An Introduction to Ordinary Differential Equations, Prentice Hall India.
6. E. L. Ince, 1958, Ordinary Differential Equations, Dover Publications.
7. J. W. Brown and R. V. Churchill, 2004, Complex Variables and Applications, 7th Ed., Mc-Graw Hill.
8. N.P. Bali and Manish Goyal, 2008, A text book of Engineering Mathematics, Laxmi Publications.
9. B.S. Grewal, 2010, Higher Engineering Mathematics, 36th Edition, Khanna Publishers.

Instructions for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each PART-A and PART-B. Student needs to attempt two questions out of three from each part. Each question will be of 20 marks.

Distribution of Continuous Assessment:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Assessment Tools:

Assignment/Tutorials.
Sessional tests.
Surprise questions during lectures/Class Performance.
End Term Examination.

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Course Articulation Matrix

CO Statement (BMA-202)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
BMA-202.1	3	3	2	2	2	--	--	--	--	--	--	2	--	--	--	--
BMA-202.2	3	3	2	2	2	--	--	--	--	--	--	1	--	--	--	--
BMA-202.3	3	3	2	2	3	--	--	--	--	--	--	2	--	--	--	--
BMA-202.4	2	2	3	1	2	--	--	--	--	--	--	1	--	--	--	--
BMA-202.5	3	3	2	2	3	--	--	--	--	--	--	2	--	--	--	--
BMA-202.6	3	3	1	2	2	--	--	--	--	--	--	2	--	--	--	--

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MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES

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BBT-100 BIOLOGY FOR ENGINEERS

Periods/week Credits	Max. Marks 200
L: 2 T: 0 P:0 02	Continuous Evaluation 100
Duration of Examination: 3 Hrs	End Semester Examination:100

Pre-requisites: Knowledge of 10+2 Science
Course Type: Basic Sciences

Course Outcomes:
The students will be able to-

BBT-100.1 describe the taxonomic diversity of life forms and their functions.
BBT-100.2 assess the role of biomolecules in physiology and genetics.
BBT-100.3 illustrate the structural and functional organization of the human body.
BBT-100. 4 apply the principles of biology for sustenance.

PART-A

Unit 1: The Living World

What is living World?
Diversity in the living world
Taxonomy and Biological Classification
Structural organization in plants and animals
Cell- The unit of Life

Unit 2: Microbiology

Microbial diversity, Ecology and Population dynamics, Microbial growth on surfaces Environmental effect on microbial growth.
Bioremediation, examples of bioremediation, Acid mine drainage, Enhanced metal recovery, Wastewater microbiology
Solid waste microbiology, Landfills, Leachate, Anaerobic degradation phases.
Antimicrobial resistance

PART-B

Unit 3: Biochemistry

Carbohydrates- monosaccharides, disaccharides and Polysaccharides,
Lipids- fatty acids, fats and oils, lipids of biological importance
Amino acids – essential and non-essential amino acids, peptide bond formation
Proteins- overview of proteins synthesis, structural organization, functions of proteins
Nucleic acids- structure and functions of DNA and RNA.
Enzymes: role as biological catalysts,Mechanism of enzyme action, Industrial applications of enzymes

Unit 4: Human Anatomy

General Anatomy- Basic terms in anatomy- Anterior, posterior, lateral, medial, Elementary tissues of the human body
Cardiovascular system, Respiratory System

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Gastrointestinal System, Genito-urinary system
Musculoskeletal system, Nervous system& Sense organs
Endocrine System

Unit 5: Human Physiology

Body fluids and salts, composition and functions of blood, Blood groups, blood clotting

Cardiac cycle and heart sounds, Electrocardiogram (ECG), Blood pressure, Hypertension, Hypotension, Arteriosclerosis, Atherosclerosis, Angina, Myocardial infarction, Congestive heart failure and cardiac arrhythmias

Respiratory volumes and capacities, Hypoxia, Asphyxia
Disorders of GIT, Endocrine disorders
Microbial infections, Cancer

Unit 6: Genetics & Computational Approach to Biology

Genetics- DNA as a blueprint and RNA as a messenger, from DNA sequence to Genes (From alphabets to words), Mendelian Inheritance

DNA to Chromosomes- Genes and Mutations, Information pathways – Replication, Transcription and Translation, Epigenetic Modifications.

Computational Approach to Biology- Finding a needle in the haystack – Making sense of the Big Data,Types of Biological Datasets.

The "Omics" Approach, Introduction to Network Biology - Basics of Graph and Network Theory, Cellular Networks.

Text/ Reference Books:

1) Biology: A global approach: Campbell, N. A.; Reece, J. B.; Urry, Lisa; Cain, M,L.; Wasserman, S. A.; Minorsky, P. V.; Jackson, R. B. Pearson Education Ltd
2) Outlines of Biochemistry, Conn, E.E; Stumpf, P.K; Bruening, G; Doi, R.H., John Wileyand Sons
3) Principles of Biochemistry (V Edition), By Nelson, D. L.; and Cox, M. M.W.H. Freemanand Company
4) Molecular Genetics (Second edition), Stent, G. S.; and Calender, R.W.H. Freeman andcompany, Distributed by Satish Kumar Jain for CBS Publisher
5) Microbiology, Prescott, L.M J.P. Harley and C.A. Klein 1995. 2nd edition Wm, C.Brown Publishers.

Instructions for paper setting: Seven questions are to be set in total. First question will be conceptual covering the entire syllabus and will be compulsory to attempt. Three questions will be set from each PART-A and PART-B (one from each Unit). Students need to attempt two questions out of three from each part. Each question will be of 20 marks.

Continuous Evaluation:

Sessional-I 30%
Sessional-II 30%
Assignment/Tutorial 20%
Class Work/ Quiz 20%

Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
BBT-100.1	2	1	1	-	-	1	1	-	-	-	3	2				
BBT-100.2	3	2	2	-	-	2	2	-	-	-	3	3				
BBT-100.3	3	3	3	-	-	3	3	-	-	-	3	3				
BBT-100.4	3	3	3	-	-	3	3	-	-	-	3	3				

MITS

MANAV RACHNA INTERNATIONAL INSTITUE OF RESEARCH & STUDIES
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NAAC 'A' Grade University

BCH-151A: CHEMISTRY LAB

Periods/week Credits	Max. Marks : 100
P: 2 1	Continuous Evaluation : 50
Duration of Examination: 2 Hrs	End Term Examination : 50

Pre-requisite: Basic knowledge of 10+2 level Chemistry
Course Type: Basic Sciences Courses

Course Outcomes: The students will be able to:

BCH-151A.1. analyze the need and utility of the experiments.
BCH-151A.2. do precise quantitative measurements using volumetric glassware, analytical balance, and prepare standards solutions independently.
BCH-151A.3. carry out experiments to check the hardness, alkalinity and chloride content of different water samples and interpret the results.
BCH-151A.4. employ the basic methods/techniques to measure surface tension, viscosity, conductance, emf, saponification value of different samples.

List of Experiments:

1. Preparation and standardization of volumetric solutions.
2. Determination of viscosity using Ostwald Viscometer.
3. Determination of hardness of water by EDTA method.
4. Determination of alkalinity of water.
5. Determination of strength of solution by Conductometric titration.
6. Determination of Ferrous ion concentration using Potentiometer.
7. Determine the percentage composition of given mixture of sodium hydroxide and sodium chloride.
8. Determination of viscosity of lubricating oils using Redwood viscometers.
9. Determination of chloride content of water.
10. Determination of surface tension using Stalagmometer.
11. Determination of saponification value of oils.
12. Determination of the partition coefficient of a substance between two immiscible liquids.

Text Books/ Reference books/Web references:

1, Sunita Rattan, 2011, Experiments in Applied Chemistry, S.K.Kataria& sons.
2. Shailendra K.Sinha,2014, Physical Chemistry A Laboratory Manual, Alpha Science International Limited.
3. https://vlab.amrita.edu/index.php?sub=2&brch=190
4.https://vlab.amrita.edu/index.php?sub=2&brch=193&sim=575&cnt=1

Instructions for Exam: One experiment out of 10 given randomly needs to be performed in exams.

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Distribution of Continuous Evaluation:

Viva-I	30%
Viva-II	30%
File/Records	20%
Class Work/ Performance	20%

Evaluation Tools:
Experiments in lab
File work/Class Performance
Viva (Question and answers in lab)
End Term Practical Exam

Course articulation Matrix

CO Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BCH-151A.1	3	3	2	1	1	-	1	1	1	1	-	2
BCH-151A.2	3	3	2	1	2	-	1	1	1	1	-	2
BCH-151A.3	3	3	2	1	2	-	2	1	1	1	-	2
BCH-151A.4	3	3	2	1	1	-	1	1	1	1	-	2

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BHM-151: ENGLISH LAB

(Humanities and Social Sciences including Management Courses)

Periods/week Credits
L: 0 T:0 P:2 1
Duration of Exam: 2 Hours

Max. Marks: 100
Continuous Assessment: 50
End Semester Examination: 50

Prerequisites: Basic knowledge of English language
Course Type: HSMC

Course Outcomes:

BHM-151.1. Students would be able to speak in English confidently.
BHM-151.2. To develop the understanding of correct pronunciation and intonation.
BHM-151.3. Students would be able to communicate professionally in a corporate environment.

List of Activities

1. Listening exercises for correct pronunciation and intonation
2.Role plays for speaking confidently
1. Group Discussions
2. Extempore
3. Mock Interviews
4. In Class Presentations
5. JAM Sessions
6. Theatre activity

Text Books/Reference Books:

1. Liz Hamp-Lyons and Ben Heasly, 2006, Study Writing, Cambridge University Press.
2. Sanjay Kumar and PushpLata, 2011, Communication Skills,. Oxford University Press.
3. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press.

Instructions for Exam: Every student needs to complete 5activities in a semester. One activity out of 5 randomly needs to be performed in exams.

Distribution of Continuous Assessment:

Viva- I	30%
Viva- II	30%
File/Records	20%
Class Work/ Performance	10%
Attendance	10%

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BCH-MC-002: ENVIRONMENTAL SCIENCE

Periods/week
T: 1

Max. Marks: 100
Continuous Assessment : 50
End Semester Examination : 50

Pre-requisite: Basic knowledge of Environment related issues
Course Type: Mandatory

Pre-requisite: Basic knowledge of Environment related issues
Course Type: Mandatory
Course Outcomes : The students will be able to
BCH-MC-002.1: comprehend various environmental issues through various activities.
BCH-MC-002.2: understand that each and every action of ours reflects on the environment and collaborate in groups to suggest innovative ways to protect environment through project work/report writing.

Activities:

i) Small group meetings about conservation and management of natural resources, conservation of biodiversity, solid waste management and environmental remediation
ii) Visit to a local polluted site-Urban/Rural/Industrial/Agricultural
iii) Expert talk
iv) Sloganwriting/Poster making event
v) Cycle rally to create awareness on issues like pollution control, cleanliness, and waste management.
vi)Plantation activity
vii) Cleanliness drive
viii) Drive for segregation of waste
ix)Visit to an area to document environmental assets: river/ forest/ flora/fauna, etc.
x) Environment protection related efforts

Distribution of Continuous Assessment:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

The break-up for marks

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Continuous assessment Marks

Evaluation based on participation in activities: 50 marks

External Marks

Field work, Report writing & Viva: 20+20+10 = 50 marks

Course Articulation Matrix

CO Statement (BCH-MC-002)	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
BCH-MC-002.1	1	2	1	-	-	2	3	2	1	-	-	1	-	-	-	-
BCH-MC-002.2	1	2	1	-	-	2	3	2	1	-	-	1	-	-	-	-

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NAAC 'A' Grade University

BCS-101A: PROGRAMMING FOR PROBLEM SOLVING

Periods/week	Credits	Max. Marks : 200
L :3 T: 0	3.0	Continuous Evaluation : 100
Duration of Exam: 3 Hrs		End Term Examination : 100

Pre-Requisite: Basic Knowledge of Computers
Course Type: Program Core

Course Outcomes: The students will be able to-
BCS-101A.1. Formulate simple algorithms for arithmetic and logical problems with correct logic.
BCS-101A.2. Implement the conditional statement and ietration with understanding of concepts.
BCS-101A.3. Decompose a problem into functions and able to understand use of functions.
BCS-101A.4. Apply advance C programming techniques such as arrays, pointers, dynamic memory allocation, structures to develop solutions for particular problems.

PART- A

Unit-1: Introduction to Programming

Introduction to programming

Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.)

Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/ Pseudo code with examples.

From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code.

Expressions, Precedence and Associatively, Expression Evaluation, Type conversions

Unit-2: Loops and Conditional Statements

Arithmetic expressions and precedence
Conditional Branching; Writing and evaluation of conditionals and consequent branching
Iteration and loops

Unit-3: Arrays and Structures

3.1 Arrays (1-D, 2-D):1 D array and function–Passing individual array elements to a function,
3.2 passing individual array elements address to a function,
passing whole 1d array to a function, 2D array and function,
Passing individual array elements to a function, passing individual array elements address to a function,
passing whole 2d array to a function
Character Arrays and Strings
Structures; Defining Structures
Array of Structures

PART –B

Unit-4: Functions

Functions (including using built in libraries)
Parameter passing in functions
call by value.
Passing arrays to functions: idea of call by reference
Recursion, as a different way of solving problems.

Example programs, such as Finding Factorial, Fibonacci series.

Unit-5: Basic Algorithms

Iterative Searching (Linear and Binary Search)
Basic Sorting Algorithms with implementation (Bubble, Insertion and Selection)
Finding roots of equations
Notion of order of complexity through example programs (no formal definition required)

Unit-6: Pointers and File Handling

6.1 Idea of pointers, Defining pointers,Pointer to an array,
6.2 Array of pointers,Pointers and two dimensional arrays
Use of Pointers in self-referential structures
Notion of linked list (no implementation)
File Handling :Working with text files and Binary Files,
File operations using std. library and system calls–File management I/O functions

Text Books / Reference Books:

1. Byron Gottfried, 2015, Schaum's Outline of Programming with C: 2nd Ed., McGraw-Hill.
2. E. Balaguruswamy, 1998, Programming in ANSI C: 2nd Ed., Tata McGraw-Hill.
3. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language:, 2nd Ed., PHI.

Software required/Weblinks:

Turbo C
www.tutorialpoint.com
www.nptel.com
www.w3schools.com

Instructions for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each Part A and Part B (one from each unit) Student needs to attempt two questions out of three from each part. Each question will be of 20 marks.

Distribution of Continuous Evaluation:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Quiz	20%

Evaluation Tools:

Assignment/Tutorials
Sessional tests
Surprise questions during lectures/Class Performance
Term end examination

COURSE ARTICULATION MATRIX :

CO Statement (BCS-101A)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
BCS-101A.1	2	3	2	-	2	-	-	-	-	-	-	3	1	1	-
BCS-101A.2	2	1	2	1	3	-	-	-	-	-	-	-	-	1	1
BCS-101A.3	-	1	2	-	1	2	-	-	-	-	-	1	3	2	1
BCS-101A.4	3	3	1	3	2	-	-	-	-	-	-	-	3	1	2

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NAAC 'A' Grade University

BCS-151A: PROGRAMMING FOR PROBLEM SOLVING LAB

Periods/week	Credits	Max. Marks	100
P :2	1.0	Continuous Evaluation	50
Duration of Exam: 2 Hrs		End Term Examination	50

Co-Requisite: Programming for problem solving (BCS-101A)
Course Type: Program Core

Course Outcomes: Students will be able to-

BCS-151A.1. Formulate the algorithms for simple problems in C language.
BCS-151A.2. Understanding of syntax errors as reported by the compilers as well as logical errors.
BCS-151A.3. Write iterative as well as recursive programs,implementing of arrays, strings and structures and various graph traversing algorithms.
BCS-151A.4. Declare pointers of different types and able to understand the concept of file handling.

NOTE: The laboratory should be preceded or followed by a tutorial to explain the approach or algorithm to be implemented for the problem given.

List of Practicals:
Tutorial 1: Problem solving using computers:
Lab1: Familiarization with programming environment
Tutorial 2: Variable types and type conversions:
Lab 2: Simple computational problems using arithmetic expressions
Tutorial 3: Branching and logical expressions:
Lab 3: Problems involving if-then-else structures
Tutorial 4: Loops, while and for loops:
Lab 4: Iterative problems e.g., sum of series
Tutorial 5: 1D Arrays: searching, sorting:
Lab 5: 1D Array manipulation
Tutorial 6: 2D arrays and Strings
Lab 6: Matrix problems, String operations
Tutorial 7: Functions, call by value,call by refrence
Lab 7: Simple functions
Tutorial 8: Recursion, structure of recursive calls
Lab 8: Recursive functions
Tutorial 9: Numerical methods (Root finding, numerical differentiation, numerical integration):
Lab 9: Programming for solving Numerical methods problems
Tutorial 10: Pointers, structures and dynamic memory allocation
Lab 10: Pointers and structures
Tutorial 11: File handling
Lab 11: File operations

Software required/Weblinks:
Turbo C

www.tutorialpoint.com
www.nptel.com
www.w3schools.com

Note: At least 5 more exercises to be given by the teacher concerned.

Distribution of Continuous Evaluation:

Viva- I	30%
Viva- II	30%
File/Records	20%
Class Work/ Performance	20%

Evaluation Tools:
Experiments in lab
File work/Class Performance
Viva (Question and answers in lab)
End Term Practical Exam

COURSE ARTICULATION MATRIX :

CO Statement (BCS-151A)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
BCS-151A.1	2	1	2	2	-	-	-	-	-	-	2	1	2	-	1
BCS-151A.2	3	-	-	3	2	-	-	-	-	-	-	-	2	3	3
BCS-151A.3	3	1	2	3	-	1	-	-	-	-	-	-	1	2	-
BCS-151A.4	2	3	1	2	3	-	-	-	-	-	1	1	3	2	-

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IIIrd Semester

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BME-DS-301A: ENGINEERING MECHANICS

Periods/week Credits
L: 3 T: 1 P: 0 4
Duration of Examination: 3 Hrs

Max. Marks : 200
Continuous Assessment : 100
End Semester Exam : 100

Prerequisites: BPH-101: Physics, BMA-102: Mathematics-I
Course Type: Engineering Science Course
Course Outcomes:
After completion of this course the students will be able to
BME-DS-301A.1: Memorize vector theory, laws of mechanics, force systems and apply mathematics to obtain analytical solutions relevant to engineering mechanics
BME-DS-301A.2: Examine static structures while applying the concept of free body diagram and analyze the various application of friction.
BME-DS-301A.3: Analyze the structures like beams, trusses and frames by using the principle of statics and compute the centroid and moment of inertia for different types of section.
BME-DS-301A.4: Apply the principles of dynamics to solve engineering problems of particles and rigid bodies."

Part-A

Unit 1: Introduction to Force System

Forces and Force System: Introduction to vector- Vector algebra, Law of mechanics, Classification of force systems-principle of transmissibility of a force Composition and resolution-Resultant of a coplanar force systems, Moment of a force, couple, properties of couple-Varignon's theorem, Concurrent and parallel forces

Unit 2: Equilibrium; Friction

Equilibrium: Free body diagram, free bodies involving interior sections, general equations of equilibrium, problems of equilibrium, static indeterminacy. Friction: Introduction, Laws of friction, Types of friction-Ladder friction, Wedge friction, Collar friction Application of Friction In Simple Lifting Machine, Belt and Pulley Arrangement and Screw Jack.

Unit 3: Properties of surfaces:

Centroid of simple and composite areas-Theorems of Pappus and Guldinus. Moment of inertia of areas, Parallel and perpendicular axes theorems-Radius of Gyration, moment of inertia of simple and composite areas.

Part-B

Unit 4: Analysis of Structures:

Beam; Truss and Frames Beams: Introduction, Types of Beams, Support Reactions, Shear Force and Bending Moment Diagram for Simply Supported, Overhanging and Cantilever Beam, Point of Contra-flexure. Plane trusses and frames: Statically determinate trusses; Analysis of Forces in Trusses and Frame -Method of joints, Method of section.

Unit 5: Dynamics of Particles

Kinematics of Particles :Differential equations of kinematics; Cartesian coordinate system; Normal and tangent co-ordinate system, velocity and acceleration in terms of cylindrical coordinates, projectile motion. Kinetics of Particles: Kinetics of rectilinear and curvilinear motion, D'Alemberts Principle, Principle of impulse and momentum, Work, energy and power, Direct and oblique collision..

Unit 6: Dynamics of Rigid Bodies

Kinematic of rigid bodies: Translation and fixed axis rotation, General Plane motion: velocity, acceleration, Instantaneous centre of rotation, Motion of rigid body in space. Kinetic of rigid bodies: Force and acceleration, Energy methods for a rigid body, momentum method for a rigid body. Motion of a rigid body in 3-D, Motion of a gyroscope.

Text Books:

1. R. C. Hibbeler " Engineering Mechanics, Statics & Dynamics" Pearson's
2. S. S. Bhavikatti "Engineering Mechanics", New Age International Publishers.
3. Ferdinand P. Beer, E. Russell Johnston, Jr, David F. Mazurek, Phillip J. Cornwell, Brian P. Self, "Vector Mechanics for Engineers, Statics & Dynamics", Mc Graw Hill Education.
4. Kumar, K.L., "Engineering Mechanics", Tata McGraw-Hill Publishing company

Reference Books:

1. Manoj K. Harbola , "Engineering Mechanics", Cengage Learning.
2. J. L. Meriam and L. G. Kraige, "Engineering Mechanics", Wiley Publication.
3. Irving H. Shames and Krishna Mohana Rao. G., "Engineering Mechanics – Statics and Dynamics", Pearson Education
4. M. F. Beatty, "Principles of Engineering Mechanics", Springer Science & Business Media

Weblinks:

https://nptel.ac.in/courses/122104015
https://nptel.ac.in/courses/112103109
https://onlinecourses.nptel.ac.in/noc19_me01/preview

Instructions for setting of Paper Seven questions are to set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each part A and part B (one from each unit). Student needs to attempt two questions out of three questions from each part. Each question will be of 20 marks.

Assessment Tools:
In general parameters for Internal /Continuous Assessment (Theory Courses):

Parameter	Weightage
Two Sessional (Mid-Term)Tests	60%
Assignments	20%
Class Performance	10%

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Class Attendance	10%

Theory Course: Total Marks 200
Internal/Continuous Assessment: 100

- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
BME-DS-301A.1	3	2	2	2	3	2	3	1	1	-	2	-	3	3	2
BME-DS-301A.2	3	3	3	3	3	2	2	2	1	2	-	1	3	3	1
BME-DS-301A.3	2	2	3	3	3	2	2	3	1	1	-	2	3	3	2
BME-DS-301A.4	3	3	3	2	3	3	3	3	3	2	3	3	3	3	1

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BME-DS-302: THERMODYNAMICS

Periods/week Credits	Max. Marks : 200
L: 4 T: 0 P: 0 4	Continuous Assessment : 100
Duration of Examination: 3 Hrs	End Semester Exam : 100

Prerequisites BPH-101: Physics, BMA-102: Mathematics-I
Course Type: Professional Core Course

Course Outcomes:
After completion of this course the students will be able to

BME-DS-302.1 Remember the basic theory of thermodynamics, various relative laws, entropy and various thermodynamic cycles.

BME-DS-302.2 Understand the various concepts of thermodynamic laws , develop and design various devices based on laws of thermodynamics and their applications.

BME-DS-302.3 Apply the acquired knowledge of basic concepts of thermodynamics in situation involving heat and work interaction, change in property of substances & energy performance of devices

BME-DS-302.4 Compare and discuss various cycles, laws and relevant properties of thermodynamics.

Part-A

Unit 1: Introduction to Thermodynamics

Fundamentals - System & Control volume; Property, State & Process; Exact & Inexact differentials; Work- Thermodynamic definition of work; examples; Displacement work; Path dependence of displacement work and illustrations for simple processes; Temperature, Definition of thermal equilibrium and Zeroth law; Temperature scales, Thermometric Property.

Unit 2: First Law of Thermodynamics

Definition of heat; examples of heat/work interaction in systems- First Law for Cyclic & Non-cyclic processes; Concept of total energy E ; Demonstration that E is a property; Various modes of energy, Internal energy and Enthalpy. First Law for Flow Processes - Derivation of general energy equation for a control volume; Steady state steady flow processes including throttling; Examples of steady flow devices; Unsteady processes.

Unit 3: Second Law of Thermodynamics

Second law - Definitions of direct and reverse heat engines; Definitions of thermal efficiency and COP; Kelvin-Planck and Clausius statements and their equivalence; Definition of reversible process; Internal and external irreversibility; Carnot cycle; Absolute temperature scale, Clausius inequality.

Part-B

Unit 4: Entropy, Available Energy and Energy

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Definition of entropy; Demonstration that entropy is a property; Evaluation for solids, liquids, ideal gases and ideal gas mixtures undergoing various processes; Determination of entropy from steam tables- principle of increase of entropy; Illustration of processes in T-S coordinates; Definition of isentropic efficiency for compressors, turbines and nozzles- Irreversibility and Availability, Availability function for systems and control volumes undergoing different processes, Lost work. Second law analysis of control volume. Third Law of Thermodynamics and concept of exergy

Unit 5: Pure Substance, Ideal and Real Gas

Definition of Pure substance, Ideal Gases and ideal gas mixtures, Real gases and real gas mixtures, Compressibility charts- Properties of two phase systems - Const. temperature and Const. pressure heating of water; Definitions of saturated states; P-v-T surface; Use of steam tables; Saturation tables; Superheated tables; Identification of states & determination of properties, Mollier's chart.

Unit 6: Basic Thermodynamic Cycles

Thermodynamic cycles - Basic Rankine cycle; Basic vapor compression cycle and comparison with Carnot cycle.

Text Books:

1. P. K Nag; Engineering Thermodynamics; Tata McGraw Hill Education Pvt. Ltd
2. Y. A. Cengel, M. A. Boles; Thermodynamics –An Engineering Approach; Tata McGraw Hill Education Pvt. Ltd.
3. D.S. Kumar, "Thermodynamics", Katson Publication
4. R.K. Rajput; "Thermal Engineering", Laxmi Publication

Reference Books:

1. Michael J. Moran, Howard N. Shapiro, Daisie D. Boettner, Margaret B. Bailey, "Principles of engineering thermodynamics", Wiley India publishers,
2. Sonntag, Van Wylen, G. J., "Fundamentals of Thermodynamics", John Wiley and Sons.
3. P.K. Nag, "Basic & Applied Thermodynamics", Tata McGraw-Hill Education Pvt. Ltd
4. M. David Burghardt, "Engineering Thermodynamics with Applications", Harper and Row Publications,

Weblinks:
https://nptel.ac.in/courses/112105123
https://nptel.ac.in/courses/112106133

Instructions for setting of Paper Seven questions are to set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each part A and part B (one from each unit). Student needs to attempt two questions out of three questions from each part. Each question will be of 20 marks.

Assessment Tools:
In general parameters for Internal /Continuous Assessment (Theory Courses):

Parameter	Weightage
Two Sessional (Mid-Term)Tests	60%

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Assignments	20%
Class Performance	10%
Class Attendance	10%

Theory Course: Total Marks 200
Internal/Continuous Assessment: 100

- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

Course Articulation Matrix

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
BME-DS-302.1	1	1	1	1	1	-	-	2	-	-	-	3	-	3	-
BME-DS-302.2	2	2	2	2	-	-	-	2	3	-	-	3	-	3	-
BME-DS-302.3	3	2	2	2	3	3	-	3	3	2	2	3	-	3	-
BME-DS-302.4	3	3	3	3	3	2	3	-	-	3	2	3	2	3	-

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MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH & STUDIES

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BME-DS-303: FLUID MECHANICS & MACHINES

Periods/week Credits	Max. Marks : 200
L: 4 T: 0 P: 0 4	Continuous Assessment : 100
Duration of Examination: 3 Hrs	End Semester Exam : 100

Prerequisites: BPH-101: Physics, BMA-102: Mathematics-I
Course Type: Professional Core Course

Course Outcomes:
After completion of this course the students will be able to
BME-DS-303.1 Define fluid properties, heads and efficiencies and also state various fluid laws.
BME-DS-303.2 Compare types of flow, understand mechanics of fluid at rest and in motion and also explain the type and working of hydraulic machines.
BME-DS-303.3 Apply principles of continuity, energy, & momentum and interpret the sketch of energy gradient lines and performance curves of hydraulic machines.
BME-DS-303.4 Evaluate parameters of fluid flow and also the performance parameters of turbines and pumps.

PART-A

Unit 1: Fluid Properties and Fluid Statics

Definition of fluid, Newton's law of viscosity, Units and dimensions-Properties of fluids, mass density, specific volume, specific gravity, viscosity, compressibility and surface tension; capillarity, Types of pressures, Manometers, , buoyant force, stability of floating and submerged bodies.

Unit 2: Fluid Kinematics and Fluid Dynamics

Flow characteristics: Steady and Unsteady flow, Uniform and Non-uniform flow, Laminar and Turbulant flow, Compressible and Incompressible flow, Rotational and Irrotational Flow, Concept of control volume, Continuity equation and its application, Energy equation and its application and Momentum equation.

Unit 3: Flow through pipes and Boundary Layer Flow

Hydraulic and energy gradient, Laminar flow through circular pipe and parallel plates, Major and minor losses in pipe flow, Compound pipes, Equivalent pipes. Boundary layer concepts, types of boundary layer thickness

PART-B

Unit 4: Hydraulic Turbines

Impact of jets, Euler's equation ,various heads and efficiencies, velocity components at entry and exit of the rotor, velocity triangles , Classification of turbines, Pelton wheel, Francis turbine and Kaplan turbines-

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working principles, work done by water on the runner, draft tube. Specific speed, unit quantities, performance curves for turbines, governing of turbines.

Unit 5: Hydraulic Pumps

Pumps classification, Centrifugal pumps working principle, work done by the impeller, performance curves, NPSH, Cavitations in pumps. Reciprocating pumps working principle, Slip, Air vessel.

Unit 6: Dimensional Numbers and Analysis

Need for dimensional analysis, methods of dimensional analysis, Similitude, types of similitude, Dimensionless parameters, application of dimensionless parameters, Model and Prototype analysis applied to Turbines and Pumps.

Text Books:

1. D.S. Kumar, "Fluid Mechanics & Fluid Power Engineering" Kataria& sons
2. R.K. Bansal " Fluid Mechanics & Hydraulic Machines" Laxmi Publications
3. P.N Modi. and S.M Seth, "Hydraulics and Fluid Mechanics", Standard Book House
4. F.M White, "Fluid Mechanics", Tata McGraw-Hills Publishing Company

Reference Books:

1. Yunus A Cengel, John M. Cimbala "Fluid Mechanics – Fundamentals and Applications" McGraw Hill Publication.
2. K. Subramanya "Hydraulic Machines" McGraw Hill Publication.
3. Fox and Pritchard, "Introduction to Fluid Mechanics", Wiley India
4. S.K. Som and G. Biswas, "Introduction to Fluid Mechanics and Fluid Machines", Tata McGraw-Hills Publishing Company

Weblinks:

https://nptel.ac.in/courses/112105171
https://nptel.ac.in/courses/112104118
https://nptel.ac.in/courses/112103249
https://nptel.ac.in/courses/112104117

Instructions for setting of Paper Seven questions are to set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each part A and part B (one from each unit). Student needs to attempt two questions out of three questions from each part. Each question will be of 20 marks.

Assessment Tools:

In general parameters for Internal /Continuous Assessment (Theory Courses):

Parameter	Weightage
Two Sessional (Mid-Term)Tests	60%
Assignments	20%
Class Performance	10%
Class Attendance	10%

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Theory Course: Total Marks 200

Internal/Continuous Assessment: 100

- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
BME-DS-303.1	**1**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**3**
BME-DS-303.2	**2**	**1**	**1**	**1**	**2**	**-**	**-**	**1**	**-**	**1**	**1**	**3**	**3**	**3**	**3**
BME-DS-303.3	**3**	**2**	**3**	**1**	**-**	**-**	**-**	**1**	**-**	**1**	**3**	**3**	**3**	**3**	**3**
BME-DS-303.4	**3**	**3**	**2**	**2**	**-**	**1**	**-**	**1**	**-**	**2**	**3**	**3**	**3**	**3**	**2**

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MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH & STUDIES

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BME-DS-304: MANUFACTURING PROCESSES

Periods/week	Credits	Max.	
L: 4 T: 0 P: 0	4		Marks : 200
Duration of Examination: 3 Hrs			Continuous Assessment : 100
			End Semester Exams 100

Prerequisites: BME-102: Workshop / Manufacturing Practices
Course Type: Professional Core Course

Course Outcomes:
After completion of this course the students will be able to

BME-DS-304.1 Understanding the science of engineering operations like foundry practices, forging of metals, sheet metal operations, joining processes, powder metallurgy and additive manufacturing

BME-DS-304.2 Classify and compare various metal forming and metal machining processes and identify machine equipment to be used in various manufacturing engineering applications.

BME-DS-304.3 Demonstrate various manufacturing processes to fabricate new products.

BME-DS-304.4 Select appropriate and apply knowledge to Manufacturing Processing with analytical calculations to manufacture engineering components for Industry Applications..

PART-A

Unit 1: Casting and Moulding

Metal casting processes and equipment, Heat transfer and solidification, shrinkage, riser design, casting defects and residual stresses.

Unit 2: Bulk Metal Forming Process

Fundamentals of hot and cold working processes; characteristics, advantages and disadvantages of metal forming. Rolling and its mechanism, hot and cold extrusions. Basic forging operations, press forging, drop forging, machine forging, cold forgings, defects of forging.

Unit 3: Sheet Metal Forming Process

Press operation, press working terminology, rating of press, types of dies, principle of metal cutting, cutting forces. Drawing dies: Calculation of blank size, deep drawing, number of draws, drawing force, blank holding pressure. Bending dies, bending methods, bending allowances, numerical.

PART-B

Unit 4: Additive Manufacturing

Rapid prototyping and rapid tooling, rapid manufacturing, direct and indirect A/M processes, classification on the basis of raw materials, processing techniques, metal additive manufacturing processes, application of A/M.

Unit 5: Powder Metallurgy

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Advantages and limitation of P/M, manufacturing of metal powders, metal powder characteristics, mixing and blending, compacting, sintering, secondary operation of P/M, application of P/M.

Unit 6: Joining Processes

Physics of welding, Arc welding electrodes, electrode coatings, coding of electrodes, types of electric arc welding, Resistance welding, Brazing and Soldering; Design considerations in welding, Solid and liquid state joining processes; Adhesive bonding.

Text Books:

1. B. S. Raghuwansi, "Workshop Technology-I", Dhanpat Rai Publication
2. P. N. Rao, "Manufacturing Technology-I & II", TMH Publication
3. P.C.Sharma, "A Textbook of Production Engineering", S.Chand Publication
4. A.Ghosh, A.K.Mallik, "Manufacturing Science", EWP Publication.

Reference Books:

1. Kalpakjian and Schmid, "Manufacturing processes for engineering materials", Pearson India
2. G.K. Lal, "Introduction to Machining Science", New Age International Publishers.
3. Mikell P. Groover, "Fundamentals of Modern Manufacturing: Materials, Processes, and Systems", Pearson Publication.
4. Degarmo, Black &Kohser, Materials and Processes in Manufacturing

Weblinks:

https://nptel.ac.in/courses/112107144
https://nptel.ac.in/courses/112104195

Instructions for setting of Paper Seven questions are to set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each part A and part B (one from each unit). Student needs to attempt two questions out of three questions from each part. Each question will be of 20 marks.

Assessment Tools:

In general parameters for Internal /Continuous Assessment (Theory Courses):

Parameter	Weightage
Two Sessional (Mid-Term)Tests	60%
Assignments	20%
Class Performance	10%
Class Attendance	10%

Theory Course: Total Marks 200
Internal/Continuous Assessment: 100

- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

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Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
BME-DS-304.1	3	1	-	2	-	1	2	-	-	-	1	-	3	1	-
BME-DS-304.2	3	2	-	-	-	2	1	-	-	-	1	-	3	1	-
BME-DS-304.3	3	-	2	2	1	2	2	1	-	1	2	1	2	2	1
BME-DS-304.4	3	3	3	3	2	-	-	1	-	1	2	1	3	3	-

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MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH & STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

BME-DS-351: ENGINEERING MECHANICS LAB

Periods/week	Credits	Max.	
L: 0 T: 0 P: 2	1		Marks : 100
Duration of Examination: 2 Hrs			Continuous Assessment : 50
			End Semester Exams : 50

Prerequisites:
Course Type: Engineering Science Course

Course Outcomes:
After completion of this course the students will be able to
BME-DS-351.1 Understand and verify the various laws of forces, law of moment and law of friction
BME-DS-351.2 Determine the shear force & bending moment in beams and forces in the members of a truss.
BME-DS-351.3 Examine stability of lifting machine like jib crane by applying the concept of mechanics.
BME-DS-351.4 Evaluate the mechanical advantage, velocity ratio and efficiency of various lifting machines.

List of Experiments:

1. To verify the parallelogram law of forces.
2. To verify the polygon law of forces.
3. To verify the principle of moments by using Bell crank Lever.
4. To verify the law of friction and to determine the coefficient of friction of glass surface.
5. To verify the law of friction and to determine the coefficient of friction of wooden surface.
6. To calculate the shear force and bending moment for a cantilever beam and simply supported beam.
7. To determine the forces in the members of a simply supported roof truss.
8. To determine the moment of inertia of circular disc.
9. To calculate the mechanical advantage, velocity ration and efficiency of a square thread screw jack.
10. To calculate the mechanical advantage, velocity ration and efficiency of pulley system.

Value Added Experiment:

1. To calculate the mechanical advantage, velocity ration and efficiency of a single start, double start and triple start worm and worm wheel.
2. To find the stability (force, tension & moment) of jib crane.
3. To calculate the mechanical advantage, velocity ratio and efficiency of double purchase winch crab.

Note:

1. 10 Experiments are to be performed in the semester.

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2. At least eight experiments should be performed from above list. Remaining two experiments may either be performed from the above list or designed & set as per the scope of the syllabus.

Assessment Tools:

In general parameters for Internal/Continuous Assessment (Lab/Practical Courses):

Parameter	Weightage
Two Mid-Term Viva	60%
File/Record Keeping	20%
Class Performance	10%
Class Attendance	10%

Lab/Practical Course: Total Marks 100
Internal/Continuous Assessment: 50

- Two Viva: 15 Marks Each
- File/Records: 10 Marks
- Class Work/ Performance: 5 Marks
- Attendance: 5 Marks

End Semester Exam: 50 Marks

Course Articulation Matrix

CO Statement	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
BME-DS-351.1	3	3	3	2	3	1	2	1	-	1	2	1	3	3	1
BME-DS-351.2	3	3	3	2	3	3	1	3	-	-	2	-	3	3	2
BME-DS-351.3	3	3	3	3	2	2	1	2	1	2	-	-	3	3	1
BME-DS-351.4	3	2	3	3	2	2	2	2	1	-	2	1	3	3	1

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MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH & STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

BME-DS-352: FLUID MECHANICS & MACHINE LAB

Periods/week Credits	Max. Marks: 100
L: 0 T: 0 P: 2	Continuous Assessment: 50
Duration of Examination: 2 Hrs	End Semester Exam: 50

Prerequisites:

Course Type: Professional Core Course

Course Outcomes:

After completion of this course the students will be able to

BME-DS-352.1 Conduct experiment with flow measurement devices like venturimeter and orifice meter and develop good understanding of concepts and their applications in the laboratory

BME-DS-352.2 Apply Bernoulli's Equation to determine the major and minor losses in fluid flow and flow characterization to sketch TEL and HGL..

BME-DS-352.3 Analyze the influence of variations of load on various performance parameters of Turbines.

BME-DS-352.4 Calculate & compare the efficiencies, performance characteristics for different turbines.

List of Experiments:

1. To determine the metacentric height of a floating body
2. To determine coefficient of discharge of an Orifice-meter and Venturimeter
3. To determine the major losses and minor losses for flow through circular pipe.
4. To verify the Bernoulli's Theorem and draw the TEL and HGL.
5. To find Reynold's number in a pipe flow and conclude the flow characteristic.
6. To determine the forces exerted by a jet on flat and hemispherical vane.
7. To study the model of hydroelectric power plant and draw its layout.
8. To determine the efficiency of Pelton Wheel
9. To determine the efficiency of Francis Turbine
10. To determine the efficiency of Kaplan Turbine
11. To determine the coefficient of discharge of Notch (V and rectangular Types)
12. To determine the coefficient of Discharge, Contraction & Velocity of an orifice and Mouthpiece.

Value Added Experiment

1. To determine the efficiency of gear oil pump
2. To develop a prototype of a micro hydel turbine

Note:

1. 10 Experiments are to be performed in the semester.

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2. At least eight experiments should be performed from above list. Remaining two experiments may either be performed from the above list or designed & set as per the scope of the syllabus.

Assessment Tools:

In general parameters for Internal/Continuous Assessment (Lab/Practical Courses):

Parameter	Weightage
Two Mid-Term Viva	60%
File/Record Keeping	20%
Class Performance	10%
Class Attendance	10%

Lab/Practical Course: Total Marks 100
Internal/Continuous Assessment: 50

- Two Viva: 15 Marks Each
- File/Records: 10 Marks
- Class Work/ Performance: 5 Marks
- Attendance: 5 Marks

End Semester Exam: 50 Marks

Course Articulation Matrix

CO Statement	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
BME-DS-352.1	1	1	-	1	-	-	-	2	2	1	1	3	3	3	1
BME-DS-352.2	2	1	-	2	2	-	-	3	3	2	2	3	3	3	2
BME-DS-352.3	3	2	1	3	2	-	-	3	3	2	3	3	3	3	2
BME-DS-352.4	3	2	1	3	-	-	1	3	3	3	3	3	3	3	2

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(Deemed to be University under section 3 of the UGC Act 1956)

BME-DS-353: CAD LAB

Periods/week Credits — Max. Marks : 100

L: 0 T: 0 P: 2 1 — Continuous Assessment

: 50 Duration of Examination: 2 Hrs — End Semester Exam : 50

Prerequisites: BME-101: Engineering Graphics & Design
Course Type: Professional Core Course

Course Outcomes:
After completion of this course the students will be able to

BME-DS-353.1 Understand the basic theories of graphics & design and CAD modeling packages.

BME-DS-353.2 Learn the different drafting techniques of mechanical parts and finding properties of material.

BME-DS-353.3 Model the 3-D geometric information of mechanical components including assemblies, and generation of detailing of drawings

BME-DS-353.4 Model the complex shapes by freeform curves and surfaces.

List of Experiments:

1. To study about the Modeling packages and their interfaces and basic concepts.
2. To study about the sketcher geometry and constrained model dimensioning.
3. To Create 3-d Modeling features (5 Exercises): a. Extrude: Direction 1, Direction 2, from option, Thin Feature, Applying Draft b. Revolve: Selecting Axis, Thin Features c. Sweep: Selecting profile and path, orientation/twist type, Path alignment, Start/End Tangency, Thin Features. d. Datum Planes and Axes, Curves, Points .
4. To Create 3-D modeling features (5 Exercises) Chamfer, Shell, Round, Hole, Rib, Draft, Pattern.
5. To Create 3-D modeling features (5 Exercises) using Blend, Boundary Blend, Swept Blend, Variable Section Sweep and Helical Sweep.
6. Modeling the flange coupling and assemble the parts and the mass properties of the final assembly.
7. Modeling the pipe vice and assemble the parts by using Creo -software and find the mass properties of the final assembly.
8. Modeling the bench vice assembly and assemble the parts find the mass properties of the final assembly.
9. Detailing of Drawing: Creating new drawing and its respective views, adding details of drawing, adding notes of drawing, creating reports (B.O.M.) .
10. Surface Modeling Tools (3 Exercises): Creating Extrude, Revolve, Swept, loft, Boundary surface.

Value Added Experiment

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1. Surface Modeling Features (3 Exercises) Replace Face, Delete face, Trim/Un-trim surface Thickening a surface, Move face.
2. Sheet-Metal Design (3 Exercises): Setting the Sheetmetal environment, Creating primary and secondary Sheetmetal, Wall features, Modifying Sheetmetal models, Sheetmetal Bends.

Note:

1. 10 Experiments are to be performed in the semester.
2. At least eight experiments should be performed from above list. Remaining two experiments may either be performed from the above list or designed & set as per the scope of the syllabus.

Assessment Tools:

In general parameters for Internal/Continuous Assessment (Lab/Practical Courses):

Parameter	Weightage
Two Mid-Term Viva	60%
File/Record Keeping	20%
Class Performance	10%
Class Attendance	10%

Lab/Practical Course: Total Marks 100
Internal/Continuous Assessment: 50

- Two Viva: 15 Marks Each
- File/Records: 10 Marks
- Class Work/ Performance: 5 Marks
- Attendance: 5 Marks

End Semester Exam: 50 Marks

Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
BME-DS-353.1	3	1	1	1	2	2	1	1	2	1	1	1	3	3	2
BME-DS-353.2	3	2	2	1	3	3	2	2	3	1	1	3	3	3	2
BME-DS-353.3	3	2	2	1	3	3	2	2	3	1	1	3	3	3	2
BME-DS-353.4	3	3	3	2	3	1	2	1	2	3	3	1	3	3	2

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MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)
NAAC 'A' Grade University

DTI -300: Design, Thinking and Innovation-I

Periods/week	Credits	Max. Marks	50
L:0 T:1 P:0	1	Continuous Assessment :	50

Pre-requisites: Nil
Course Type: Research & Training

Course Outcomes:
DTI300.1. To explore different sources for generating ideas for Research.
DTI300.2.To understand the problem classification based on domain specific resources.
DTI300.3. To realize the design thinking stages.
DTI300.4. Topresent critical analysis of literature survey.

Activity 1: Motivation
Divergent thinking and brain storming
Creative process

Activity 2: Introduction to Design Thinking
Empathize Mode
Discussions and deliberations
Define Mode
Ideate Mode
2.3.1Contemporary Relevance.
Tools and techniques for generating ideas
Idea Challenges

Activity 3: Problem Classification
Domain Classification.
Identification of Mentors

Activity 4: Problem identification
Literature survey and option analysis.
Feasibility study.
Formulation of problem statement.
4.4Expected Outcome / Model of the problem.
4.5 Planning Matrix

Activity5: Presenting the Ideation
Structuring and preparation of PPT
Review on presentation skills and content delivered
Incorporating the review comments.

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Course Articulation Matrix:

CO Statement (DTI-300)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
DTI 300.1	1	2	-	-	1	-	2	3	3	3	2	2	-	3
DTI 300.2	2	3	-	-	2	3	3	2	2	2	2	3	3	-
DTI 300.3	3	3	1	2	3	2	2	3	2	-	-	2	2	2
DTI 300.4	3	3	1	2	3	3	2	3	3	-	2	2	3	-

'3' (Tick) or 'More' Substantial/High Correlation, '2' Moderate/Medium Correlation, '1' Slightly/Low Correlation, 'Blank' No Correlation

Evaluation Criteria: The following evaluation parameters shall be considered for internal assessment by both research coordinators and faculty coordinator or research mentors:-

S. No:	Parameters	Description	Marks	
1.	**Attendance**	Percentage of classes attended by the students	**5**	**5**
2.	**Continuous Performance**	Group participation and response of the students to a given task:		**15**
		Judge individual student in the group	**5**	
		Meeting timelines as per activity plan	**10**	
3.	**Literature Review**	Student interaction with faculty mentors	**5**	**15**
		Relevance of the topic	**3**	
		Usage of Scientific Literature Databases. e.g., Scopus/ Web of Science/ etc.	**2**	
		Number of relevant papers / design referred for the given topic	**5**	
4.	**PPT & Report**	Report structure and Slide sequence	**5**	**15**
		Contribution of individual group member towards the presentation and report	**5**	
		Scientific/Technical writing	**5**	
		Max. Marks	**50**	**50**

References:

1. http://nptel.ac.in/courses/121106007/
2. http://public.wsu.edu/~taflinge/research.html

MITS

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH & STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

BHM-MC-004: QUANTITATIVE APTITUDE

Periods/week Credits	Max. Marks: 100
L:0 T:0 P :2 AP	Continuous Assessment: 50
Duration of Exam: 2 Hrs	End Semester Exam :50

Pre-requisites: Basic knowledge of mathematics
Course Type: HSMC
Course Outcomes:
After completion of the course the students will be able to
BHM-MC-004.1. Recognize problems based on arithmetic & number system.
BHM-MC-004.2. Solve problems based on verbal reasoning & simplification.
BHM-MC-004.3. Calculate the correct answers to the problems within given time.
BHM-MC-004.4. Plan their career meticulously by setting their time oriented goals.
BHM-MC-004.5. Introspect and enhance their personality.
BHM-MC-004.6. Develop cultural sensitivity and communicate respectfully across cultures.

PART – A

Unit 1: Number System 1

Vedic Mathematics
- Basic of mathematics
- Addition and subtraction using Vedic Mathematics
- Multiplication of two and three numbers.

Simplification
- BODMAS rule
- Fractions and recurring decimals
- Surds and indices

Numbers
- Types of numbers and number tree
- Divisibility Rule
- HCF & LCM

Unit 2: Verbal Reasoning 1

Direction Sense Test
Blood Relation Test

Unit 3: Arithmetic 1
Problem on Ages
Problem on Numbers
Averages

Part B

Unit 4: Career Planning
Career planningProcess - Self Assessment, Research, Decision Making, Action and Employability
Goal Setting: Relevance, SMART goals, The Dos & Don'ts

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Unit 5: Personality Enhancement

Emotional Intelligence: Emotional Self -Awareness, Self- Control, Emotional Management

Stress Management: What is Stress, Types of Stress, Stress Response Example, Vulnerability to Stress, Why do we Stress out, Stress Warning Symbols, Suggestions for Reducing Stress,

Time Management: Setting Priorities, Managing Time, Four Quadrants of Time Management

5.4. **Team Building:** Definition –Team, Characteristics of effective Teams, Competence, Clear and Compelling goal, Supportive Environment, Alignment, Designing the Team, Identifying Roles and Responsibilities, Determining Reward, Troubleshooting Guide, Good Team member

Unit 6: Effective Communication

Courtesy in Communication: Being Polite, Self -Discipline, Respecting Others and understanding other's perspective in communication

Inter cultural Communication: Breaking Stereotypes, Diversity Inclusion and Cultural Sensivity

Text Books/Reference Books:

1. Quantitative Aptitude for Competitive Examinations: R S Aggarwal, S Chand & Company Pvt Ltd, Edition 2017
2. A Modern Approach to Verbal & Non Verbal Reasoning: R S Aggarwal, S Chand & Company Pvt Ltd, Edition 2018
3. College to Career: The Student Guide to Career and Life Navigation by Mark A Griffin
4. Effective Communication in the Workplace by Anthony Gutierez

Instructions for paper setting: Fifty MCQ will be set in total. Twenty Five MCQ will be set from Part A and Twenty Five MCQ will be set from Part B. All questions will be compulsory. Each question will be of 1 mark. There will be no negative marking. Calculator will not be allowed.

Assessment Tools:

In general parameters for Internal /Continuous Assessment (Theory Courses):

Parameter	Weightage
Two Sessional (Mid-Term)Tests	60%
Assignments	20%
Class Performance	10%
Class Attendance	10%

Cours Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
BHM-MC-004.1	1	-	-	2	-	-	-	-	-	-	-	-	3	1	2
BHM-MC-004.2	1	-	-	-	-	1	-	-	-	-	-	1	1	-	-
BHM-MC-004.3	1	-	-	1	-	-	-	-	-	-	-	-	3	1	-
BHM-MC-004.4	-	-	-	-	-	-	-	1	-	-	-	1	3	-	-
BHM-MC-004.5	-	-	-	-	-	-	-	1	3	3	-	1	3	-	-
BHM-MC-004.6	-	-	-	-	-	-	-	1	2	3	-	1	1	1	1

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PROJ-ME-300A: SUMMER INTERNSHIP-I

Periods/week Credits — Max. Marks: 50
2 weeks 1 — Continuous Assessment: 50
Duration of Exam: 2 Hrs

Course Type: Internship

Course Outcomes:
After the completion of the course the students will be able to:
Proj-ME-300.1. Recognize the practical aspects of mechanical engineering.
Proj-ME-300.2. Understand the significance of skill enhancement in employability in industry.
Proj-ME-300.3. Apply the knowledge gained in the real life industrial problems.
Proj-ME-300.4. Analyze the problems and identify their root cause.
Proj-ME-300.5. Generate new ideas and innovative techniques for increasing the efficiency of the system.

Summer internship –I constitutes of in-house training to students after 2nd semester wherein internal faculty and material resources utilized to add value to students by training them on some software or new technology or advance course or hands on training on machines etc. which are relevant to industry. Duration of the course is 2 weeks.

Assessment Tools:
Continuous Evaluation during training:
1. Report : 10 marks
2. Class Performance : 10 marks
3. Viva/Present : 20 marks
4. Attendance : 10 marks

Course Articulation Matrix

CO Statement (Proj-ME-300)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O 1	PS O 2	PS O 3
Proj-ME-300.1	3	3	3	3	3	2	3	3	3	3	3	2	3	3	3
Proj-ME-300.2	3	3	3	3	3	2	3	3	3	3	3	2	3	3	3
Proj-ME-300.3	3	3	2	3	3	2	2	3	3	3	3	2	2	3	3
Proj-ME-300.4	3	3	3	3	3	2	3	3	3	3	3	3	2	3	2
Proj-ME-300.5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2

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MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH & STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)

BEC-DS-301: ELECTRONIC DEVICES

Periods/week	Credits	Max. Marks	: 200
L: 3 T: 0	3	Continuous Assessments	: 100
Duration of Examination: 3 Hrs		End Semester Examinations	: 100

Pre-requisites: BPH-104: Physics
Course Type: Program Core

Course Outcomes
The students will be able to:
BEC-DS-301.1. Apply semiconductor physics for analyzing performance of diode and transistor.
BEC-DS-301.2. Implement various applications of diode.
BEC-DS-301.3. Analyze bipolar junction transistor under different biasing arrangements.
BEC-DS-301.4. Illustrate operation of bipolar junction transistor and field effect transistor.
BEC-DS-301.5. Design regulated power supply.

PART-A

Unit 1: Introduction to Semiconductor Physics

1.1 Review of Quantum Mechanics, Electrons in periodic Lattices
1.2 E-k diagrams, Energy bands in intrinsic and extrinsic silicon
1.3 Carrier transport: diffusion current, drift current
1.4 Mobility and resistivity, sheet resistance, design of resistors

Unit 2: Semiconductor-Diode Characteristics

2.1 Generation and recombination of carriers, Poisson and continuity equation
2.2 P-N junction characteristics, I-Vcharacteristics, Diode breakdown: Avalanche and Zener
2.3 Small signal switching models
2.4 Amplifier models: Voltage amplifier, current amplifier, trans-conductance amplifier and trans- resistance amplifier
2.5 Zener diode, Schottky diode,LED, photodiode and solar cell

Unit 3: Applications of Diode
3.1 Rectifiers: Half wave rectifier: The analysis of average current, Average voltage, Peak Inverse voltage, Ripple factor and Efficiency
3.2 Full wave rectifiers: Center tapped and Bridge rectifier: The analysis of average current, Average voltage, Peak Inverse voltage, Ripple factor and Efficiency, Numerical based on rectifiers
3.3 Filters Circuits: Inductor filters with half wave and full wave rectifier, Capacitor filters with Half wave and Full wave rectifiers, L-Section filter and Π-Section filter
3.4 Voltage regulation using Zener diode
3.5 Diode Clipping & Clamping Circuits: Positive, Negative series and shunt circuit
3.6 Peak to peak detector circuit, Voltage multipliers

PART-B

Unit 4:Bipolar Junction Transistor

4.1 The junction transistor, Transistor current components, Transistor as an amplifier,Ebers-Moll Model

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4.2 Transistor construction, Detailed study of currents in a transistor, Transistor operating regions
4.3 **Common** base configuration, Common emitter configuration, Common collector configuration
4.4 Transistor Biasing: The operating point, Bias stability
4.5 Collector to base bias, Emitter feedback bias, Collector-emitter feedback bias
4.6 Self bias stabilization against variations in V_{BE} and I_B for self bias circuit
4.7 Bias compensation, Thermistor and Sensistor compensation
4.8 Thermal runaway, Thermal stability

Unit 5: Field Effect Transistor

5.1 Introduction to FET, JFET-n channel & p channel: construction, working and its V-I characteristics
5.2 Introduction to MOSFET,MOS capacitor, C-V characteristics
5.3 Depletion and Enhancement MOSFET - n channel & p channel: construction, working and its V-I characteristics
5.4 Small signal model of MOS transistor
5.5 Comparison of BJT, JFET and MOSFET
5.6 FET as a VVR

Unit 6: Regulated power supplies

6.1 Elements of a regulated power supply system, Stabilization
6.2 Emitter follower regulator, Series voltage regulation
6.3 Monolithic linear regulators
6.4 Performance parameters of 3-terminal IC regulators
6.5 Shunt voltage regulators

Text Books/Reference Books:

1. G. Streetman and S. K. Banerjee , 2014, Solid State Electronic Devices , 7th edition, Pearson.
2. D. Neamen , D. Biswas , Semiconductor Physics and Devices, McGraw-Hill Education
3. S. M. Sze and K. N. Kwok, 2006, Physics of Semiconductor Devices , 3rd edition, John Wiley &Sons,
4. C.T. Sah , 1991, Fundamentals of solid state electronics, World Scientific Publishing Co. Inc,.
5. Y. Tsividis and M. Colin, 2011, Operation and Modeling of the MOS Transistor, Oxford Univ.Press.

Software Required/Weblinks:

Transistor Amplifier Circuit Designer Software
PSPICE, ORCAD
nptel.ac.in/courses/117103063/31
nptel.ac.in/courses/117103063/30

Instructions for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each Part A and Part B (one from each unit). Student needs to attempt two questions out of three from each part. Each question will be of 20 marks.

Distribution of Continuous Assessment:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Theory Course: Total Marks 200
Internal/Continuous Assessment: 100

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- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

Assessment Tools:
Assignment/Tutorials
Sessional tests
Surprise questions during lectures/Class Performance
Term end examination

Course Articulation Matrix

CO Statement (BEC-DS-	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
BEC-DS-301.1	3	3	2	2	2	-	-	-	-	-	-	2	2	1	3
BEC-DS-301.2	3	3	2	2	2	-	-	-	-	-	-	2	2	-	3
BEC-DS-301.3	3	3	3	2	2	-	-	-	-	-	-	2	-	-	3
BEC-DS-301.4	3	3	3	2	2	-	-	-	-	-	-	2	2	-	3
BEC-DS-301.5	3	3	3	3	2	-	-	-	-	-	-	2	2	-	3

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MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH & STUDIES
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BEC-DS-351: ELECTRONIC DEVICES LAB

Periods/week Credits	Max. Marks : 100
P: 2 1	Continuous Assessment : 50
Duration of Examination: 2 Hrs	End Semester Examination : 50

Co- requisites: BEC-DS-301: Electronic Devices
Course Type: Program Core

Course Outcomes
The students will be able to:
BEC-DS-351.1. Analyze the operation and characteristics of P-N Junction diode and Zener diode.
BEC-DS-351.2. Implement the various applications of diode.
BEC-DS-351.3. Realize amplifier circuits using bipolar junction transistor and calculate their parameters.
BEC-DS-351.4. Develop the various biasing circuits of bipolar junction transistor.
BEC-DS-351.5. Design an RC coupled Amplifier and evaluate its frequency response.

LIST OF EXPERIMENTS:

1. To verify the V-I Characteristics of Semiconductor Diode.
2. To verify the V-I characteristics of Zener diode & its application as Voltage regulator.
3. To design a rectifier circuit using diode and calculate ripple factor, efficiency and regulation.
4. To design a clipper circuit using diode.
5. To design a clamper circuit using diode.
6. To design a dc voltage Doubler using diode.
7. To plot the input and output characteristics of transistor in common Base /common emitter configuration.
8. To design a buffer using transistor in Common Collector configuration.
9. To design a BJT fixed bias circuit with and without emitter resistor.
10. To plot the V-I characteristics of JFET and to find its parameters (dynamic resistance (r_d), transconductance (g_m), amplification factor(μ)).
11. To plot the V-I characteristics of MOSFET.
12. To Design and measure the frequency response of an RC coupled amplifier using discrete components.
13. To Design a two stage RC coupled amplifier and determine the effect of cascading on gain and bandwidth.
14. To Design and verify IC voltage regulator.

PROJECTS BASED ON ABOVE EXPERIMENTS:

1. Design a Full wave Rectifier.
2. Design a fixed Power Supply (5V and 12 V).
3. Design a Function Generator (Square wave and Triangular wave).
4. Design Astable Multivibrator.
5. Design of RC Coupled Amplifier.

NOTE: Every student needs to do minimum 10 number of experiments/practicals and 1 project in a semester. 20% new experiments should be added every year.

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Distribution of Continuous Assessment:

Viva- I	30%
Viva- II	30%
File/Records	20%
Class Work/ Performance	10%
Attendance	10%

Lab/Practical Course: Total Marks 100
Internal/Continuous Assessment: 50

- Two Viva: 15 Marks Each
- File/Records: 10 Marks
- Class Work/ Performance: 5 Marks
- Attendance: 5 Marks

End Semester Exam: 50 Marks

Assessment Tools:
Experiments in lab
File work/Class Performance
Viva (Question and answers in lab)
End Term Practical Exam

Course Articulation Matrix

CO Statement (BEC-DS-351)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
BEC-DS-351.1	3	3	2	2	3	-	-	-	-	-	-	2	-	2	1
BEC-DS-351.2	3	3	2	3	3	-	-	-	-	-	-	2	-	2	1
BEC-DS-351.3	3	3	2	3	3	-	-	-	-	-	-	2	-	2	1
BEC-DS-351.4	3	3	2	2	3	-	-	-	-	-	-	2	-	1	1
BEC-DS-351.5	3	3	3	2	3	-	-	-	-	-	-	2	-	2	1

MITRS

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH & STUDIES
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BEC-DS-302: DIGITAL ELECTRONICS

Periods/week	Credits	Max. Marks	: 200
L: 3 T: 0	3	Continuous Assessment	: 100
Duration of Examination: 3 Hrs		End Sem Examination	: 100

Course Type: Program Core

Course Outcomes

The students will be able to:

BEC-DS-302.1. Explain the fundamentals of digital electronics such as logic gates, coding techniques etc.
BEC-DS-302.2. Optimize the combinational logic circuits by applying different minimization techniques.
BEC-DS-302.3. Design various combinational and sequential logics by using fundamentals of digital electronics.
BEC-DS-302.4. Compare various A/D and D/A conversion techniques by analyzing their performance parameters for different applications.
BEC-DS-302.5. Classify various logic families and implement basic logic gates based on these logic families.

PART-A

Unit 1: Fundamentals of Digital Logic Circuits

1.1 Digital Signal, Number System, Conversion of Bases
1.2 Codes: BCD code, Excess-3 code, Gray code and Alpha-numeric code
1.3 Binary & BCD Arithmetic, Boolean algebra
1.4 Logic Gates, Concept of Universal Gates
1.5 Error Detection and Correction: Parity Method, Hamming Code Method

Unit 2: Logic Simplification and Combinational Logic Design

2.1 Review of Boolean Algebra and De Morgan's Theorem,
2.2 SOP & POS forms, Canonical forms,
2.3 Boolean expression minimization techniques: K-Map(up to 6 variables), Quine Mccluskey Method
2.4 Design of Combinational Circuits using ROM, PAL ,PLA and FPGA

Unit 3: MSI Devices

3.1 Digital Comparator, Multiplexer, De-multiplexer, Encoder, Decoder
3.2 Half and Full Adders, Subtractors, Serial and Parallel Adders,
3.3 BCD Adder, Barrel shifter and ALU
3.2 Driver and multiplexed display

PART-B

Unit 4: Sequential Logic Design

4.1 Combinational v/s Sequential Circuit, Latch v/s Flip-Flop
4.2 Types of Flip-Flops: S-R, J-K, D & T, Excitation Table of Flip Flops, Toggling & Race around Condition
4.3 Master Slave Flip-Flop
4.4 Shift Registers & Types: SISO, SIPO, PISO and PIPO
4.5 Bidirectional Shift Register, Universal Shift Register

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4.6 Counter & Types: Ripple Counter, Decade Counter, Ring and Johnson Counter

Unit 5: A/D and D/A Converters

5.1 Requirement and Specification of A/D and D/A Converters
5.2 Digital-to-analog converters (DAC): Weighted resistor, R-2R ladder, resistor string etc.
5.3 Analog-to-digital converters (ADC): Single slope, dual slope, successive approximation, flash etc.
5.4 Switched capacitor circuits: Basic concept, practical configurations, application in amplifier, integrator, ADC etc.

Unit 6: Digital Logic Families

6.1 Unipolar and Bipolar Logic Families, Characteristics of Digital ICs
6.2 Bipolar Logic Families: Tristate TTL and ECL
6.3 Unipolar Logic Families: NMOS, PMOS, CMOS
6.4 Interfacing between TTL and CMOS
6.5 Memory elements

Text Books/ Reference Books:

1. William H. Gothmann, 2006, Digital Electronics: An Introduction To Theory And Practice: , 2nd Edition, PHI Learning.
2. M. Morris Mano, Michael D Ciletti, 2008, Digital Design , 4th Edition, Pearson.
3. Thomas L. Floyd, R. P. Jain, 2005, Digital Fundamentals:, 8th Edition, Pearson.
4. D.V. Hall , 1989, Digital Circuits and Systems, Tata McGraw Hill.
5. John Morris, 1992, Digital Electronics, 1stEdition ,Routledge.
6. Digital Systems: Ronald J. Tocci, Neal S. Widmer, Gregory L. Moss,2009, 10thEdition, Pearson.

Software required/Weblinks:
nptel.ac.in/courses/117101055

Instructions for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each PART-A and PART-B (one from each unit) Student needs to attempt two questions out of three from each part. Each question will be of 20 marks

Distribution of Continuous Assessment:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Theory Course: Total Marks 200
Internal/Continuous Assessment: 100

- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

Assessment Tools:
Assignment/Tutorials

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Sessional tests
Surprise questions during lectures/Class Performance
Term end examination

Course Articulation Matrix

CO Statement (BEC-DS-302)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
BEC-DS-302.1	2	1	1	-	1	1	-	-	-	-	-	1	2	1	-
BEC-DS-302.2	3	2	3	1	2	2	-	-	-	-	-	1	-	2	-
BEC-DS-302.3	3	1	3	1	2	2	-	-	-	-	-	1	2	2	-
BEC-DS-302.4	3	1	2	-	1	1	-	-	-	-	-	-	-	2	-
BEC-DS-302.5	3	1	2	-	1	1	-	-	-	-	-	-	1	2	-

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MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH & STUDIES
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BEC-DS-352: DIGITAL ELECTRONICS LAB

Periods/week Credits	Max. Marks : 100
P: 2 1	Continuous Assessment : 50
Duration of Examination: 2 Hrs	End Semester Examination : 50

Course Type: Program Core
Course Outcomes
The Students will be able to:

BEC-DS-352.1. Demonstrate the operations of various TTL gates.
BEC-DS-352.2. Apply K map minimizing procedures for circuit realization and compare the original and minimized circuits.
BEC-DS-352.3. Interpret the functioning of different combinational circuits and flip-flops by relating the outputs of these IC's with the truth tables.
BEC-DS-352.4. Build various sequential circuits such as shift registers, counters with the help of flip-flops.
BEC-DS-352.5. Describe the functioning of logic gates based on extensively used CMOS logic family.

List of Experiments:

1. To verify the truth tables of TTL gates AND, OR, NOT, NAND, NOR, EX-OR, EX-NOR.
2. To design and realize a given function using K maps & using its performance.
3. To verify the operation of multiplexer and demultiplexer.
4. To verify the operation of comparator.
5. To verify the truth tables of S-R, J-K, T and D type flip flops.
6. To verify the operation of bi-directional shift register.
7. To design and verify the operation of 3 bit synchronous counter.
8. To design the operation of a ring counter.
9. To design the operation of a Johnson counter.
10. To design and verify the operation of a- synchronous UP / DOWN decade counter using J-K Flip flops.
11. To design and verify the operation of synchronous UP / DOWN decade counter using J-K Flip flops.
12. To design and realize a sequence generator for a given sequence using J-K flip flops.
13. To understand the working of CMOS NAND & NOR gates & interfacing between TTL and CMOS gates.
14. Design a 4-bit shift register and verify its operation.

PROJECTS BASED ON ABOVE EXPERIMENTS:

1. Design various logic gates using transistor
2. Design and verify the operation of 2 bit synchronous counter using JK flip flops
3. Design a binary to gray code converter using gates
4. Design visitor counter using BCD to 7 segment Display
5. Design and verify the operation of logic gates using Multiplexer

NOTE: Every student needs to do minimum 10 number of experiments/practicals and 1 project in a semester. 20% new experiments should be added every year.

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Distribution of Continuous Assessment:

Viva- I	30%
Viva- II	30%
File/Records	20%
Class Work/ Performance	10%
Attendance	10%

Lab/Practical Course: Total Marks 100
Internal/Continuous Assessment: 50

- Two Viva: 15 Marks Each
- File/Records: 10 Marks
- Class Work/ Performance: 5 Marks
- Attendance: 5 Marks

End Semester Exam: 50 Marks

Assessment Tools:
Experiments in lab
File work/Class Performance
Viva (Question and answers in lab)
End Term Practical Exam

Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
BEC-DS-352.1	3	1	2	1	1	-	-	-	-	-	-	2	-	2	1
BEC-DS-352.2	3	2	3	3	2	-	-	-	-	-	-	2	-	1	2
BEC-DS-352.3	3	2	3	3	2	-	-	-	-	-	-	2	-	1	2
BEC-DS-352.4	3	1	3	2	2	-	-	-	-	-	-	2	-	2	2
BEC-DS-352.5	3	1	3	2	2	-	-	-	-	-	-	2	-	1	2

MITRS

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

NAAC 'A' Grade University

BME-DS-311: BASICS OF AUTOMOBILE ENGINEERING.

Periods/week Credits	Max. Marks : 200
L: 3 T: 0 3	Continuous Evaluation : 100
Duration of Ext. Exam: 3 Hrs	End Semester Exam : 100

Pre-requisites: Nil

Course Type: Program Core

Students will be able to

BME-DS-311.1: Know and identify the different parts of automobiles.

BME-DS-311.2: Understand the functioning of different parts used in automobiles.

BME-DS-311.3: Solve problems based on the requirements of parts to be used in for proper functioning of automobile.

BME-DS-311.4: Analyze the functioning of each part of automobile for better performance.

Part-A

Unit 1: Introduction:

Classification of two wheeled and four wheeled vehicles.
Specification Analysis
Main Engine Parts
Layout out of power transmission with parts, (clutch, gear box, final drive, propeller shaft, differential, U joints, wheels, tyres & tubes)
Frames & frameless construction,
Important Systems Introduction (steering, suspension, braking, power train & drives)

Unit 2: Power Plant:

Constructional & working details of two stroke & four stoke petrol & diesel engines,
Fuel Supply and Ignition System,
Starting and charging system,
Lighting, cooling system and lubrication system.
Introduction to M.P.F.I, CRDi, D.T.S.S.I. VTEC (Variable Valve Timing & Lift Electronic Control) Technologies.
Types of resistance vehicle encounters their calculation with selection of engine calculations.

Unit 3: Clutches and transmission:

Necessity, working & Types of clutch,
Single plate, multiple plate, diaphragm & Electromagnetic clutch constructional & working details,
Clutch plate Construction, clutch lining materials.
Functions, necessity and types of transmission,
Sliding mesh, Constant mesh and Synchromesh gear boxes, constructional & working details.
Automatic transmission, their constructional & working details.

Part-B

Unit 4: Steering System and suspension system:

Steering system requirements and steering linkages.
Front axle details & Steering geometry, (Castor, Camber, Toe in, Toe out)
Different types of steering gear boxes, their constructional & working details.

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Need and types of suspension system,

Constructional details & characteristics of leaf, coil springs.
Independent suspension, Front & rear suspension systems of the vehicle,
Shock absorbers.

Unit 5: Braking System:

Classification and working of brakes, Drum brakes and Disc brakes,
Hydraulic brake, Parking brake, Vacuum and Air Brakes
leading & trailing brake shoes, working of tandem master cylinder, wheel cylinders,
Characteristics of brake fluid.
Anti lock Braking system (ABS) construction & working.

Unit 6: Wheels & Tyres:

Wheel requirements and its types.
Constructional & working details of Rims & their types.
Types of tyres, Tyre selection, Tyre Nomenclature, ordinary, radial tyres, tubeless tyres, Constructional details, comparison & application.
Factors affecting tyre life.
Wheel balancing: Static and Dynamic their effects

Text Books:

1. Automobile Engineering by Dr. Devendra Vashist I.K.International publishers 2017
2. Automobile **E**ngineering Vol 1 by Dr Kripal Singh Standard Publishers Distributors Delhi.
3. Automotive Technology by Sethi, TMH, New Delhi
4. Automobile Engineering by K.K. Ramalingam, Scitech Publication, Chennai – 2001
5. Automotive Chassis & Body by P.L. Kohli, TMH, New Delhi

Reference Books:

1. Motor Vehicles by Newton Steeds and Garrot, Butterworths, London – 2000.
2. Mechanism of the Car by Judge A.W, Chapman and Halls Ltd., London –1986
3. Automotive Chassis and Body by Crouse W.H, McGraw –Hill, New York –1971.
4. Automobile Engg. by K.K. Jain, R.B. Asthana, TMH –2002.
5. Automobile Engg (Vol-1) by Dr. Kripal Singh, Standard Publisher Distributors

Evaluation Tools:

Assignment/Tutorials 20 Marks
Sessional tests 60 Marks
Class Quiz 20 Marks
Term end examination 100 Marks

Assignments, Sessional and End Semester Examination paper will consist of various difficulty levels to accommodate the different capabilities of students. Assessment should cover all course outcomes and upper limit for lower order skills will be 40% (for knowledge-oriented questions). However, weightage for different cognitive levels in the question papers can vary.

The paper setter must ensure the coverage of the entire syllabus while setting the question papers and mention the learning outcomes across each section to be measured by the examination. Weightage of the sections may vary as per the number of respective lecture hours mentioned in the syllabus. Action verbs should be used from Bloom's Taxonomy while designing question papers.

MRIRS

Course Articulation Matrix:

CO Statement (BME-DS-311)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
BME-DS-311.1	2	-	-	-	-	-	-	-	-	-	-	-	2	2	-
BME-DS-311.2	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-
BME-DS-311.3	-	-	2	-	-	-	-	-	-	-	2	2	-	-	-
BME-DS-311.4	-	-	2	-	-	-	-	2	-	-	-	-	3	2	-

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MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)
NAAC 'A' Grade University

BME-DS-312: BASICS OF AUTOMOBILE ENGINEERING LAB

Periods/week Credits:	Max. Marks :100
L: 0 T: 0 P: 2 1	Continuous Evaluation : 50
Duration of Ext. Exam: 2 Hrs	End Semester Exam : 50

Pre-requisites: Nil
Course Type: Program Core

Course Outcomes

BME-DS-312.1: Students will be able to know and identify the different parts of automobiles.
BME-DS-312.2: Students will be able to understand the functioning of different parts used in automobiles.
BME-DS-312.3: Students will be able to solve problems based on the requirements of parts to be used in for proper functioning of automobile.
BME-DS-312.4: Students will be able to analyze the functioning of each part of automobile for better performance.

List of experiments

1. To prepare a layout and identify part of power transmission drive line of front engine two wheel drive and front engine rear wheel drive.
2. To prepare a layout and identify part of power transmission drive line of four wheel drive vehicle.
3. To assemble a single plate and multi plate clutch and identify causes of wear of clutch plate.
4. To assemble a diaphragm type clutch and differentiate it with single plate helical coil spring clutch.
5. To study and prepare layouts of sliding mesh, constant mesh and synchromesh gear boxes.
6. To study construction of front & rear suspension systems and draw sketches.
7. To study construction of steering system for manual / power arrangement and draw sketches.
8. To study construction of hydraulic braking (disc/drum) systems, functioning of master & wheel cylinders, with sketches. Perform bleeding of hydraulic brakes operation.
9. To analyze alternator and measure the value of current at different rpm.
10. Study construction of different types of Automobile Wheels and tyres and identify the causes of tyre wear.
11. To study constructional details and prepare layout of different types of cooling systems.
12. To study & prepare layout of Lubrication System in Automobiles.

Note:

1. At least ten experiments are to be performed in the semester.
2. At least eight experiments should be performed from the above list. Remaining two experiments may either be performed from the above list or designed & set by the concerned faculty as per the scope of the syllabus.

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Marks distribution for Continuous evaluation

Parameter	Weightage
Two Mid-Term Viva	60%
File/Record Keeping	20%
Class Performance	10%
Class Attendance	10%

Course Articulation Matrix:

CO Statement (BME-DS-311)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
BME-DS-312.1	2	-	-	-	-	-	-	-	-	-	-	-	2	2	-
BME-DS-312.2	--	2	2	-	-	-	-	-	-	-	-	-	-	-	--
BME-DS-312.3	--	--	2	--	--	--	--	--	--	--	2	2	--	--	--
BME-DS-312.4	--	--	2	--	--	--	--	2	--	--	--	--	3	2	--

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IVth Semester

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BME-DS-401: APPLIED THERMODYNAMICS

Periods/week Credits Max. Marks : 200

L: 3 T: 1 P: 0 4 Continuous Assessment : 100

Duration of Examination: 3 Hrs End Semester Exam : 100

Prerequisites: BME-DS-302: Thermodynamics

Course Type: Professional Core Course

Course Outcomes:

After completion of this course the students will be able to

BME-DS-401.1	Define thermodynamic cycle, psychometric process and describe thermodynamic systems and devices.
BME-DS-401.2	Classify fuels & thermodynamic devices and understand the effect of various operating parameters on thermodynamic cycles and devices
BME-DS-401.3	Apply principle of energy conversions, sketch various property diagrams and evaluate the performance parameters & appraise effect of their modifications
BME-DS-401.4	To identify and formulate power production based on the fundamental laws of thermal engineering

Part-A

Unit 1: Fuels and Combustion

Introduction to solid, liquid and gaseous fuels, Stoichiometry- Theoretical air Excess Air, Air fuel ratio, Calorific Value of fuel, Bomb Calorimeter, exhaust gas analysis- First law analysis of combustion reactions, Adiabatic flame temperature, Enthalpy of formation.

Unit 2: Gas Power Cycles

Air standard assumptions, Otto, Diesel and Dual cycles-their analysis, Comparison of Otto, diesel and dual cycle. Brayton cycle, effect of reheat, regeneration and intercooling in Brayton Cycle.

Unit 3: Vapor Power Cycles

Simple Rankine cycle, Effect of operating parameters on Rankine cycle efficiency, Modification with superheat, reheat and regeneration, Supercritical and ultra super-critical Rankine cycle. Combined gas and vapor power cycles.

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Part-B

Unit 4: Compressible Flow and Nozzle

Basics of compressible flow, Stagnation properties, Isentropic flow of a perfect gas through a nozzle, choked flow, subsonic and supersonic flows- normal shocks- Flow of steam and refrigerant through nozzle, efficiency of nozzle and diffuser.

Unit 5: Steam Turbines

Classification, Impulse Turbine: Flow through blades, velocity diagram, power output and efficiency, maximum blade efficiency of single stage impulse turbine, blade friction, compounding of impulse turbine. Reaction Turbine: Flow through impulse reaction blades, degree of reaction, velocity diagram, power output, efficiency.

Unit 6: VCRS and Psychometrics

Vapor compression refrigeration cycles in T-S and P-H diagram, and its analysis. Refrigerants and their properties. Properties of dry and wet air, use of pschyrometric chart, processes involving heating/cooling and humidification/dehumidification, dew point.

Text Books:

1. P. K Nag, "Basic and Applied Thermodynamics" Tata McGraw Hill Education Pvt. Ltd
2. D.S.Kumar, "Applied Thermodynamics", Katson Publication.
3. R.K. Rajput, "Thermal Engineering", Laxmi Publication
4. S. Domkundwar, "Thermal Engineering" ,Dhanpat Rai& Co (p) Ltd.

Reference Books:

1. Y. A. Cengel, M. A. Boles, "Thermodynamics – An Engineering Approach", Tata McGraw Hill Education Pvt. Ltd.
2. Sonntag, Van Wylen, G. J., "Fundamentals of Thermodynamics", John Wiley and Sons.
3. Gordon Rogers and Yon Mayhew,"Engineering Thermodynamics" , Pearson Publication
4. T.D. Eastop, "Applied Thermodynamics for Engineering Technologists", Prentice Hall.

Weblinks:

https://nptel.ac.in/courses/112105123
https://nptel.ac.in/courses/112106133

Instructions for setting of Paper Seven questions are to set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each part A and part B (one from each unit). Student needs to attempt two questions out of three questions from each part. Each question will be of 20 marks.

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Assessment Tools:

In general parameters for Internal /Continuous Assessment (Theory Courses):

Parameter	Weightage
Two Sessional (Mid-Term)Tests	60%
Assignments	20%
Class Performance	10%
Class Attendance	10%

Theory Course: Total Marks 200
Internal/Continuous Assessment: 100

- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS01	PS02	PS03
BME-DS-401.1	1	1	1	1	1	-	-	2	-	-	-	3	1	-	2
BME-DS-401.2	2	2	2	2	-	-	-	2	2	-	-	3	2	1	2
BME-DS-401.3	3	3	3	1	-	1	2	-	2	2	1	2	3	1	1
BME-DS-401.4	1	3	3	1	3	1	-	-	-	3	1	3	1	1	2

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(Deemed to be University under section 3 of the UGC Act 1956)

BME-DS-402A: STRENGTH OF MATERIALS

Periods/week Credits	Max. Marks : 200
L: 4 T: 0 P: 0 4	Continuous Assessment : 100
Duration of Examination: 3 Hrs	End Semester Exam : 100

Prerequisites: BME-DS-301: Engineering Mechanics, BMA-102: Mathematics-I
Course Type: Professional Core Course
Course Outcomes:
After completion of this course the students will be able to
BME-DS-402A.1: Memorize basic theory, principles and apply mathematics to obtain analytical solutions relevant to strength of material
BME-DS-402A.2: Compute stress and deformation in axial loaded members, circular members subjected to torsion and pressure vessel.
BME-DS-402A.3: Interpret real world problem on biaxial loaded members, beams and structures after applying theory and principles of strength of material.
BME-DS-402A.4: Analyze slope and deflection for the different types of beams.

Part-A

Unit 1: Simple Stress and Strain
Basics of stress and strain, Stress-strain diagram for brittle and ductile materials, Hooke's law, volumetric, linear and shear strains, elastic constants and their relations, Saint Venant's principle, Statically indeterminate systems , Thermal stress, Elastic strain energy,

Unit 2: Principle Stresses And Strain
Transformation of Plane stresses and strains- equations of transformation, Principal stresses and principal planes, Maximum shear stress, Principle strains, Maximum shear strain, Mohr's circle representation.

Unit 3: Bending of Beams
Beams and types transverse loading on beams- shear force and bend moment diagrams- Types of beam supports, simply supported and over-hanging beams, cantilevers. Theory of bending of beams, bending stress distribution and neutral axis, shear stress distribution, point and distributed loads.

Part-B

Unit 4: Deflection of Beams
Relation between slope deflection and radius of curvature, Deflection of beams- Macaulay's method, direct integration method, Moment Area Method. Maxwell's reciprocal theorems.

Unit 5: Torsion
Torsion of solid and hollow circular shafts –Power transmission, strength and stiffness of shafts., Stresses and deformaion in solid and hollow shaft, statically indeterminate problems, strain energy in torsion, Closed and open coil helical spring subjected to axial load, spring in parallel & series.

Unit 6: Pressure Vessels

Thin Cylinders and spherical shells subjected to internal fluid pressure- Calculation of hoop, longitudinal and shear stresses in shells, Wire wound thin cylinders, Lame's equations, calculation of radial,longitudinal and hoop stresses and strains due to internal pressure in thick cylinders, compound cylinders, hub shrunk on solid shafts.

Text Book:

1. Sadhu Singh, " Strength of Material", Khanna Publications
2. R. Subramanian, "Strength of Material", Oxford University Press.
3. Gere J. M., Timoshenko S.P., "Mechanics of Materials", CBS Publication.
4. B.C Punamia, "Mechanics of Materials", Laxmi Publications

Reference Book:

1. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India,
2. Ferdinand P. Been, Russell Johnson Jr and John J. Dewole, Mechanics of Materials, Tata McGraw-Hill Publishing Co. Ltd.
3. HibbelerR.C.,"Mechanics of Materials", Prentice Hall, New Delhi
4. Fenner, Roger.T, "Mechanics of Solids", U.K. B.C. Publication

Weblinks:

https://nptel.ac.in/courses/112107146
https://nptel.ac.in/courses/112107147

Instructions for setting of Paper Seven questions are to set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each part A and part B (one from each unit). Student needs to attempt two questions out of three questions from each part. Each question will be of 20 marks.

Assessment Tools:

In general parameters for Internal /Continuous Assessment (Theory Courses):

Parameter	Weightage
Two Sessional (Mid-Term)Tests	60%
Assignments	20%
Class Performance	10%
Class Attendance	10%

Theory Course: Total Marks 200
Internal/Continuous Assessment: 100

- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3

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BME-DS-402A.1	3	2	2	2	3	2	3	1	1	-	2	-	3	3	2
BME-DS-402A.2	2	3	2	2	3	2	2	2	3	-	-	3	3	3	1
BME-DS-402A.3	3	2	2	2	3	3	-	3	3	2	2	3	3	3	2
BME-DS-402A.4	3	3	3	2	3	2	3	-	-	3	2	3	3	3	1

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BME-DS-403A: MANUFACTURING TECHNOLOGY

Periods/week Credits	Max. Marks: 200
L: 4 T: 0 P: 0 4	Continuous Assessment : 100
Duration of Examination: 3 Hrs	End Semester Exam 100

Prerequisites: BME-102: Workshop/Manufacturing Practices, BME-DS-304: Manufacturing Processes

Course Type: Professional Core Course

Course Outcomes:After completion of this course the students will be able to

BME-DS-403A.1: Apply cutting mechanics to metal machining based on cutting force and power consumption

BME-DS-403A.2: Select cutting tools, cutting fluids, machine tools, identify tool wear, calculate tool life, conceptualize machinability, machine mechanism & learn engineering economics

BME-DS-403A.3: Select and identify conventional and unconventional machining operations; finishing and super finishing operations; abrasive machining, CNC machines. Conceptualization of process parameters of all machining operations

PART-A

Unit 1: Machining with Single Point Tool

Tool Signature, Tool Geometry, Mechanism of chip formation, machining parameters, Relationship of shear angle, shear strain, strain rate, velocity relationships, Estimation of cutting force and power using Merchant's circle theory, Power and energy relationships, friction and thermal aspects of machining, numerical

Unit 2: Cutting Tools and Cutting Fluids

Types of cutting tools materials and their mechanical properties, types of cutting fluids and functions, Selection of Cutting fluid and it s Properties, Tool Wear and mechanisms. Tool life: factors affecting tool life, Taylor's tool life equation, machinability index, factors affecting machinability, machining economics, Determination of optimal cutting speed for maximum production, Maximum profit cutting speed, Determine of high efficiency zone, numerical

Unit 3: Machining with Multi Point Tool and Lathe Operations

Machine tool classification, generatix and directrix types of machining operation, basic principle mechanism of metal cutting, construction features and details of lathe machine tool and accessories/attachments, various mechanism of lathe machine and functions: rack and pinion mechanism, half-nut mechanism, worm wheel mechanism, apron mechanism, cone pulley drive & back gear drive mechanism, tumbler mechanism

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PART-B

Unit 4: Abrasive Machining

Grinding wheel specifications and selection, types of grinding process, cylindrical grinding, surface grinding, centreless grinding and internal grinding, specification & selection of grinding wheel, dressing and truing and balancing/mounting of grinding wheel. Concepts of surface integrity, evaluation of surface roughness. Super-finishing Processes: Lapping, Honing, Buffing, Burnishing, polishing.

Unit 5: Unconventional machining process

Basic principle of metal removal, machine set up, effect of process parameters, process capabilities and limitation of the following processes: Ultra sonic machining, abrassive jet machining, electro discharge and wire-cut machining, electrochemical machining, chemical machining laser beam and plasma arc machining

Unit 6: Numerically Controlled Machine Tools

Working of NC machine tools, classification of NC machines, advantages and disadvantages, programming for NC machines, Computer Numerical Control (CNC) and Direct Numerical Control. Machining Centre, Adaptive Controls.

Text Books:

1. B. S. Raghuwansi, "Workshop Technology-II", Dhanpat Rai Publication
2. P. N. Rao, "Manufacturing Technology-I & II", TMH Publication
3. P.C.Sharma, "A Textbook of Production Engineering", S.Chand Publication
4. P.C.Sharma, "A Textbook of Production Technology", S.Chand Publication

Reference Books:

1. Kalpakjian and Schmid, "Manufacturing processes for engineering materials", Pearson India
2. G.K. Lal, "Introduction to Machining Science", New Age International Publishers.
3. Mikell P. Groover, "Fundamentals of Modern Manufacturing: Materials, Processes, and Systems", Pearson Publication.
4. Degarmo, Black &Kohser, Materials and Processes in Manufacturing

Weblinks:

https://nptel.ac.in/courses/112107144
https://nptel.ac.in/courses/112104195

Instructions for setting of Paper Seven questions are to set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each part A and part B (one from each unit). Student needs to attempt two questions out of three questions from each part. Each question will be of 20 marks.

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Assessment Tools:

In general parameters for Internal /Continuous Assessment (Theory Courses):

Parameter	Weightage
Two Sessional (Mid-Term)Tests	60%
Assignments	20%
Class Performance	10%
Class Attendance	10%

Theory Course: Total Marks 200
Internal/Continuous Assessment: 100

- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PS02	PS03
BME-DS-403A.1	2	3	3	3	2	1	-	-	-	1	1	1	3	2	3
BME-DS-403A.2	2	3	3	3	2	1	-	-	-	1	1	1	3	3	3
BME-DS-403A.3	3	3	3	3	2	2	-	-	-	-	-	-	3	2	3

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(Deemed to be University under section 3 of the UGC Act 1956)

BME-DS-405: Thermal Engineering

Periods/week Credits	Max. Marks 200
L: 3 T: 1 P: 0 4	Continuous Assessment: 100
Duration of Examination: 3 Hrs	End Semester Exam 100

Course Type: Professional Core Course

Course Outcomes: Students will be able to:

BME-DS-405.1. Understand the basic theory of thermodynamics, relative laws, entropy and thermodynamic Processes.

BME-DS-405.2. Apply the basic concepts of thermodynamics, psychometric properties in industries.

BME-DS-405.3. Analyze the basic concept regarding the working of heat engine and will differentiate between the working of various thermodynamic devices

BME-DS-405.4. Compare thermo cycles and working of engines and their performance

BME-DS-405.5. Evaluate the change in properties of substances and energy performance of thermodynamic devices.

PART- A

Unit 1: Introduction to Thermodynamics:

Fundamentals-System & Control volume; Property, State & Process; Exact & Inexact differentials; Work-Thermodynamic definition of work; examples; Displacement work; Path dependence of displacement work and illustrations for simple processes; Temperature, Definition of thermal equilibrium and Zeroth law; Temperature scales.

Unit 2: First Law of Thermodynamics

Definition of heat; examples of heat/work interaction in systems- First Law for Cyclic & Non-cyclic processes; Concept of total energy; Various modes of energy, Internal energy and Enthalpy. First Law for Flow Processes - Derivation of general energy equation for a control volume; Steady state steady flow processes including throttling; Examples of steady flow devices.

Unit 3: Second Law of Thermodynamics

Second law - Definitions of direct and reverse heat engines; Definitions of thermal efficiency and COP; Kelvin-Planck and Clausius statements and their equivalence; Definition of reversible process; Internal and external irreversibility; Carnot cycle; Absolute temperature scale, Clausius inequality. Definition of entropy; Demonstration that entropy is a property.

PART-B

Unit 4: Pure Substance, Ideal and Real Gas

Definition of Pure substance, Properties of two phase systems - Const. temperature and Const. pressure heating of water; Definitions of saturated states; Use of steam tables; Saturation tables; Superheated tables; Identification of states & determination of properties

Unit 5: Power Cycles:

Air standard assumptions, Otto, Diesel and Dual cycles-their analysis, Comparisn of Otto, Diesel and Duel Cycle. Brayton cycle.

Unit 6: VCRS and Psychometrics

Vapor compression refrigeration cycles in T-S and P-H diagram, and its analysis. Refrigerants and their properties. Properties of dry and wet air, use of pschyrometric chart.

Text Books:

1. P. K Nag, "Basic and Applied Thermodynamics" Tata McGraw Hill Education Pvt. Ltd
2. D.S.Kumar, "Applied Thermodynamics", Katson Publication.
3. R.K. Rajput, "Thermal Engineering", Laxmi Publication
4. S. Domkundwar, "Thermal Engineering" ,Dhanpat Rai& Co (p) Ltd.

Reference Books:

1. Y. A. Cengel, M. A. Boles, "Thermodynamics – An Engineering Approach", Tata McGraw Hill Education Pvt. Ltd.
2. Sonntag, Van Wylen, G. J., "Fundamentals of Thermodynamics", John Wiley and Sons.
3. Gordon Rogers and Yon Mayhew,"Engineering Thermodynamics" , Pearson Publication
4. T.D. Eastop, "Applied Thermodynamics for Engineering Technologists", Prentice Hall.

Weblinks:

https://nptel.ac.in/courses/112105123
https://nptel.ac.in/courses/112106133

Assessment Tools:

In general parameters for Internal /Continuous Assessment (Theory Courses):

Parameter	Weightage
Two Sessional (Mid-Term)Tests	60%
Assignments	20%
Class Performance	10%
Class Attendance	10%

Theory Course: Total Marks 200
Internal/Continuous Assessment: 100

- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

Course Articulation Matrix

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
BME-DS-405.1	1	1	1	1	1	-	-	1	-	-	-	3	2	3	1
BME-DS-405.2	2	2	2	2	-	-	-	2	3	-	-	3	2	3	1
BME-DS-405.3	3	2	2	2	3	3	-	3	3	2	2	3	2	3	1
BME-DS-405.4	1	3	3	3	1	-	-	-	-	2	-	3	2	3	1
BME-DS-405.5	3	2	2	2	3	-	3	3	2	2	-	3	2	3	1
BME-DS-405.6	2	2	2	2	-	-	2	3	-	-	2	3	2	3	1

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BME-DS-404: MATERIAL SCIENCE

Periods/week Credits	Max. Marks : 200
L: 4 T: 0 P: 0 4	Continuous Assessment : 100
Duration of Examination: 3 Hrs	End Semester Exams : 100

Prerequisites: BPH-101: Applied Physics
Course Type: Professional Core Course

Course Outcomes:
After completion of this course the students will be able to

BME-DS-404.1 Analyze the crystal structure of materials at different levels, defects of various materials, recognize the slip system, state the mechanical properties of materials.

BME-DS-404.2 Understand the concept of heat treatment along with phase diagrams, compare and estimate the destructive and non-destructive tests, discuss fractures and failure mechanisms.

BME-DS-404.3 Develop the heat treatment processes for engineering materials

BME-DS-404.4 Classify and compare the different types of cast irons, steels and non ferrous alloys, interpretation of microstructures and properties.

PART-A

Unit 1: Crystal Structure

Unit cells, Metallic crystal structures, Classification of Imperfection in solids: Point, line, interfacial and volume defects; sources of dislocation, their effect and remedies; strengthening mechanisms and slip systems, critically resolved shear stress.

Unit 2: Mechanical Properties

Basics properties, elastic constants, stress-strain diagrams, factors affecting stress strain diagrams, elastic properties relations between true and engineering stress-strain curves, generalized Hooke's law, yielding and yield strength, ductility, resilience, toughness, elasticity, plasticity, fatigue, creep; fatigue limit and S-N diagrams, fatigue mechanism; creep curves and laws, creep mechanisms.

Unit 3: Mechanical Tests

Tensile and compression, shear and bending, torsion, hardness (Brinell, Rockwell, Vickers), impact (Izod and Charpy). Non Destructive Testing: Magnetic particle testing, radiographic testing, liquid penetration testing, acoustic emission testing, magnetic flux leakage, thermal and infrared testing.

PART-B

Unit 4: Alloys, Substitutional and Interstitial solid solutions

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Phase diagrams: Interpretation of binary phase diagrams and microstructure development; eutectic, peritectic, peritectoid monotectic reactions. Iron Iron-carbide phase diagram and microstructural aspects of ledeburite, austenite, ferrite and cementite, cast iron.

Unit 5: Heat Treatment of Steel

Annealing, tempering, normalising and spheroidising, isothermal transformation diagrams for Fe-C alloys and microstructure development. Continuous cooling curves and interpretation of final microstructures and properties- austempering, martempering, case hardening, carburizing, nitriding, cyaniding, carbo-nitriding, flame and induction hardening.

Unit 6: Engineering Material

Alloying of steel, properties of stainless steel and tool steels, maraging steels, cast irons; grey, white, malleable and spheroidal cast irons; copper and copper alloys; brass, bronze and cupro-nickel; Aluminium and Al-Cu, Mg alloys, Nickel based superalloys and titanium alloys.

Text Books:

1. W. D. Callister, 2006, "Materials Science and Engineering-An Introduction", Wiley India.
2. Kenneth G. Budinski and Michael K. Budinski, "Engineering Materials", Prentice Hall of India Private Limited
3. L. Krishna Reddy, "Principles of Engineering Metallurgy", New Age Publication
4. William F. Smith, JavedHashemi, Ravi Prakash, "Material Science & Engineering", McGraw Hill Edn(India) Pvt. Limited;

Reference Books:

1. V. Raghavan, "Material Science and Engineering', Prentice Hall of India Private Limited,
2. U. C. Jindal, "Engineering Materials and Metallurgy", Pearson Publication
3. Raymond A Higgim, "Engineering Metallurgy Part 1",Prentice Hall India
4. Dr.K.M.Gupta, "Material science, metallurgy and Engineering materials", Umesh Publications

Weblinks:

https://nptel.ac.in/courses/112108150
https://nptel.ac.in/courses/113106032

Instructions for setting of Paper Seven questions are to set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each part A and part B (one from each unit). Student needs to attempt two questions out of three questions from each part. Each question will be of 20 marks.

Assessment Tools:

In general parameters for Internal /Continuous Assessment (Theory Courses):

Parameter	Weightage
Two Sessional (Mid-Term)Tests	60%
Assignments	20%

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Class Performance	10%
Class Attendance	10%

Theory Course: Total Marks 200
Internal/Continuous Assessment: 100

- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PS02	PS03
BME-DS-404.1	3	3	2	2	1				1		1	2	3	3	3
BME-DS-404.2	3	3	3	3		1	1		1			2	3	3	2
BME-DS-404.3	3	3	3	2	1	1	2					2	3	3	3
BME-DS-404.4	3	3	2	2	1	1						2	3	3	2

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BME-DS-451: THERMAL ENGINEERING LAB

Periods/week Credits	Max. Marks 100
L: 0 T: 0 P: 2 1	Continuous Assessment 50
Duration of Examination: 2 Hrs	End Semester Exam 50

Prerequisites:

Course Type: Professional Core Course

Course Outcomes:

After completion of this course the students will be able to

BME-DS-451.1 Understand the working of various components in Test rig and apply the concept of various test on SI and CI Engine.

BME-DS-451.2 Understand the physical significance of various operating parameters in IC Engines,Analyze the influence of variations of load on various performance parameters of IC Engines.

BME-DS-451.3 Calculate & compare the efficiencies, performance characteristics of different experiments.

BME-DS-451.4 Develop heat balance sheet by proper analysis of heat losses and Analyse the Effect of Heat balance sheet on the performance of the Engines.

List of Experiments:

1. To determine Calorific Value of a sample of fuel using bomb calorimeter
2. Determination of flash point and fire point of lubricating oil by Pensky-Marten's apparatus
3. To determine frictional power and draw the heat balance sheet of a four stroke single- cylinder diesel engine with rope brake Dynamometer
4. To conduct the constant speed performance test on a single cylinder diesel engine with rope brake Dynamometer and performance characteristic curves
5. To determine brake power, fuel consumption and draw the heat balance sheet of a four stroke single- cylinder petrol engine with Eddy Current Dynamometer.
6. To draw the heat balance sheet of a four stroke four cylinder petrol engine with hydraulic Dynamometer.
7. To conduct Morse test on given multi cylinder petrol engine in order to determine the Indicated Power developed in the each cylinder of the engine and to determine the Mechanical Efficiency.
8. To study the working and construction details of different Boilers with mountings and accessories in boilers
9. To determine the COP of Vapour Compression Refrigeration system
10. To determine the COP of Heat Pump
11. To determine Air-Fuel Ratio & Volumetric Efficiency of a Multi Cylinder Four Stroke Petrol Engine with Hydraulic Dynamometer.
12. To conduct a test on two stage two cylinder air compressor to determine the volumetric efficiency.

Value Added Experiments:

1. To determine the fuel properties of Biodiesel and compare it with Diesel

2. To determine the performance parameters of a single cylinder diesel engine for Biodiesel and compare it with Diesel.

Note:

1. 10 Experiments are to be performed in the semester.
2. At least eight experiments should be performed from above list. Remaining two experiments may either be performed from the above list or designed & set as per the scope of the syllabus.

Assessment Tools:

In general parameters for Internal/Continuous Assessment (Lab/Practical Courses):

Parameter	Weightage
Two Mid-Term Viva	60%
File/Record Keeping	20%
Class Performance	10%
Class Attendance	10%

Lab/Practical Course: Total Marks 100
Internal/Continuous Assessment: 50

- Two Viva: 15 Marks Each
- File/Records: 10 Marks
- Class Work/ Performance: 5 Marks
- Attendance: 5 Marks

End Semester Exam: 50 Marks

Course Articulation Matrix

CO Statement	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PS02**	**PS03**
BME-DS-451.1	1	2	-	2	-	-		3	3	1	1	3	1	2	1
BME-DS-451.2	3	3	1	3	2	-	-	3	3	3	3	3	3	1	3
BME-DS-451.3	3	3	1	3		-	-	1	3	3	3	3	3	3	1
BME-DS-451.4	2	2	-	2		-	-	-	3	3	3	3	1	2	2

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BME-DS-452: STRENGTH OF MATERIAL LAB

Periods/week Credits	Max. Marks 100
L: 0 T: 0 P: 2 1	Continuous Assessment : 50
Duration of Examination: 2 Hrs	End Semester Exam 50

Prerequisites:
Course Type: Professional Core Course

Course Outcomes:
After completion of this course the students will be able to

BME-DS-452.1 Evaluate tensile, Compressive, Impact, and shear strength of the material.
BME-DS-452.2 Measure the modulus of elasticity for three different materials using beam deflection test and calculate the SF and BM for the simply supported and cantilever beam.
BME-DS-452.3 Determine the hardness of the material through Vicker, Rockwell and Brinell hardness testing apparatus.
BME-DS-452.4 Conduct stiffness test for open coiled and closed coiled helical spring and also compare the stiffness of different materials.

List of Experiments:

1. To study the Brienell hardness/ Rockwell hardness and perform the hardness test
2. To study the Vickers hardness testing machine and perform the Vickers hardness test.
3. To study the Erichsen sheet testing machine and perform the Erichsen sheet metal test.
4. To study the Impact testing machine and perform the Impact test (Izod and Charpy)
5. To study the Universal testing machine and perform the tensile test
6. To perform compression and bending tests on UTM
7. To perform and determine the deflection of beam of different material
8. To study the torsion testing machine and perform the torsion test
9. To draw shear force, bending moment diagram for a Simply Supported Beam under point load and distributed load.
10. To study the fatigue test of the material using fatigue testing machine.
11. To Determine the Young Modulus
12. To study different end conditions of column and strut

Note:

1. 10 Experiments are to be performed in the semester.
2. At least eight experiments should be performed from above list. Remaining two experiments may either be performed from the above list or designed & set as per the scope of the syllabus.

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Assessment Tools:

In general parameters for Internal/Continuous Assessment (Lab/Practical Courses):

Parameter	Weightage
Two Mid-Term Viva	60%
File/Record Keeping	20%
Class Performance	10%
Class Attendance	10%

Lab/Practical Course: Total Marks 100
Internal/Continuous Assessment: 50

- Two Viva: 15 Marks Each
- File/Records: 10 Marks
- Class Work/ Performance: 5 Marks
- Attendance: 5 Marks

End Semester Exam: 50 Marks

Course Articulation Matrix

CO Statement	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PS02**	**PS03**
BME-DS-452.1	3	2	2	2	1	2	3	2	2	1	2	2	3	3	1
BME-DS-452.2	3	2	2	1	3	3	2	3	3	1	2	3	3	3	2
BME-DS-452.3	2	3	3	3	3	1	3	2	1	2	1	2	3	3	2
BME-DS-452.4	2	3	2	3	2	2	1	2	2	2	1	2	3	3	2

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BME-DS-453: WORKSHOP TECHNOLOGY LAB

Periods/week Credits	Max. Marks : 100
L: 0 T: 0 P: 2 1	Continuous Assessment : 50
Duration of Examination: 2 Hrs	End Semester Exam : 50

Prerequisites:

Course Type: Professional Core Course

Course Outcomes:

After completion of this course the students will be able to

BME-DS-453.1 Understand the various manufacturing processes and operations of machine tools to produce engineering components.

BME-DS-453.2 Handle measuring equipments and acquire knowledge on how accuracy and dimensions can be ascertained.

BME-DS-453.3 Select appropriate machining processes, machine tool, cutting tools, BY taking into considerations the economic aspects and process plan.

BME-DS-453.4 Practice on manufacturing of components using workshop trades including machining and welding. tools, taking into considerations the economic aspects and process plan.

List of Experiments:

1. Joining of Material by TIG welding and to measure the weld bead geometry
2. Joining of Material by MIG welding and to measure the weld bead geometry
3. Determine the diameter and measure the surface finish of a cylindrical job during traverse grinding using cylindrical grinding machining
4. Calculation of machining time and measurement of forces in a turning process in a automatic lathe.
5. Determine the press capacity and calculate the cutting force involved for washer produced using progressive die.
6. Demonstration of thread cutting and measure the pitch, external diameter and thread angle using profile projector
7. Spur gear cutting using milling machines and measurements of features using Parkinson gear tester.
8. Measure of tool wears and single point tool profile using a tool makers microscope.
9. Measurements of jobs using auto-collimator, comparator and sine bar.
10. Measurements of threaded component using floating carriage micrometer.

Value Added Experiments

1. Propose a procedural design of a jig for the specific component
2. Propose a procedural design of a fixture for the specific component

Assessment Tools:

In general parameters for Internal/Continuous Assessment (Lab/Practical Courses):

Parameter	Weightage
Two Mid-Term Viva	60%
File/Record Keeping	20%
Class Performance	10%
Class Attendance	10%

Lab/Practical Course: Total Marks 100
Internal/Continuous Assessment: 50

- Two Viva: 15 Marks Each
- File/Records: 10 Marks
- Class Work/ Performance: 5 Marks
- Attendance: 5 Marks

End Semester Exam: 50 Marks

Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS 02	PS 03
BME-DS-453.1	3	3	3	3	2	1	1	2	2	2	2	3	1	-	1
BME-DS-453.2	3	2	3	3	3	2	1	2	2	1	2	2	1	1	1
BME-DS-453.3	3	2	2	2	2	3	3	2	2	2	2	2	-	2	-
BME-DS-453.4	3	3	2	3	2	2	1	2	2	2	1	2	-	-	2

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BHM-MC-006: QAPD-I

Periods/week Credits	Max. Marks 100
L:0 T:0 P :2 AP	Continuous Assessment: 50
Duration of Exam: 2 Hrs	End Semester Exam 50

Pre-requisites: BHM-MC-004 Quantitative Aptitude
Course Type: HSMC

Course Outcomes:
After completion of the course the students will be able to
BHM-MC-006.1. Recognize & solve problems based on non-verbal reasoning.
BHM-MC-006.2. Solve complex problems based on arithmetic reasoning.
BHM-MC-006.3. Apply short tricks on complex problems of verbal reasoning.
BHM-MC-006.4. Apply correct usage of grammar in communication.
BHM-MC-006.5. Enhance their vocabulary and use it in day to day life.
BHM-MC-006.6. Develop speed reading & writing skills.

PART – A

Unit 1: Arithmetic II

1.1 Percentages
1.2Ratio & Proportion
1.3Proportionality
Variations
Partnership
Profit & Loss
Basic terminology & Formulae
Error in Weights
Marked Price and Discounts
Time & Work
Time and Work, Chain Rule
Work & Wages
Pipes & Cisterns
Mixtures &Alligations

Unit 2: Verbal Reasoning 2

Syllogism
Ranking
Coding-Decoding
Inequalities and Mathematical Operations

Unit 3: Non Verbal Reasoning

Pictorial Series
Missing Values
Analogy and Images

Part B

Unit 4: Communication Accuracy

Relevance of Verbal Ability and preparatory guidelines
Functional Grammar – Subject Verb Agreement

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Tenses – Perfect, Simple, Continuous
Common Errors and rectification

Unit 5: Word Power Building Skills

Words: Antonyms, Synonyms, Verbal Analogies
Compound words: Homophones, Homonyms, Word Families
Root Word Technique for Prefixes & Suffixes
5.4: Word Power: 7 Tips for Learning New Words
5.5 Practice Vocabulary Exercises

Unit 6: Reading & Writing Skills

Objectives of Reading, Definition & Types of Reading & Importance of Reading
Reading Techniques: SW3R, Active Reading, Detailed, Speed
Practice Exercises: Short & Medium Passages3.1 Writing: Introduction of Writing Skills, Objectives of enhancing Writing Skills & Types of Writing
Sentences, Phrases, Types of Sentences, Parts of Sentences
Paragraph Writing: Construction, Linkage & Cohesion

Text Books/Reference Books:

1. Quantitative Aptitude for Competitive Examinations: R S Aggarwal, S Chand & Company PvtLtd, Edition 2017
2. A Modern Approach to Verbal& Non Verbal Reasoning: R S Aggarwal, S Chand & Company Pvt Ltd, Edition 2018
3. Verbal Ability and Reading Comprehension: MVN Enterprises
4. Verbal Ability and Reasoning for Competitive Examinations: P.A. Anand, Wiley

Instructions for paper setting: Fifty MCQ will be set in total. Twenty five MCQ will be set from Part A and twenty five MCQ will be set from Part B. All questions will be compulsory. Each question will be of 1 mark. There will be no negative marking. Calculator will not be allowed.

Assessment Tools:

In general parameters for Internal /Continuous Assessment (Theory Courses):

Parameter	Weightage
Two Sessional (Mid-Term)Tests	60%
Assignments	20%
Class Performance	10%
Class Attendance	10%

Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS0 2	PS0 3
BHM-MC-006.1	1	-	-	-	-	1	-	-	-	-	-	1	-	-	-
BHM-MC-006.2	1	-	-	2	-	-	-	-	-	-	-	-	1	-	
BHM-MC-006.3	1	-	-	-	-	1	-	-	-	-	-	1	-	-	-
BHM-MC-006.4	1	-	-	1	-	-	-	-	1	3	-	2	-	-	-
BHM-MC-006.5	1	-	-	1	-	1	-	-	1	3	-	2	-	-	1
BHM-MC-006.6	1	2	-	1	1	1	1	1	1	3	1	2	-	-	-

MITRS

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
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NAAC 'A' Grade University
DTI- 400: Design, Thinking and Innovation-II

Periods/week Credits — Max. Marks 50
L:0 T:1 P:0 1 — Continuous Assessment : 50

Pre-requisites: Design, Thinking and Innovation-I
Course Type: Research & Training

Course Outcomes:

DTI 400.1. To understand the research methodologies/approaches/techniques used in the literature
DTI 400.2. To formulate the experimental procedures / algorithms based on research methodology
DTI 400.3. To develop prototype by experiment / simulation.
DTI 400.4. To analyze the recorded data / output.

Activity 1: Methodology Study & Matrix design.
Analysis of different approach/methodology adopted by various researchers
Comparative analysis
Prospective Design.

Activity 2: Design of experiments
Finalization of experimental procedure / algorithm design.
Procurement of materials / Hardware and Software.
2.3. Develop experimental setup / design

Activity 3: Execution of experiments/simulations
Conduct experiments/ build prototype.
Modification of the experimental set-up / algorithm.

Activity 4:
Tabulating and analyzing data / output.
Assessment of the output with earlier published work / product
Interpretation and presentation of the results / outcome.

Course Articulation Matrix:

CO Statement (XX-400)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
DTI-400.1	3	-	-	2	3	3	-	2	1	-	-	-	1	-
DTI -400.2	3	3	-	3	3	2	1	3	2	-	3	1	3	2
DTI -400.3	3	-	2	2	2	-	3	3	3	3	3	2	3	3
DTI -400.4	3	3	2	1	2	2	2	-	2	2	2	2	3	2

'3' (Tick) or 'More' Substantial/High Correlation, '2' Moderate/Medium Correlation, '1' Slightly/Low Correlation, 'Blank' No Correlation

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Evaluation Criteria: The following evaluation parameters shall be considered for internal assessment by both research coordinators and faculty coordinator or research mentors:-

S. No.	Parameters	Description	
1.	**Attendance**	• Percentage of classes attended by the students	**5**
2.	**Continuous Performance**	Group participation and response of the students to a given task: • Judge individual student in the group • Meeting timelines as per lesson plan	**15**
3.	**Experimental Setup / Design**	• Assessment of experimental set up / design • Evaluation of result / outcome. • Validation of results. • Novelty / Relevance of work.	**20**
4.	**Structuring and presentation**	• Structuring and presentation • Group presentation with individual contribution	**10**

References:

1. http://www.sciencedirect.com/
2. https://www.ncbi.nlm.nih.gov/pubmed
3. https://www.elsevier.com/books-and-journals
4. https://www.plos.org/
5. https://www.deepdyve.com/
6. http://ieeexplore.ieee.org/Xplore/home.jsp
7. https://www.researchgate.net/
8. https://www.science.gov/
9. https://scholar.google.co.in/
10. http://www.popsci.com/

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BEC-DS-403: MICROPROCESSORS AND MICROCONTROLLERS

Periods/week Credits	Max. Marks 200
L: 3 T: 0 3	Continuous Assessment 100
Duration of Examination: 3 Hrs	End Semester Examination 100

Pre-requisites: BEC-DS-302 Digital Electronics
Course Type: Program Core

Course Outcomes

The students will be able to
BEC-DS-403.1. Identify the main function and application of microprocessor and microcomputers.
BEC-DS-403.2. Describe the architecture of 8 bit, 16 bit microprocessor and 8051 microcontroller.
BEC-DS-403.3. Demonstrate the concept of memory and Peripherals Interfacing with microprocessor and microcontroller.
BEC-DS-403.4. Apply Instruction set to develop microprocessor and microcontroller based applications
BEC-DS-403.5. Illustrate the functioning of various timers and Interrupts of 8051 microcontroller.

PART-A

Unit 1: Introduction to 8085 Microprocessors

Evolution of Microprocessors, Comparison of microprocessors and microcontrollers
Architecture of 8085 microprocessor, Pin configuration, Signal description and De-multiplexing of address data lines, Addressing modes, Instruction set, Timing diagram of MOV, MVI, IN and OUT Instructions
Interrupt structures

Unit 2: 8086 Architecture

Architecture of 8086 microprocessor
Concept of BIU and EU, Pin configuration, Signal description and De multiplexing of address data lines
Pipelining, Memory segmentation and Memory banking
Minimum mode and Maximum mode configurations, Interrupt structure
Introduction to Co-processor 8087

Unit 3: Instruction Set and Assembly Language Programming

Addressing modes of 8086 microprocessor, Instruction format
Instructions of 8086 microprocessor: Data transfer Instructions, Arithmetic Instructions, Logical Instructions
String Manipulation Instructions, Control Transfer Instructions, Processor control Instructions, BCD Instructions
Programming examples, Assembler directives and operators, Timing diagrams

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PART-B

Unit 4: Introduction to 8051

Introduction to 8051 microcontroller
Architecture
Addressing modes
4.4Instruction set of 8051

Unit 5: Timers& Interrupts

Various timers and registers of 8051 microcontroller
Various modes of operation of timers
Various interrupt codes of 8051
Simple programming examples

Unit 6: Serial Interface

Introduction to serial interface
SCON and SBUF registers, generation of control word
Various modes of operation of serial interface
Serial port baud rates
Use of Timer1 as baud rate clock generator
Simple programming examples like interfacing with LCD.

Text Books/ Reference Books:

1. Ramesh S. Gaonker,2011, Microprocessor Architecture, Programming & Applications with 8085, 5th Edition, Wiley.
2.Barry B. Brey, 2009, The Intel Microprocessors 8086/Pentium Processors, 8th Edition, Pearson Prentice Hall.
3. Mohammad Ali Mazidi, Janice GillispieMazidi and Rolin McKinlay, 2007, 8051 Microcontroller and Embedded Systems Using Assembly and C, 2nd Edition, Pearson Education.
4.I. Scott Mackenzie and Raphael C. W. Phan, 2008, The 8051 Microcontroller, 4th Edition, Pearson Education.

Software required/Weblinks:
8085 Simulator
EMU-8086
Keil µVision 4
nptel.ac.in/courses/117104072
http://nptel.ac.in/downloads/106108100/

Instructions for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each Part A and Part B (one from each unit). Student needs to attempt two questions out of three from each part. Each question will be of 20 marks.

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Distribution of Continuous Assessment:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Assessment Tools:

Theory Course: Total Marks 200
Internal/Continuous Assessment: 100

- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

Course Articulation Matrix

CO Statement (BEC-DS-403)	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
BEC-DS-403.1	1	1	1	1	2	-	-	-	-	-	-	2	1	-	3
BEC-DS-403.2	1	1	2	1	3	-	-	-	-	-	-	2	2	-	3
BEC-DS-403.3	1	2	3	3	3	-	-	-	-	-	-	3	2	1	3
BEC-DS-403.4	2	2	3	3	3	-	-	-	-	-	-	3	2	-	3
BEC-DS-403.5	1	2	2	3	3	-	-	-	-	-	-	2	2	-	3

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BEC-DS-453: MICROPROCESSORS AND MICROCONTROLLERS LAB

Periods/week	Credits	Max. Marks	: 100
P:2	1	Continuous Assessment	: 50
Duration of Examination: 2 Hrs		End Semester Examination	: 50

Co-requisites: BEC-DS-403: Microcontrollers
Course Type: Program Core

Course Outcomes: The students will be able to
BEC-DS-453.1. Describe the importance and function of each pin of 8085, 8086 microprocessor and 8051microcontroller.
BEC-DS-453.2. Apply arithmetic, data transfer and string manipulation instructions to write assembly language program.
BEC-DS-453.3. Analyze branching and loop control instructions.
BEC-DS-453.4. Implement interfacing with switches, keyboard and display devices.
BEC-DS-453.5. Realize concepts of timers and interrupts to generate waveforms

LIST OF EXPERIMENTS:

1. To understand the working of 8085 and 8086 Microprocessor kit.
2. To write and execute a program using 8085 for finding the largest/smallest number from an array and verify the result.
3. To write and execute a program using 8086 for performing the various arithmetic operations and verify the result.
4. To write and execute a program using 8086 to copy 12 bytes of data from source to destination and verify the result.
5. To write and execute a program using 8086 for Hexadecimal to Gray code conversion by using look up table and verify the result.
6. To write and execute a program using 8086 for arranging an array of numbers in ascending order and verify the result.
7. To understand the development tools for 8051 microcontroller programming & Assembly language programming style.
8. To write and execute a program using 8051 for performing the various arithmetic operations and verify the result.
9. To write a program to flash all the LED of o/p part.
10. To write a program to generate 10 KHz square wave using Timers and interrupts.
11. To write a program to display a string on LCD display.
12. To write a program to Interface a Buzzer and Relay with 8051.

PROJECTS BASED ON ABOVE EXPERIMENTS:

1. To display a string on LCD Display and verify the result.
2. To reverse a string stored in memory and verify the result
3. To interface L293 Motor Driver IC with 8051 microcontroller.
4. To interface a Real Time Clock (RTC) with 8051 microcontroller.
5. To design an alarm clock using 8051 microcontroller and RTC.
6. To design a line follower Robot using 8051 microcontroller.

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7. To control the speed of DC motor using PWM.

NOTE: Every student needs to do minimum 10 number of experiments/practicals and 1 project in a semester. 20% new experiments should be added every year.

Distribution of Continuous Assessment:

Viva- I	30%
Viva- II	30%
File/Records	20%
Class Work/ Performance	10%
Attendance	10%

Lab/Practical Course: Total Marks 100
Internal/Continuous Assessment: 50

- Two Viva: 15 Marks Each
- File/Records: 10 Marks
- Class Work/ Performance: 5 Marks
- Attendance: 5 Marks

End Semester Exam: 50 Marks

Assessment Tools:
Experiments in lab
File work/Class Performance
Viva (Question and answers in lab)
End Term Practical Exam

Course Articulation Matrix

CO Statement (BEC-DS-453)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
BEC-DS-453.1	1	2	2	2	1	-	-	-	-	-	-	2	2	2	1
BEC-DS-453.2	1	2	3	2	2	-	-	-	-	-	-	3	2	2	1
BEC-DS-453.3	2	3	3	3	3	-	-	-	-	-	-	3	2	2	2
BEC-DS-453.4	1	2	2	2	2	-	-	-	-	-	-	2	2	2	1
BEC-DS-453.5	2	3	3	2	3	-	-	-	-	-	-	3	2	2	2

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BEE-DS-421 Fundamentals of Electric and Hybrid Vehicles

Periods/week	Credits	Max. Marks : 200
L: 2 T: 0	2	Continuous Evaluation:100
Duration of Ext. Exam: 3 Hrs		End Semester Exam:100

Pre-requisites: Nil
Course Type: Program Core

Course Outcomes: After completion of this course the students will be able to
BEE-DS-421.1 Differentiate among different types of Electric and Hybrid Vehicles and their configurations.
BEE-DS-421.2 Select suitable electric propulsion system for EV and HEV.
BEE-DS-421.3 Determine the rating of energy source requirement of EV and HEV.
BEE-DS-421.4 Analyze the functioning parts of Electric and Hybrid vehicles for better performance.

Part A

Unit 1 Introduction to Electric Vehicles:
Evolution of Electric Vehicles,
EV configurations - Fixed and variable gearing,
Single- and multiple-motor drives,
In-wheel drives,
Parameters of EV systems - Weight and size parameters,
Force parameters, Energy parameters, Performance parameters.

Unit 2 Hybrid EV systems:
HEV configurations - Series hybrid system,
Parallel hybrid system, Series-parallel hybrid system,
Complex hybrid system,
Power flow control in Series hybrid system,
Parallel hybrid system,
Series-parallel hybrid system,
Complex hybrid system, Case Study.

Unit 3 Electric Propulsion Systems:
DC motor drives,
Induction motor drives,
Permanent-magnet motor drives,
Switched reluctance motor drives and their role in EV and HEV systems.
Performance study of electrical propulsion system with respect to application.

Part-B

Unit 4 Energy Sources in EV and HEV systems:
Electrochemical Batteries – Terminology,
Specific Energy, Specific Power, Energy Efficiency in Lead-Acid Batteries,
Nicked based batteries, Lithium based batteries,
Requirement of Ultra capacitors – Features,
Principle of operation and Performance of Ultra Capacitors,
High Speed Flywheels – Operating Principles,
Fuel Cell – Principle of Operation and Performance .

Unit 5 EV Auxiliary Systems:

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Battery characteristics and chargers,
Battery indication, Temperature control unit,bPower Steering Unit,bAuxiliary Power Supply, Navigation system

Unit-6 Case Study: Public and Domestic Charging Infrastructure for Electric Vehicle

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Text Books/Reference Books:

1. C.C Chan, K.T Chau,2001, Modern Electric Vehicle Technology, Oxford University Press Inc., New York.
2. Iqbal Hussein, 2003, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
3. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, 2004, Modern Electric, Hybrid Electric and FuelCell Vehicles: Fundamentals, Theory and Design, CRC Press.
4. James Larminie, John Lowry,2003, Electric Vehicle Technology Explained, Wiley.
5. T. Denton,2016, Electric and Hybrid Vehicle, 2nd Edition, Institute of the Motor Industry.
6. S K Maini 2013, Reva EV: India's Green Gift to the World, Random Businees.
7. Anupam Singh 2019 , Electric Vehicles : And the End of ICE age ,Adhyyan Books.

Softare links

https://nptel.ac.in/courses/108/106/108106170/
https://nptel.ac.in/courses/108/102/108102121/
https://nptel.ac.in/courses/108/103/108103009/

Evaluation Tools:

Assignment/Tutorials 20 Marks
Sessional tests 60 Marks
Class Quiz 20 Marks
Term end examination 100 Marks

Assignments, Sessional and End Semester Examination paper will consist of various difficulty levels to accommodate the different capabilities of students. Assessment should cover all course outcomes and upper limit for lower order skills will be 40% (for knowledge-oriented questions). However, weightage for different cognitive levels in the question papers can vary.

The paper setter must ensure the coverage of the entire syllabus while setting the question papers and mention the learning outcomes across each section to be measured by the examination. Weightage of the sections may vary as per the number of respective lecture hours mentioned in the syllabus. Action verbs should be used from Bloom's Taxonomy while designing question papers.

Course Articulation Matrix:

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
BEE-DS-421.1	2	-	-	-	-	-	-	-	-	-	-	-	2	2	-
BEE-DS-421.2	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-
BEE-DS-421.3	-	-	2	-	-	-	-	-	-	-	2	2	-	-	-
BEE-DS-421.4	-	-	2	-	-	-	-	2	-	-	-	-	3	2	-

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BME-DS-412: Electric Vehicle Safety and Standards

Periods/week	Credits	Max. Marks	200
L: 2 T: 0	2	Continuous Evaluation	100
Duration of Ext. Exam: 3 Hrs		End Semester Exam	100

Pre-requisites: Nil
Course Type: Program Core

Students will be able to
BME-DS-412.1: Understand the scientific concept behind different vehicle safety .
BME-DS-412.2: Identify and select the safety equipments for vehicles
BME-DS-412.3: Understand the need of standards and their types for Electric and Hybrid vehicles..
BME-DS-412.4: Select and analyze the standards for Electric and Hybrid vehicles.

PART A

Introduction
Design of the body for safety, energy equation, engine location, deceleration of vehicle inside passenger compartment, deceleration on impact with stationary and movable obstacle, concept of crumble zone, safety sandwich construction.

Safety Concepts
Active safety: driving safety, conditional safety, perceptibility safety, operating safety- passive safety: exterior safety, interior safety, deformation behaviour of vehicle body, speed and acceleration characteristics of passenger compartment on impact.

Safety Equipments
Seat belt, regulations, automatic seat belt tightener system, collapsible steering column, tiltable steering wheel, air bags, electronic system for activating air bags, bumper design for safety.

PART B

EV Standards
AIS-038: Construction and Functional Safety Requirements
AIS-039: Measurement of Electrical Energy Consumption
AIS-040: Method of Measuring the Range
AIS-041: Measurement of Net Power and The Maximum 30 Minute Power
AIS-049: CMVR Type Approval for Electric Power Train Vehicles

HEV Standards
AIS-102 (Part 1): CMVR Type Approval for Hybrid Electric Vehicles
AIS-102 (Part 2): CMVR Type Approval for Hybrid Electric Vehicles of M and N Category with GVW > 3500 kg
AIS-048: Battery Operated Vehicles - Safety Requirements of Traction Batteries

Retrofitment Standards AIS-123 (Part 1, 2 & 3)
a. AIS 123 (PART 1): CMVR Type Approval of Hybrid Electric System Intended for Retrofitment on Vehicles of M and N Category having GVW <= 3500 kg

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b. AIS-123 (Part 2) CMVR Type Approval of Hybrid Electric System Intended for Retrofitment on Vehicles of M and N Category having GVW > 3500 kg
c. AIS-123 (Part 3): CMVR Type Approval of Electric Propulsion Kit Intended for Conversion of Vehicles for Pure Electric Operation

Source1: https://emobility.araiindia.com/standards/
Source 2: Veltech University & Anna University

Text Book
1. Bosch - "Automotive Handbook" - 5th edition - SAE publication - 2000.

References
1. J.Powloski - "Vehicle Body Engineering" - Business books limited, London - 1969.
2. Ronald.K.Jurgen - "Automotive Electronics Handbook" - Second edition- McGraw-Hill Inc., - 1999.

Evaluation Tools:
Assignment/Tutorials 20 Marks
Sessional tests 60 Marks
Class Quiz 20 Marks
Term end examination 100 Marks

Assignments, Sessional and End Semester Examination paper will consist of various difficulty levels to accommodate the different capabilities of students. Assessment should cover all course outcomes and upper limit for lower order skills will be 40% (for knowledge-oriented questions). However, weightage for different cognitive levels in the question papers can vary.

The paper setter must ensure the coverage of the entire syllabus while setting the question papers and mention the learning outcomes across each section to be measured by the examination. Weightage of the sections may vary as per the number of respective lecture hours mentioned in the syllabus. Action verbs should be used from Bloom's Taxonomy while designing question papers.

Course Articulation Matrix:

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
BME-DS-412.1	2	-	-	-	-	-	-	-	-	-	-	-	2	2	-
BME-DS-412.2	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-
BME-DS-412.3	-	-	2	-	-	-	-	-	-	-	2	2	-	-	-
BME-DS-412.4	-	-	2	-	-	-	-	2	-	-	-	-	3	2	-

MKTRS

Vth Semester

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BME-DS-501A: THEORY OF MACHINES

Periods/week CreditsMax. Marks : 200

L: 3 T: 1 P: 0 4 Continuous Assessment : 100

Duration of Examination: 3 Hrs End Semester Exam : 100

Prerequisites: BME-DS-301: Engineering Mechanics

Course Type: Professional Core Course

Course Outcomes:

After completion of this course the students will be able to

BME-DS-501.1A: Understand the function of mechanism and gyroscopic effect in common machines

BME-DS-501.2A: Understand the dynamics involved in the study of displacement, velocity, acceleration and jerk of a mechanism

BME-DS-501.3A: Analyze balancing problems in rotating and reciprocating machinery

Part-A

Unit 1: Simple Mechanisms

Machine and structure, kinematic link, pair, types of constrained motion, Kinematic chain, mechanism, degree of freedom, Kutzbach criterion, Grubler's criterion, inversions of four bar mechanism, single slider and double slider crank chain, Introduction to synthesis mechanism, Chebychev's Spacing.

Unit 2: Gear and Gear Trains

Classification of gears, terms used for gearing, law of gearing, cycloidal and involute profiles and their comparison, length of path of contact, length of arc of contact, contact ratio, interference in involute gears, minimum number of teeth on pinion to avoid interference, minimum number of teeth on gear to avoid interference, problems. Types of gear trains, simple and compound gear trains, reverted gear train, epicylic gear train, compound epicyclic gear train, torque in epicyclic gear train, problems.

Unit 3: Cam and Follower

Classification of cams and followers, displacement, velocity and acceleration diagrams for uniform velocity motion of follower, for SHM follower motion, for uniform acceleration and retardation motion of follower and for cycloidal motion of follower, synthesis of cam profile for radial cam with knife edge follower – without offset and with offset, synthesis of cam profile for radial cam with roller follower without and with offset, tangent and circular arc cams, problems.

Part-B

Unit 4: Balancing of rotating and reciprocating masses

Introduction to static and dynamic balancing, analytical and graphical method, transfer of a force from one plane to another, problems. Primary and secondary unbalanced forces, balancing of primary unbalanced force, balancing of locomotives, Hammer Blow, variation of tractive force, swaying couple,

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problems, secondary balancing, balancing of inline engines – two cylinder, four cylinder and six cylinder, balancing of radial engines – direct and reverse crank method, problems.

Unit 5: Governor and Flywheel

Classification of governors, centrifugal governors, terms used in governors, Watt and Porter governors, Proell governor, Hartnell governor, inertia governor, sensitiveness, hunting, isochronism and stability of governor, controlling force of governor, problems. Turning moment diagram, fluctuation of energy, Coefficient of fluctuation of energy, coefficient of fluctuation of speed and energy stored in flywheel

Unit 6: Gyroscope

Total angular acceleration of a disc in precessional motion, active and reactive gyroscopic couple, gyroscopic effect on aeroplane, gyroscopic effect on ship while turning, pitching, rolling, stability of four-wheeler while turning, stability of a two-wheeler while turning, problems.

Text Books:

1. S.S. Rattan, " Theory of Machines", Tata McGraw Hill Publication
2. R.S.Khurmi," Theory of Machines", Eurashia Publishing House
3. A Ghosh and A K Mallik, "Theory of mechanisms and machines", East-West Press
4. R.L. Norton, "Kinematics and Dynamics of Machinery", Tata McGraw-Hill

Reference Books:

1. J. E. Shigley, J. J. Uicker, " Theory of Machines and Mechanisms", McGraw Hill
2. V.P.Singh, "Theory of Machines", Dhanpat Rai Publication
3. Thomas Bevan, "The Theory of Machines", CBS publishers and distributers
4. P.L. Ballaney, "Theory of Machines and Mechanism", Khanna Publishers

Weblinks:

- https://nptel.ac.in/courses/112104121/
- https://nptel.ac.in/courses/112104114/
- https://nptel.ac.in/courses/112105268/

Instructions for setting of Paper Seven questions are to set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each part A and part B (one from each unit). Student needs to attempt two questions out of three questions from each part. Each question will be of 20 marks.

Assessment Tools:

In general parameters for Internal /Continuous Assessment (Theory Courses):

Parameter	Weightage
Two Sessional (Mid-Term)Tests	60%
Assignments	20%

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Class Performance	10%
Class Attendance	10%

Theory Course: Total Marks 200
Internal/Continuous Assessment: 100

- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
BME-DS-501A.1	3	3	3	-	2	3	2	-	2	2	-	3	3	3	2
BME-DS-501A.2	3	3	3	3	-	2	-	-	2	2	-	3	3	3	2
BME-DS-501A.3	3	3	3	1	-	1	-	-	1	-	-	1	3	3	3

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BHM-MC-008: QAPD-II

Periods/week	Credits	Max. Marks: 100
L:0 T:0 P :2	AP	Continuous Assessment: 50
Duration of Exam: 2 Hrs		End Semester Exam :50

Pre-requisites: BHM-MC-006 QAPD-I
Course Type: Elective

Course Outcomes:After completion of this course the students will be able to
BHM-MC-008.1. Analyze various forms of data.
BHM-MC-008.2. Solve complex problems based on arithmetic reasoning.
BHM-MC-008.3. Apply short tricks on complex problems of number system.
BHM-MC-008.4. Enhance and expand word knowledge by fostering word consciousness.
BHM-MC-008.5. Construct simple and complex sentences accurately.
BHM-MC-008.6. Develop reading skills & build verbal reasoning skills.

PART – A

Unit 1: Number System II
- Factors and Multiples
- Unit Digits & Cyclicity
- Remainders
- Factorials
- Logarithm

Unit 2: Arithmetic III
- Interest
  - Simple Interest
  - Compound Interest
    - Relation between SI & CI
- Time, Speed & Distance
  - Basics Formulas & Proportionality
  - Average & Relative Speed
  - Trains and Boats & Streams
  - Circular Motion and Clocks

2.3Data Interpretation
- Table and Bar graph
- Line and Pie Charts
- Mixed Charts and Caselets

Unit 3: Verbal Reasoning III

3.1 Calendar 3.2 Cubes and Dices 3.3 Data Sufficiency

PART – B

Unit 4: Advanced Vocabulary
- Synonym & Antonym
- One Word Substitution
- Ordering of Words
- Idioms and Phrases

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Vocabulary, COW, Punctuation

Unit 5: Sentence Construction & Syntax

Sentence Improvement
Spotting Errors
Ordering of Sentences
Change of Voice/ Direct & Indirect speech
Completing Statements/Sentences

Unit 6: Reading Comprehension & Reasoning

Strategic Reading, Eliminating Poor Reading Habits
Techniques to increase speed reading, comprehension and recall
Solving Sample RC Passages
Closet Test
Para Jumbles

Text Books/Reference Books:

1. Quantitative Aptitude for Competitive Examinations: R S Aggarwal, S Chand & Company PvtLtd, Edition 2017
2. A Modern Approach to Verbal& Non Verbal Reasoning: R S Aggarwal, S Chand & Company Pvt Ltd, Edition 2018
3. An Advanced Approach to Data interpretation: R S Aggarwal, S Chand & Company PvtLtd, latest Edition
4. Verbal Ability and Reasoning for Competitive Examinations: P.A. Anand, Wiley

Instructions for paper setting: Fifty MCQ will be set in total. Twenty five MCQ will be set from Part A and twenty five MCQ will be set from Part B. All questions will be compulsory. Each question will be of 1 mark. There will be no negative marking. Calculator will not be allowed.

Assessment Tools:

In general parameters for Internal /Continuous Assessment (Theory Courses):

Parameter	Weightage
Two Sessional (Mid-Term)Tests	60%
Assignments	20%
Class Performance	10%
Class Attendance	10%

Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PS02	PS03
BHM-MC-008.1	1	-	-	-	-	1	-	-	-	-	-	1	-	-	-
BHM-MC-008.2	1	-	-	-	-	1	-	-	-	-	-	1	1	-	-
BHM-MC-008.3	1	-	-	2	-	-	-	-	-	-	-	-	-	-	1
BHM-MC-008.4	1	-	1	-	-	-	-	-	1	3	1	2	-	-	-
BHM-MC-008.5	1	-	1	1	-	1	-	-	1	3	1	2	-	-	-
BHM-MC-008.6	1	-	-	-	-	-	-	-	-	1	-	-	-	-	1

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PROJ-ME-500: SUMMER INTERNSHIP-II

Duration of Training: 4 weeks | Max. Marks 100
Credits: 2 | Continuous Assessment : 100

Pre-requisites: Solid foundation of Core Subjects
Course Type: Internships/Seminars

Course Outcomes
After the completion of the course the students will be able to:

Proj-ME-500.1. Analyze the real working environment and get acquainted with the organizational structure, business operations and administrative functions.
Proj-ME-500.2. Apply subject knowledge to related fields so that they can relate and reinforce what has been taught at the university.
Proj-ME-500.3. Develop synergetic collaboration between industry and the university.
Proj-ME-500.4. Demonstrate the role of the professional/specialist/manager/supervisor confidently in the relevant industry.
Proj-ME-500.5. Explore options in their career plans and make a gradual transition from academia to professional career.

Every student will have to undergo Industrial Training for 4 weeks in the relevant field of Engineering in which he/she is enrolled for B.Techprogramme after 4th semester. Respective Head of Department will approve the Industry/Organization for training. During this course of time he/she will be regularly monitored and evaluated. Before he/she is again registered for next semester i.e. 5th semester of studies, the student will have to submit the training report, deliver a seminar about the work/project undertaken during the training and will have to appear for viva. The evaluation of the industrial training shall be made as following:

Assessment Tools:
Continuous Evaluation during training:

1. Evaluation by the Supervisor in the Industry	:	30 marks
2. Evaluation by Faculty mentor during training visit	:	30 marks
3. Internal Seminar/Presentation	:	40 marks
Total Internal Marks	:	**100**
Total Credits	**:**	**2**

The parameters for evaluation during the training for Supervisor shall be as under:

		Marks
a)	Work/Project undertaken	5
b)	Punctuality/ Regularity	5
c)	Discipline/ Overall Conduct/ Relations with Seniors and others	5
d)	Eagerness to acquire Technical Knowledge	5
e)	Overall Proficiency achieved during Training	5

f) Any contribution to the organization 5

Total 30

The parameters for evaluation by the faculty during training shall be as under:

a) Maintenance of Training Diary and Regularity 5
b) Relations with Seniors and others 5
c) Overall Conduct 10
d) Willingness to Work 5
e) Proficiency achieved 5

30

Course Articulation Matrix

CO Statement (Proj-ME-500)	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
Proj-ME-500.1	3	3	3	3	3	2	3	3	3	3	3	2	3	3	3	3
Proj-ME-500.2	3	3	3	3	3	2	3	3	3	3	3	2	3	3	3	3
Proj-ME-500.3	3	3	2	3	3	2	2	3	3	3	3	2	3	3	3	3
Proj-ME-500.4	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3
Proj-ME-500.5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

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BME-DS-522A: MECHATRONICS SYSTEMS & CONTROL

Periods/week Credits — Max. Marks :200
L: 3 T:0 P: 0 3 — Continuous Assessment :100
Duration of Examination: 3 Hrs — End Semester Exam :100

Prerequisites: BEC-DS-421: Basic of Electronics Engineering
Course Type: Domain Specific Elective Course (Compulsory)

Course Outcomes:
After completion of this course the students will be able to

BME-DS-522A.1 Identify key elements of Mechatronics system.

BME-DS-522A.2 Acquire knowledge of Sensors, Actuators as well as Mathematicalmodeling and its application in industries.

BME-DS-522A.3 Understand the principle and working of signal conditioning, data presentation system and various Mechatronics products.

Part-A

Unit 1: Introduction

Definition of Mechatronics, systems, measurement systems, control systems, programmable logic controller, Mechatronics in manufacturing products and design, comparison between Traditional and Mechatronics approach

Unit 2: Sensors

An introduction to sensors, classification, static and dynamic characteristics, sensors for motion and position, force, torque and tactile sensors, flow sensors, temperature sensing devices, range sensors, ultrasonic sensors

Unit 3: Pneumatic and Hydraulic Actuation Systems

Actuation systems, pneumatic and hydraulic systems, directional control valves, pressure control valves, cylinders, servo and proportional control valves, process control valves, rotary actuators

Part-B

Unit 4: System Modeling

Mathematical models, building blocks of mechanical, electrical, fluid and thermal system, rotational-translation systems, electromechanical systems, hydraulic-mechanical systems

Unit 5: Data Presentation System

Data presentation systems – displays, data presentation elements; magnetic recording, data acquisition systems, testing and calibration

Unit 6: Mechatronics Product Design

Autotronics: Wind screen wiper motion, Engine management system, Digital speedometer and odometer, Automatic dim and bright control, Engine temperature measurements, Radiator

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water level indicator, Bath room scale, A pick and place robot, Automatic camera, Bar code recorder

Text Books:

1. Mechatronics by W. Bolton, Published by Addition Wesley.
2. Mechatronics System Design-Devdas Shetty and Richard A. Kolk Thomson Brooks/Cole 1997.
3. Introduction to Mechatronics and Measuring System: David G. Alciation and Michael B. Hist, Tata McGraw Hill.
4. Mechatronics Principles, Concepts and Application, Mahalik, N.P. Tata McGraw Hill.

Reference Books:

1. Introduction to Mechtronics: AppuuKuttan, K. K. Oxford Higher Education.

Weblinks:

http://nptel.ac.in/courses/112103174
http:/nptel.ac.in/syllabus/112103174

Instructions for setting of Paper Seven questions are to set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each part A and part B (one from each unit). Student needs to attempt two questions out of three questions from each part. Each question will be of 20 marks.

Assessment Tools:

In general parameters for Internal /Continuous Assessment (Theory Courses):

Parameter	Weightage
Two Sessional (Mid-Term)Tests	60%
Assignments	20%
Class Performance	10%
Class Attendance	10%

Theory Course: Total Marks 200
Internal/Continuous Assessment: 100

- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO 3
BME-DS-	3	3	3	3	2	2	2	2	2	2	2	3	3	3	3

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522A.1															
BME-DS-522A.2	3	2	3	2	3	3	3	2	3	2	3	3	3	3	3
BME-DS-522A.3	3	2	2	2	3	3	3	2	3	2	3	3	3	3	3

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BME-DS-551: THEORY OF MACHINES LAB

Periods/week	Credits	Max. Marks: 100
L: 0 T: 0 P: 2	1	Continuous Assessment : 50
Duration of Examination: 2 Hrs		Semester Exam : 50

Prerequisites:
Course Type: Professional Core Course

Course Outcomes:
After completion of this course the students will be able to
BME-DS-551.1 Remember and create new linkages for machines and mechanisms using Grashof's law
BME-DS-551.2 Understand the theory of cams, gears and gear trains.
BME-DS-551.3 Evaluate the performance of types of governors and gyroscopes.
BME-DS-551.4 Analyze the conditions of static and dynamic balancing of rotor practically used for balancing in automobile industries.

List of Experiments:

1. To study models of different types of mechanisms and study of Grashoff's Law.
2. To study models of different types of cam and follower arrangements and draw cam profile
3. To study models of different types of gears and gear trains and perform simple and compound gear train
4. To perform analysis of epicyclic gear train
5. To perform experiments on Watt and Porter governors to prepare performance characteristics curve
6. To perform experiment on Proell governor to prepare performance characteristics curve
7. To perform experiment on Hartnell governor to prepare performance characteristics curve
8. To study gyroscopic effect and to determine gyroscopic couple on motorized gyroscope
9. To perform the experiment on static balancing on balancing machine
10. To perform the experiment on dynamic balancing on balancing machine

Value Added Experiments:

1. To determine moment of inertia of a rod by physical pendulum method.
2. To determine whirling of shaft.
3. To calculate Coriolis component of acceleration.

Note:

1. 10 Experiments are to be performed in the semester.

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2. At least eight experiments should be performed from above list. Remaining two experiments may either be performed from the above list or designed & set as per the scope of the syllabus.

Assessment Tools:

In general parameters for Internal/Continuous Assessment (Lab/Practical Courses):

Parameter	Weightage
Two Mid-Term Viva	60%
File/Record Keeping	20%
Class Performance	10%
Class Attendance	10%

Lab/Practical Course: Total Marks 100
Internal/Continuous Assessment: 50

- Two Viva: 15 Marks Each
- File/Records: 10 Marks
- Class Work/ Performance: 5 Marks
- Attendance: 5 Marks

End Semester Exam: 50 Marks

Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PS02	PS03
BME-DS-551.1	3	-	3	2	2	-	1	-	2	-	-	3	3	-	3
BME-DS-551.2	2	3	2	3	-	3	-	-	1	3	-	3	3	-	3
BME-DS-551.3	-	3	3	-	3	2	-	-	1	-	2	1	3	3	-
BME-DS-551.4	3	-	2	3	3	1	-	-	-	-	1	1	3	3	-

MBIRS

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

HM 506: FRENCH I

Periods/week	Credits	Max. Marks	: 100
P:2	2	Continuous Assessment	: 50
Duration of Examination: 1.5 Hrs		End Semester Examination	50

Course Type: Elective
Course Outcomes:
The student will be able to:

HM-506.1. Exchange greetings and do introductions using formal and informal expressions. Understand and use interrogative and answer simple questions.
HM-506.2. Learn Basic vocabulary that can be used to discuss everyday life and daily routines, using simple sentences and familiar vocabulary. Express their likes and dislikes. Also will have understanding of simple conversations about familiar topics (e.g., greetings, weather and daily activities,) with repetition when needed.
HM-506.3. Identify key details in a short, highly-contextualized audio text dealing with a familiar top relying on repetition and extra linguistic support when needed. Describe themselves, otpeople, familiar places and objects in short discourse using simple sentences and basic vocabulary.
HM-506.4. Describe themselves, other people, familiar places and objects in short discourse using simple sentences and basic vocabulary. Provide basic information about familiar situations and topics of interest.
HM-506.5. Express or/and justify opinions using equivalents of different verbs. Differentiate certain patterns of behavior in the cultures of the French-speaking world and the student's native culture.

PART-A

Unit 1: Saluer et épelerl'alphabet
Les Salutations & forms of politeness
Alphabets

Unit 2: Usage de Vous et de Tu
Taking leave expressions
Les pronomssujets
Basic Questions

Unit 3: Présentez-vous
Les verbes ER
Self introduction
Décrivezvotreami(e)

PART-B

Unit 4: Identifier un nombre, compter
Les noms
VerbesAvoir, Etre, Aller & Faire
Les nombres

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Unit 5: Demander/ donner l'explications

Les articles define et indefini
Les mois de l'annee
Les jours de la semaine

Unit 6: Parler des saisons et demander l'heure

Time
Weather
Unseen Passage

Text Books/Reference Books/ Suggested Readings:

1. Annie Berthet, Catherine Hugot, Veronique M Kizirian , 2006, Alter Ego Level One Textbook, Hachette Publications
2. Mahitha Ranjit, 2014, Apprenons Le Francais II & III, Saraswati Publications

Weblinks:

www.bonjourfrance.com
www.allabout.com

Instructions for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Student needs to attempt four questions from the remaining six questions. Five questions need to be attempted in total. Each question will be of 10 marks.

Assessment Tools:

Sessional tests
Term end examination scores
Participation in class activities
Home assignments
Class attendance

Distribution of Continuous Assessment:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Course Articulation Matrix

CO Statement (HM–506)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
HM-506.1	-	-	-	-	-	1	1	-	-	1	-	1	-	-	-
HM-506.2	-	-	-	-	-	1	1	-	-	1	-	1	-	-	-
HM-506.3	-	-	-	-	-	1	1	-	-	1	-	1	-	-	-
HM-506.4	-	-	-	-	-	1	1	-	-	1	-	1	-	-	-
HM-506.5	-	-	-	-	-	1	1	-	-	1	-	1	-	-	-

MRIRS

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(Deemed to be University under section 3 of the UGC Act 1956)

HM 507: GERMAN I

Periods/week	Credits	Max. Marks	: 100
P:2	2	Continuous Assessment	: 50
Duration of Examination: 1.5 Hrs		End Semester Examination	50

Course Type: Elective

Course Outcomes: Students will be able to

HM-507.1. Exchange greetings and introductions using formal and informal expressions. They will be able to ask and answer simple questions.

HM-507.2. Discuss everyday life and daily routines, using simple sentences and familiar vocabulary.

HM-507.3. Identify key details in short, highly-contextualized audio text dealing with a familiar topic, relying on repetition and extra linguistic support when needed.

HM-507.4. Discuss likes and dislikes, understand simple conversations about familiar topics (e.g., greetings, weather and daily activities,) with repetition when needed

HM-507.5. Differentiate certain patterns of behavior in the cultures of theGerman- speaking world and the student's native culture.

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PART-A

Unit 1: Begrüßungen

Salutations/Greetings
Introduction

Unit 2: sichvorstellen und Zahlen

Introduction
Alphabets
Numbers 1-20

Unit 3: Berufe/ Pronomen

Personal pronouns
Hobbies and professions

PART-B

Unit 4: Café

Café related vocabulary and dialogues
Revision personal pronouns

Unit 5: Café dialog

Café related vocabulary and dialogues
Common verbs and their conjugations

Unit 6: Zeit und Monate

Time
Days
Months

Text Books/Reference Books:

1. Hermann Funk , 2011, Studio D A1, Cornelson Publication
2. TangaramAktuell A1, Kursbuch&Arbeitsbuch, 2011, Hueber

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3. Stefanie Dengler, Paul Rusch et. A,lNetzwerk, Klett

Weblinks:

http://www.nthuleen.com/

Instructions for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Student needs to attempt four questions from the remaining six questions. Five questions need to be attempted in total. Each question will be of 10 marks.

Assessment Tools:
Sessional tests
Term end examination scores
Participation in class activities
Home assignments
Class attendance

Distribution of Continuous Assessment:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Course Articulation Matrix

CO Statement (HM-507)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
HM-507.1	-	-	-	-	-	1	1	-	-	1	-	1	-	-	-
HM-507.2	-	-	-	-	-	1	1	-	-	1	-	1	-	-	-
HM-507.3	-	-	-	-	-	1	1	-	-	1	-	1	-	-	-
HM-507.4	-	-	-	-	-	1	1	-	-	1	-	1	-	-	-
HM-507.5	-	-	-	-	-	1	1	-	-	1	-	1	-	-	-

MITRS

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(Deemed to be University under section 3 of the UGC Act 1956)

HM 508: SPANISH 1

Periods/week	Credits	Max. Marks	: 100
P:2	2	Continuous Assessment	: 50
Duration of Examination: 1.5 Hrs		End Semester Examination	50

Course Type: Elective

Course Outcomes

HM-508.1. Students will be able to exchange greetings and introductions using formal and informal expressions and students will be able to ask and answer simple questions.

HM-508.2. Students will be able to discuss everyday life and daily routines, using simple sentences and familiar vocabulary and students will be able to discuss likes and dislikes understand simple conversations about familiar topics.

HM-508.3. Students will be able to identify key details in a short, highly-contextualized audio text dealing with a familiar topic, relying on repetition and extra linguistic support when needed and students will be able to offer basic descriptions of self, other people, familiar places and objects in short discourse using simple sentences and basic vocabulary.

HM-508.4. Students will be able to provide basic information about familiar situations and topics of interest and students will be able to express or/and justify opinions using equivalents of different verbs.

HM-508.5. Students will be able to differentiate certain patterns of behavior in the cultures of the Spanish-speaking world and student's native culture.

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PART-A

Unit 1: Introduction to Spanish and SER

Presentation on Spanish language
Greetings and goodbyes
Spanish letters
Introduction of Verbo SER

Unit 2: Verb Ser, Nationality, Profession and Counting

Uses of Verbo SER
Adjectives related to Verbo SER.
Introduction of Nationality
Professions and vocabulary related to professions.
Counting till number 20

PART-B

Unit 3: Articles, Interrogative and Estar

Introduction of Articles and Indefinite articles
Interrogatives
Introduction of Verbo Estar

Unit 4:Estar, Preposition, Tener and Self Introduction

Uses of Verbo ESTAR and adjectives related to it
Prepositions related to the positioning of an object
Tener & its uses

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Self – introduction

Unit 5 : Day, Month and Regular AR verb

Days
Months
Introduction to regular –AR verbs

Text Books/Reference Books:

1. Eric V Greenfield, 1971, Spanish Grammar , Barnes and Noble
2. Jesus Sanchez Lobato and Isabel Santos Gargallo, 2006, NuevoEspanol sin fronteras 1 + Workbook + CD, Goyal Saab, ELE & SGEL

Weblinks:
http://studyspanish.com/

Instructions for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Student needs to attempt four questions from the remaining six questions. Five questions need to be attempted in total. Each question will be of 10 marks.

Assessment Tools:
Sessional tests
Term end examination scores
Participation in class activities
Home assignments
Class attendance

Distribution of Continuous Assessment:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Course Articulation Matrix

CO Statement (HM-508)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
HM-508.1	-	-	-	-	-	1	1	-	-	1	-	1	-	-	-
HM-508.2	-	-	-	-	-	1	1	-	-	1	-	1	-	-	-
HM-508.3	-	-	-	-	-	1	1	-	-	1	-	1	-	-	-
HM-508.4	-	-	-	-	-	1	1	-	-	1	-	1	-	-	-
HM-508.5	-	-	-	-	-	1	1	-	-	1	-	1	-	-	-

MRIPS

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

BEC-DS-510: DIGITAL SIGNAL PROCESSING AND ITS APPLICATIONS

Periods/week	Credits	Max. Marks	: 200
L: 3	3	Continuous Assessment	: 100
Duration of Examination: 3 Hrs		End Semester Examination	100

Course Type: Program Core
Course Outcomes: The student will be able to

BEC-DS-510.1. Explain various application areas of digital signal processing and its advantages.
BEC-DS-510.2. Understand basics of time domain signals through z- transform.
BEC-DS-510.3. Understand basics of frequency domain signals through z-transform
BEC-DS-510.4. Design & realize digital filters using various techniques.
BEC-DS-510.5. Implement the concept of multirate digital signal processing.

PART-A

Unit 1: Discrete-Time Signals

Signal classifications
Frequency domain and time domain representation of signals
Representation of sequences by Fourier transform, properties of Fourier transform
Discrete time random signals
Energy and power theorems

Unit2: Discrete-Time Systems

Classification of discrete time systems and their properties
Time invariant system, Finite impulse Response (FIR) system, Infinite impulse response (IIR) system.

Unit 3: Sampling Of Time Signals

Sampling theorem
Application of sampling theorem
Frequency domain representation of sampling
Reconstruction of band limited signal from its samples
Discrete time processing of continuous time signals
Changing the sampling rate using discrete time processing.

PART-B

Unit 4: Z-Transform

Definition of Z-transform
ROC & its Properties
Relation between s-plane & z-plane
Properties of Z-transform & its proof : Linearity, Time Shifting, Frequency Shifting,Time Scaling, Time Reversal, Differentiation in time domain, Convolution, Correlation
Numericals on Z-transform

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Inverse Z-transform using Long Division Method & Partial Fraction Method
Analysis of LTI systems using Z-transform

PART B

Unit5: Basics of Digital Filters

Fundamentals of digital filtering, various types of digital filters
Design techniques of digital filters: window technique for FIR, bi-linear transformation and backward difference methods for IIR filter design
Analysis of finite word length effects in DSP
DSP algorithm implementation consideration
Applications of DSP

Unit6: Digital Signal Processing & its applications

Introduction to multirate digital signal processing
Sampling rate conversion
Filter structures, multistage decimator and interpolators
Digital filter banks
Introduction to-TMS3206713 DSP processor

Text Books/Reference Books:

1. Digital Signal Processing, Principles, Algorithms and Applications: John G.Proakis and Dimitris G.Manolakis , 4th Edition, Prentice Hall , 2006.
2.Digital Signal Processing: Salivahanan, Vallavaraj and Gananapriya, 2nd Edition, TMH, 2001.
3. Discrete Time Signal Processing: Oppenheim A.V. & Schafer, Ronald W., 2nd Edition, Prentice Hall, 1998.
4. Digital Signal Processing: Sanjit K. Mitra, 3rd Edition, Mc Graw Hill, 2005.

Software required/Weblinks:

MATLAB
http://nptel.ac.in/courses/117102060/

Instructions for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each PART-A and PART-B (one from each unit) Student needs to attempt two questions out of three from each part. Each question will be of 20 marks.

Assessment Tools:

In general parameters for Internal /Continuous Assessment (Theory Courses):

Parameter	Weightage
Two Sessional (Mid-Term)Tests	60%
Assignments	20%
Class Performance	10%
Class Attendance	10%

Theory Course: Total Marks 200
Internal/Continuous Assessment: 100

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- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
BEC-DS-510.1	3	3	2	2	2	-	-	-	-	-	-	2	1	2	2
BEC-DS-510.2	3	3	2	2	2	-	-	-	-	-	-	2	1	2	2
BEC-DS-510.3	3	3	2	2	2	-	-	-	-	-	-	2	1	2	2
BEC-DS-510.4	3	3	2	2	2	-	-	-	-	-	-	2	1	2	2
BEC-DS-510.5	3	3	2	2	2	-	-	-	-	-	-	2	2	2	2

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MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

BEC-DS-551: DIGITAL SIGNAL PROCESSING LAB

Periods/week Credits — Max. Marks : 100
P: 2 1 — Continuous Assessment : 50
Duration of Examination: 2 Hrs — End Semester Examination : 50

Course Type: Program Core

Course Outcomes: The students will be able to:

BEC-DS-551.1. Appreciate working on MATLAB tool and differentiate between different workspace of MATLAB.
BEC-DS-551.2. Demonstrate the effect of under sampling and necessity of sampling theorem.
BEC-DS-551.3. Design digital filters which include IIR filter and FIR filter.
BEC-DS-551.4. Apply code composer studio (CCS) to interface DSK6713 kit .
BEC-DS-551.5. Generate simple waveforms using DSK6713 kit.

LIST OF EXPERIMENTS:

1. To represent basic continuous & discrete time signals (Ramp, Unit Impulse, Unit Step, Square, Saw tooth, Triangular, Sine, Sinc).
2. To perform basic operations on sequences like addition , multiplication, scaling, shifting, folding and also compute energy and power.
3. To calculate Inverse Z-transform of a rational transfer function and to check stability of a system.
4. To compute DFT of a given discrete time sequence.
5. To find step response and unit impulse response of a system from its difference equation.
6. To perform linear & circular convolution of two discrete time signals.
7. To prove sampling Theorem.
8. To convert Analog filter into Digital filter using Impulse Invariant & Bilinear Transformation method.
9. To design Digital filter using Rectangular window.
10. To study effect of Random Noise on a Signal and to minimize its Effect using FIR filter
11. To generate Sine wave using DSK6713 trainer kit.
12. To perform convolution using DSK6713 trainer kit.
13. To generate echo of a signal using DSK 6713 kit.
14. To perform DFT of a sequence using DSK 6713 kit.

PROJECTS BASED ON ABOVE EXPERIMENTS:

1. To design a multirate system using MATLAB/SIMULINK.
2. To design a noise cancellation system using adaptive filters to reduce noise in MATLAB/SIMULINK.
3. IIR Filter design and analysis using FDA Tool.
4. To compare Amplitude modulation techniques using MATLAB/SIMULINK.
5. FIR Filter design and Spectrum analysis using MATLAB/SIMULINK.

NOTE: Every student needs to do minimum 10 number of experiments/practicals and 1 project in a semester. 20% new experiments should be added every year.

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Distribution of Continuous Assessment:

Viva- I	30%
Viva- II	30%
File/Records	20%
Class Work/ Performance	10%
Attendance	10%

Lab/Practical Course: Total Marks 100
Internal/Continuous Assessment: 50

- Two Viva: 15 Marks Each
- File/Records: 10 Marks
- Class Work/ Performance: 5 Marks
- Attendance: 5 Marks

End Semester Exam: 50 Marks

Assessment Tools:
Experiments in lab
File work/Class Performance
Viva (Question and answers in lab)
End Term Practical Exam

Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
BEC-DS-551.1	3	3	2	1	2	-	-	-	-	-	-	2	2	1	3
BEC-DS-551.2	3	3	2	1	2	-	-	-	-	-	-	2	2	1	2
BEC-DS-551.3	3	3	2	1	2	-	-	-	-	-	-	2	2	1	2
BEC-DS-551.4	3	3	2	1	2	-	-	-	-	-	-	2	2	1	3
BEC-DS-551.5	3	3	2	1	2	-	-	-	-	-	-	2	2	1	1

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MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)
NAAC 'A' Grade University

BEE-DS-535 Design Architecture and Control of Electric Vehicle

Periods/week Credits	Max. Marks : 200
L: 3 T: 0 3	Continuos Evaluation : 100
Duration of Examination: 3 Hours	End Semester Exam : 100

Pre requisites: NIL
Course Type: Program Core

Course Outcomes After completion of this course the students will be able to
BEE-DS-535.1 get insight of drive train strategies.
BEE-DS-535.2 design the controllers for electric vehicles.
BEE-DS-535.3 understand energy management strategies of Electric vehicles.

Unit 1: Hybrid drivetrain
1.1 Economic and Environment impact of Hybrid vehicles Configurations-
Series configuration Parallel configuration,
Series-parallel configuration, Complex configuration,
Power Flow control in different configuration,
Basic Architecture of Electric Drive Train.

Unit 2: Electric Vehicle Architecture Design:
Types of Electric Vehicle and components,
Battery Electric vehicle (BEV),Hybrid electric vehicle (HEV),
Plug-in hybrid vehicle (PHEV ,
Fuel cell electric vehicle (FCEV),
Solar Power operated Electric vehicles

Unit 3: DC-DC Converters for EV and HEV Applications:
Buck converters,
Boost converters
Buck Boost Converters,
Multiquadrant DC-DC Converters,
Introduction to Multi input DC-DC Converters.

Unit 4: DC- AC Converters for EV & HEV Applications-
Principle of Operation of Half Bridge DC-AC Inverter (R Load),
Single Phase Bridge DC-AC Inverter with R Load,
Single Phase Bridge DC-AC Inverter with R-L Load,
Three phase DC-AC Converters:180-Degree Conduction with Star Connected Resistive Load,
Voltage control of DC-AC Inverters using PWM.

Unit 5: Electric Propulsion:
Introduction to electric components used in hybrid and electric vehicles,
Configuration and control of DC Motor drives,
Configuration and control of Induction Motor drives,
configuration and control of Permanent Magnet Motor drives,
Configuration and control of SwitchReluctance Motor drives,
drive system efficiency.

Unit 6: Control System for Electric and Hybrid Electric Vehicle
Function of Control System in HEVs and EVs,

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Elementary of Control Theory,
Overview of Control System:
The Electronic Control Unit (ECU),
Control Area Network, Control Variables,
energy management strategy(EMS),
Rule based & Optimization based EMS,
Fuzzy Logic (FLC) Based Controllers for HEVs

Text Books/Reference Books

1. C.C Chan, K.T Chau,2002, Modern Electric Vehicle Technology, Oxford University Press Inc., New York.
2. Iqbal Hussein, 2010, Electric and Hybrid Vehicles- Design Fundamentals, CRC Press.
3. Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi,2004, Modern Electric, Hybrid Electric and FuelCell Vehicles: Fundamentals, Theory and Design, CRC Press.
4. James Larminie, John Lowry, 2003, Electric Vehicle Technology Explained, Wiley.
5. Ali.Emadi, 2017, Advanced Electric Drive Vehicle, CRC Press.
6. Chris Mi, M Abdul Masrur, 2017, Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, Wiley.
7. A K Babu, 2019, Electric & Hybrid Vehicles, Khanna Publishers.

Softare links

https://nptel.ac.in/courses/108/106/108106170/
https://nptel.ac.in/courses/108/102/108102121/
https://nptel.ac.in/courses/108/103/108103009/

Evaluation Tools:

Assignment/Tutorials 20 Marks
Sessional tests 60 Marks
Class Quiz 20 Marks
Term end examination 100 Marks

Assignments, Sessional and End Semester Examination paper will consist of various difficulty levels to accommodate the different capabilities of students. Assessment should cover all course outcomes and upper limit for lower order skills will be 40% (for knowledge-oriented questions). However, weightage for different cognitive levels in the question papers can vary.

The paper setter must ensure the coverage of the entire syllabus while setting the question papers and mention the learning outcomes across each section to be measured by the examination. Weightage of the sections may vary as per the number of respective lecture hours mentioned in the syllabus. Action verbs should be used from Bloom's Taxonomy while designing question papers.

Course Articulation Matrix:

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
BEE-DS-535.1	1	-	1	-	-	-	-	-	-	-	-	-	1	-	1
BEE-DS-535.2	2	2	3	2	-	-	-	-	-	-	-	1	2	-	2
BEE-DS-535.3	2	-	2	-	1	-	-	-	-	-	-	-	2	-	1

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BEE-DS-554: Electric Vehicle Simulation Lab

Periods/week Credits1 Max. Marks : 100
P:2 Continuous Evaluation : 50
Duration of Examination: 2 Hours End Semester Exam : 50

Pre requisite
Course type: Program Core
Course Outcomes: After completion of this course the students will be able
BEE-DS-554.1Simulate the Controllers required in EV applications
BEE-DS-554.2 Analyze and Simulate HEV & EV
BEE-DS-554.3 Simulate and compare EV using Different sources

LIST OF EXPERIMENTS:

Experiments are Simulations in MatLab/PSIM
1. Simulate Buck Converter in closed Loop.
2. Simulation of Boost Converter in Closed loop Control.
3. Simulation of Buck-Boost Converter in closed control Loop Control.
4. Vehicle Dynamics modeling and simulation
5. Simulation of Electric Vehicle
6. Simulation of Electric Vehicle tied to grid.(V2G)
7. Photovoltaic based Electric Vehicle Simulation.
8. Fuel Cell based Electric Vehicle Simulation.
9. Simulation of charging circuits of Batteries used in EV.
10. Energy management of Electric Vehicles.
11. Estimation of health of batteries of EV

Text Books:

1. Kumar S. Swapna, Lenina S V B, 2016, MATLAB: Easy Way of Learning PHI.
2. S. N. Alam , S. S. Alam, 2013, Understanding MATLAB: A Textbook for Beginners, Ik publishers.
3. I.J. Nagrath and M. Gopal,2017, Control Systems Engineering, New Age International.

Instructions for Exam: One experiment out of 10 given randomly needs to be performed in exams.

Assessment Tools:
File work/Class Performance 30 Marks
Rubrics/Viva 20 Marks
End Term Practical Examination 50 Marks

Course Articulation Matrix:

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
BEE-DS-554.1	1	-	1	-	-	-	-	-	-	-	-	-	1	-	1
BEE-DS-554.2	2	2	3	2	-	-	-	-	-	-	-	1	2	-	2
BEE-DS-554.3	2	-	2	-	1	-	-	-	-	-	-	-	2	-	1

MRIIRS

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956**)**

DTI -500: Design, Thinking and Innovation-III

Periods/week Credits — Max. Marks 50
L:0 T:2 P:0 2 — Continuous Assessment : 50

Pre-requisites: Design, Thinking and Innovation-II
Course Type: Research & Training

Course outcomes
The students will be able to**:**

DTI – 500.1 Understand the Plagiarism / Feasibility tools
DTI – 500.2 Document the outcome as Research Paper / Patent / Product / Start-up /copyright

Activity 1:

Compilation / Documentation of the outcome (Research Paper / Patent / Product / Start-up /copyright).
Plagiarism / Feasibility check.
Identification of the suitable Journal / Patenting Agencies / Angel Investors.
Submission to the identified Journal / Patenting Agencies / Angel Investors.

Course Articulation Matrix:

CO Statement (DTI-500)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
DTI-500.1	-	3	-	-	-	-	-	3	-	-	-	1	-	-
DTI -500.2	-	3	2	3	2	2	2	3	3	3	2	2	3	3

'3' (Tick) or 'More' Substantial/High Correlation, '2' Moderate/Medium Correlation, '1' Slightly/Low Correlation, 'Blank' No Correlation

Evaluation Criteria: The following evaluation parameters shall be considered for internal assessment by both research coordinators and faculty coordinator or research mentors:-

S. No.	Parameters	Description	(Marks)
1.	**Attendance**	• Percentage of classes attended by the students	**5**
2.	**Continuous Performance**	• Judge individual student's participation in the Activities • Time bound completion of Activities	**15**
3.	**Accomplishment of the Outcome**	• Quality of the content and results • Acceptance of the outcome (Research Paper/ Patent/ Product/ Copyright) • Report submission / Presentation	**30**

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References:

1. www.originlab.com
2. http://www.cambridgesoft.com/software
3. http://www.synergy.com/
4. www.mathworks.com/products/matlab.html

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VIth Semester

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BME-DS-602: HEAT TRANSFER

Periods/week Credits Max. Marks : 200

L: 3 T: 1 P: 0 4 Continuous Assessment : 100

Duration of Examination: 3 Hrs End Semester Exam : 100

Prerequisites: BME-DS-302: Thermodynamics, BME-DS-401: Applied Thermodynamics
Course Type: Professional Core Course

Course Outcomes:
After completion of this course the students will be able to

BME-DS-602.1 Understand the modes of heat transfer.
BME-DS-602.2 Apply governing laws of heat transfer to evaluate the heat transfer rates and coefficients.
BME-DS-602.3 Design heat exchangers using LMTD and NTU methods.
BME-DS-602.4 Understand and analyze radiation networks.

Part-A

Unit 1: Introduction

Introduction to three modes of heat transfer, Derivation of heat balance equation. General concepts of heat transfer viz thermal conductivity, thermal diffusivity, conduction in solid, liquids and gases, Basics of convection and radiation.

Unit 2: Steady State Conduction

Steady one dimensional solution for conduction heat transfer in Cartesian, cylindrical and spherical geometry, concept of conduction and film resistances, critical insulation thickness.

Unit 3: Transient Heat Conduction

Lumped system approximation and Biot number, heat transfer through pin fins- Two dimensional conduction solutions for both steady and unsteady heat transfer-approximate solution to unsteady conduction heat transfer by the use of Heissler charts.

Part-B

Unit 4: Convection Heat Transfer

Heat convection, basic equations, boundary layers- Forced convection, external and internal flows- Natural convective heat transfer- Dimensionless parameters for forced and free convection heat transfer-Correlations for forced and free convection.

Unit 5: Radiation Heat Transfer

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Interaction of radiation with materials, definitions of radiative properties, Stefan Boltzmann's law, black and gray body radiation, Calculation of radiation heat transfer between surfaces using radiative properties, view factors and the radiosity method.

Unit 6: Heat Exchangers and Phase Change
Types of heat exchangers, Analysis and design of heat exchangers using bothLMTD and ε-NTU methods. Boiling and Condensation heat transfer, Pool boiling curve.

Text Books:

1. Heat and mass Transfer by D.S.Kumar, S.K.Kataria and Sons, New Delhi.
2. Holman, J.P., "Heat Transfer", Tata McGraw Hill Book Company, 1988
3. Yunus A Cengel, Heat Transfer: A Practical Approach, McGraw Hill, 2002
4. Kothandaraman, CP., "Fundamentals of Heat and Mass Transfer", Second Edition, New Age International Publishers, Chennai, 1997

Reference Books:

1. A.Bejan, Heat Transfer John Wiley, 1993
2. F.P.Incropera, and D.P. Dewitt, Fundamentals of Heat and Mass Transfer, John Wiley, Sixth Edition, 2007.
3. MassoudKaviany, Principles of Heat Transfer, John Wiley, 2002
4. Sachdeva, KC, "Fundamentals of Engineering Heat and Mass Transfer", New Age International Publishers, New Delhi, 1996.

Weblinks:

http://nptel.ac.in/courses/103103032
http://nptel.ac.in/courses/112101097
http://nptel.ac.in/downloads/112108149

Instructions for setting of Paper Seven questions are to set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each part A and part B (one from each unit). Student needs to attempt two questions out of three questions from each part. Each question will be of 20 marks.

Assessment Tools:

In general parameters for Internal /Continuous Assessment (Theory Courses):

Parameter	Weightage
Two Sessional (Mid-Term)Tests	60%
Assignments	20%
Class Performance	10%
Class Attendance	10%

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Theory Course: Total Marks 200
Internal/Continuous Assessment: 100

- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS01	PS02	PS03
BME-DS-602.1	3	3	3	3	3	1	1	-	2	-	-	2	2	2	-
BME-DS-602.2	3	3	3	3	2	3	-	-	-	-	-	3	-	3	-
BME-DS-602.3	3	3	3	3	3	-	-	-	1	-	-	1	1	2	-
BME-DS-602.4	3	3	3	3	3	3	3	-	-	-	-	-	2	3	-

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BME-DS-604: MACHINE DESIGN

Periods/week Credits	Max. Marks : 200
L: 3 T: 1 P: 0 4	Continuous Assessment : 100
Duration of Examination: 3 Hrs	End Semester Exam : 100

Prerequisites: BME-DS-402: Strength of Materials, BME-DS-501: Theory of Machines
Course Type: Programme Core Course

Course Outcomes:
After completion of this course the students will be able to

BME-DS-604.1 Learn the basic concepts of machine design.
BME-DS-604.2 Understand the concept of design of mechanical elements with static and dynamic loading.
BME-DS-604.3 Perform the design of various mechanical elements to fulfill the industrial and social needs.

Part-A

Unit 1: Introduction to Machine Design

Machine Design, Basic procedure of machine design, Basic requirements of Machine Elements, Design of Machine Elements, Design synthesis, Aesthetic considerations in Design, Ergonomic considerations in Design, Concurrent Engineering, Factor of safety

Unit 2: Friction Clutches

Clutches, Friction materials, Torque transmitting capacity, Multi-Disk clutches, Cone clutches and Centrifugal clutches, Energy equation, Thermal considerations

Unit 3: Brakes

Various types of brakes, Block brake with short shoe, Block brake with long shoe, Band brakes, Disk brakes, Thermal considerations

Part-B

Unit 4: Variable Loading

Stress concentration, Stress concentration factors, Reduction of stress concentration, Fluctuating stresses, Fatigue failure, Endurance limit, Low-cycle and High-cycle fatigue, Notch sensitivity, Endurance limit— approximate estimation, Reversed stresses—Design for Finite and Infinite life, Cumulative damage in fatigue

Unit 5: Bearings

Types of bearings, Static and dynamic load carrying capacity, Equivalent bearing load, Load-life relationship, Selection of bearing life, Selection of bearing from manufacturer's catalogue, Design for cyclic loads and speeds, Bearing with a probability of survival other than 90 per cent

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Unit 6: Gears

Classification, Selection of gears, Terminology of gears, Force analysis, Selection of material for gears, Beam and wear strength of gear tooth, Form or Lewis factor for gear tooth, Dynamic load on gear teeth -Barth equation and Buckingham equation and their comparison, Design of Spur gear

Text Books:

1. Design of Machine Elements – V.B. Bhandari – Tata McGraw Hill, New Delhi.

2. Design Data Book – V.B. Bhandari – Tata McGraw Hill, New Delhi.

Reference Books:

1. Mechanical Engineering Design- Joseph Edward Shigley-Mc Graw Hill Book Co.
2. Engineering design: George Dieter, McGraw Hill, New York.
3. Product Design and Manufacturing: A.K. Chitale and R.C. Gupta, PHI, New Delhi.
4. Machine Design An Integrated Approach: Robert L.Norton, Second Edition –Addison Wisley Longman
5. Machine Design: S.G. Kulkarni, TMH, New Delhi.

Weblinks:

http://nptel.ac.in/courses/112105124
http://nptel.ac.in/courses/112106137
nptel.ac.in/downloads/112105125

Evaluation Tools:
Assignment/Tutorials 20 Marks
Sessional tests 60 Marks
Class Quiz 20 Marks
Term end examination 100 Marks

Assignments, Sessional and End Semester Examination paper will consist of various difficulty levels to accommodate the different capabilities of students. Assessment should cover all course outcomes and upper limit for lower order skills will be 40% (for knowledge-oriented questions). However, weightage for different cognitive levels in the question papers can vary.

The paper setter must ensure the coverage of the entire syllabus while setting the question papers and mention the learning outcomes across each section to be measured by the examination. Weightage of the sections may vary as per the number of respective lecture hours mentioned in the syllabus. Action verbs should be used from Bloom's Taxonomy while designing question papers.

Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO 3
BME-DS-604.1	3	2	3	3	2	1	2	1	1	2	3	2	3	3	3
BME-DS-604.2	3	2	3	3	2	1	2	1	2	2	2	2	3	3	3
BME-DS-604.3	3	3	3	3	2	1	2	1	2	2	2	3	3	3	3

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BME-DS-652: HEAT TRANSFER LAB

Periods/week	Credits	Max. Marks : 100
L: 0 T: 0 P: 2	1	Continuous Assessment : 50
Duration of Examination: 2 Hrs		End Semester Exam : 50

Prerequisites:

Course Type: Professional Core Course

Course Outcomes:

After completion of this course the students will be able to

BME-DS-652.1 Evaluate the convective heat transfer coefficient in case of free and forced convection.

BME-DS-652.2 Measure the thermal conductivity of materials.. BME-

DS-652.3 Measure the efficiency and effectiveness of pin fins.

BME-DS-652.4 Evaluate the effectiveness and efficiency of parallel flow, counter flow and cross flow

List of Experiments:

1. To determine the thermal conductivity of a metallic rod.
2. To determine the thermal conductivity of a composite pipe insulation (legged pipe).
3. To determine the thermal conductivity of a solid by the guarded hot plate method.
4. To find the effectiveness of a pin fin in a rectangular duct natural convective condition and plot temperature distribution along its length.
5. To find the effectiveness of a pin fin in a rectangular duct under forced convective and plot temperature distribution along its length.
6. To measure the emmisivity of the gray body (plate) at different temperature and plot the variation of emmisivity with surface temperature.
7. To find overall heat transfer coefficient and effectiveness of a heat exchange under parallel and counter flow conditions. Also plot the temperature distribution in both the cases along the length of heat of heat exchanger.
8. To verify the Stefen-Boltzmann constant for thermal radiation.
9. To study the two phases heat transfer unit.
10. To determine the water side overall heat transfer coefficient on a cross-flow heat exchanger.

Value Added Experiments:

1. To determine the surface heat transfer coefficient for a heated vertical tube under natural convection and plot the variation of local heat transfer coefficient along the length of the tube. Also compare the results with those of the correlation.
2. To determine average heat transfer coefficient for a externally heated horizontal pipe under forced convection and plot Reynolds and Nusselt numbers along the length of pipe. Also compare the results with those of the correlations.

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Note:

1. 10 Experiments are to be performed in the semester.
2. At least eight experiments should be performed from above list. Remaining two experiments may either be performed from the above list or designed & set as per the scope of the syllabus.

Assessment Tools:

In general parameters for Internal/Continuous Assessment (Lab/Practical Courses):

Parameter	Weightage
Two Mid-Term Viva	60%
File/Record Keeping	20%
Class Performance	10%
Class Attendance	10%

Lab/Practical Course: Total Marks 100
Internal/Continuous Assessment: 50

- Two Viva: 15 Marks Each
- File/Records: 10 Marks
- Class Work/ Performance: 5 Marks
- Attendance: 5 Marks

End Semester Exam: 50 Marks

Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS01	PS02	PS03
BME-DS-652.1	3	3	3	3	3	3	-	-	-	3	3	3	2	2	-
BME-DS-652.2	3	3	3	2	-	-	-	-	-	-	2	3	-	3	-
BME-DS-652.3	3	3	3	-	-	-	-	-	3	3	3	2	1	2	-
BME-DS-652.4	3	3	3	2	-	-	3	3	-	-	2	-	2	3	-

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PROJ-ME- 600: PROJECT PHASE-I

Periods/week Credits
P: 2 1

Max. Marks : 50
Continuous Assessment : 50

Pre-requisites:
Course Type: Projects

Course Outcomes
After completion of this course the students will be able to
PROJ-ME- 600.1. Explain the concept and working of the prototype.
PROJ-ME- 600.2. Apply practical knowledge of designing and manufacturing.
PROJ-ME- 600.3. Design basic projects on thermal, manufacturing and design domain.
PROJ-ME- 600.4. Identify their area of interest and do extensive literature survey on the same.
PROJ-ME- 600.5. Summarized report in the form of synopsis
PROJ-ME- 600.6. Design and develop prototype which have social and environmental impact and can be economically viable.

NOTE: Every student should design any one mini project from the above list or can choose any other project beyond the given list.

Assessment Tools:
Continuous Evaluation during Project Phase-I:
1. Attendance : 10 marks
2. Literature survey : 10 marks
3. Synopsis Submission : 10 marks
4. Presentation Skills : 5 marks
5. Innovation : 5 marks
6. Regularity : 5 marks
7. Viva : 5 marks

Course Articulation Matrix

CO Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
PROJ-ME-600.1	3	-	3	3	3	-	-	-	-	-	2	2	3	3	3
PROJ-ME-600.2	2	-	3	3	3	-	-	-	-	-	2	2	3	3	3
PROJ-ME-600.3	2	3	3	3	3	2	2	1	2	2	2	2	3	3	3
PROJ-ME-600.4	-	3	3	3	3	2	3	3	3	3	3	3	3	3	3
PROJ-ME-600.5	-	3	2	3	3	2	2	3	3	3	3	3	3	3	3
PROJ-ME-600.6	2	3	3	3	3	3	3	3	3	2	2	1	3	3	3

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BME-DS-603: ROBOTIC ANALYSIS

Periods/week Credits	Max. Marks : 200
L: 3 T: 0 3 Continuous Assessment : 100	
Duration of Examination: 3 Hrs	End Semester Examination:100

Course Type: Core

Course Outcomes

The students will be able to:

BEC-DS-603.1. Apply the fundamental aspects of Robotics.
BEC-DS-603.2. Comprehend various methodologies to be taken into account for development of robotic systems.
BEC-DS-603.3. Explain the contextual architecture of robotics.
BEC-DS-603.4. Analyze the motions and trajectory of a robot.
BEC-DS-603.5 Explore the industrial applications of a robot

Part-A

Unit-1 Structure of Robotic System

Anatomy of Robot**,** Classification of Robot**,** Robot Configuration & Robotic system**,** Robot Specification: Number of axes, Payloads Capacity, Repeatability, Attachment precision, Reach & Stroke

Unit-2 Robot Motion Analysis (Part-I)

Robot arm kinematics, transformation, rotation matrix, geometric interpretation of rotation matrix, inverse transformation, numerical, rotation matrix about an arbitrary axis, Euler Angle representation

Unit-3Robot Motion Analysis (Part-II)

Homogeneous transformation and geometric interpretation, inverse and composite homogeneous transformations, Denavit-HartenbergRepresentation, arm matrix, kinematic (arm) equations, inverse kinematics problem

Part-B

Unit-4 Design of Gripper Fingers

1. Force Analysis of gripper mechanism, Linkage analysis (Numerical)
2. Gripper and Jaw Design Geometry, Gripper Design Procedure
3. Gripper Design: A case study

Unit-5 Robot Arm Dynamics

Joint velocities, the kinetic energy, potential energy, lagrangian equation of motion, the dynamic equation, dynamic equation for a general manipulator, numerical

Unit-6 Trajectory Planning

Introduction, path control modes, general consideration in trajectory planning, general consideration of joint interopolated trajectory, trajectory generation planning, linear path with parabolic bend, trajectory planning with 3rd order and 5th order polynomial

Text Books/ Reference Books:

1. Yoram Koren, 1985, Robotics for Engineers, 1st Edition, McGraw Hill Book Company.
2.John J. Craig, 2004, Introduction to Robotics, 3rd Edition, Pearson.
3. Ganesh S. Hegde, 2006, A textbook on Industrial Robotics, Laxmi Publications.

Software required/Weblinks:

Keil, FlashMagic

http://nptel.ac.in/video.php?subjectId=112101099
http://freevideolectures.com/Course/2373/Robotics

Instructions for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each Part A and Part B (one from each unit). Student needs to attempt two questions out of three from each part. Each question will be of 20 marks.

Distribution of Continuous Assessment:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Assessment Tools:
Assignment/Tutorials
Sessional tests
Surprise questions during lectures/Class Performance
Term end examination

Theory Course: Total Marks 200
Internal/Continuous Assessment: 100

- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

Course Articulation Matrix

CO Statement (BEC-DS-603)	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
BEC-DS-603.1	3	3	2	2	2	-	-	1	-	3	-	2	3	2	3
BEC-DS-603.2	3	3	2	2	2	-	-	-	-	-	-	2	-	2	3
BEC-DS-603.3	3	3	2	2	2	-	-	-	-	3	-	2	-	2	3
BEC-DS-603.4	3	3	2	2	2	-	-	-	-	3	-	2	3	2	2
BEC-DS-603.5	3	3	2	2	2	-	-	-	-	-	-	2	3	2	2

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BEC-DS-717: ROBOTICS LAB

Periods/week Credits	Max. Marks 100
P:2 1	Continuous Assessment : 50
Duration of Examination: 2 Hrs	End Semester Examination: 50

Co-requisites: BEC-DS-603: Robotics
Course Type: Elective

Course Outcomes
The students will be able to
BEC-DS-717.1. Implement designs using developmental tools for Arduino and Embedded C Language.
BEC-DS-717.2.Classify different sensors used in Robotics, working principle and motors to be interfaced for meeting certain applications.
BEC-DS-717.3. Develop programs to design wireless control mechanism of Robot.
BEC-DS-717.4.Implement Robotic Arm control.
BEC-DS-717.5. Develop programming concepts of Maze solving Robotic applications.

List of Experiments:

1. To understand the developmental tools for Arduino programming and Robotics Development Kit.
2. Write a program to control DC motor using L293D and Arduino.
3. Write a program to control Servo Motor movement using Arduino.
4. Implement Line Follower Robot using Robotics Development Kit.
5. Implement the motion control mechanism of Robot using Computer.
6. Write a program to control the movement of Robotic Arm.
7. Write a program to control Robot motion using Joystick.
8. Write a program to design a Grid Solver Robot.
9. Design a Gesture Controlled Robot using Accelerometer.
10. Write a program to control the Robot motion using Bluetooth.

PROJECTS BASED ON ABOVE EXPERIMENTS:

1. To implement a fire extinguishing robot using infrared (IR) photodiodes.
2. To write a program to control Robotic arms used for welding or handling hazardous materials.
3. To implement a soccer robot that can move forward, reverse, forward-left, forward-right, reverse-left and reverse-right.
4. To implement a line-following robots with pick-and-placement capabilities.
5. To implement a wireless robocar using arduino board.

Software required/Weblinks:

Keil, FlashMagic
http://nptel.ac.in/video.php?subjectId=112101099
http://freevideolectures.com/Course/2373/Robotics

NOTE: Every student needs to do minimum 10 number of experiments/practicals in a semester. 20% new experiments should be added every year.

Distribution of Continuous Assessment:

Viva- I	30%
Viva- II	30%
File/Records	20%
Class Work/ Performance	10%
Attendance	10%

Assessment Tools:
Experiments in lab
File work/Class Performance
Viva (Question and answers in lab)
End Term Practical Exam

Course Articulation Matrix

CO Statement (BEC-DS-717)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O 1	PSO 2	PS O 3
BEC-DS-717.1	3	3	2	2	2	-	-	-	-	-	-	2	-	2	3
BEC-DS-717.2	3	3	2	2	2	-	-	-	-	-	-	2	2	2	3
BEC-DS-717.3	3	3	2	2	2	-	-	-	-	-	-	2	2	2	3
BEC-DS-717.4	3	3	2	2	2	-	-	-	-	-	-	2	-	2	-
BEC-DS-717.5	3	3	2	2	2	-	-	-	-	-	-	2	-	2	3

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BEE-DS-502: CONTROL SYSTEMS

Periods/week Credits	Max. Marks 200
L: 3T: 1 4	ContinuosAssessment 100
Duration of Examination: 3 Hours	End Semester Exam 100

Pre requisites: NIL
Course Type: Program Core

Course Outcomes
After completion of this course the students will be able to

BEE-DS-502.1 model linear time invariant systems using transfer function and state space.
BEE-DS-502.2 evaluate stability of linear time invariant systems both in time domain as well as frequency domain.
BEE-DS502.3 analyse the response of second order system using test signals
BEE-DS-502.4 to design simple feedback controllers.
BEE-DS-502.5 describe optimal control and nonlinear control.

PART -A

Unit 1: Introduction to control problem (4 hours)

Industrial Control examples.
Mathematical models of physical systems.
Transfer function models of linear time-invariant systems.
Feedback Control: Open-Loop and Closed-loop systems.Benefits of Feedback,
Block diagram algebra,
Signal flow graph

Unit 2: Time Response Analysis (10 hours)

Standard test signals.
Time response of first and second order systems for standard test inputs.
Applicationofinitial and final value theorem.
Design specifications for second-order systems based on thetime-response.
Concept of Stability. Routh-Hurwitz Criteria. Relative Stabilityanalysis.
Root-Locus technique.
Construction ofRoot-loci.

Unit 3: Frequency-response analysis (6 hours)

Relationship between time and frequency response,
Polar plots,
Bode plots.
Nyquist stability criterion.
Relative stability using Nyquist criterion
gain and phase margin.
Closed-loop frequency response.

PART –B

Unit 4: Introduction to Controller Design (10 hours)

Stability, steady-state accuracy, transient accuracy,
disturbance rejection, insensitivity and robustness of control systems.
Root-loci method of feedback controller design.
Design specifications in frequency-domain.

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Frequency-domain methods of design.
Application of proportional, Integral and Derivative Controllers,
Lead and Lag compensation in designs.
Analog and Digital implementation of controllers.

Unit 5: State variable Analysis (6 hours)

Concepts of state variables.
State space model.
Diagonalization of State Matrix.
Solution of state equations.
Eigenvalues and Stability Analysis.
Concept of controllability and observability.
Pole-placement by state feedback.
Discrete-time systems.
Difference Equations. State-space models of linear discrete-time systems.
Stability of linear discrete-time systems.

Unit 6: Introduction to Optimal Control and Nonlinear Control (5 hours)

Performance Indices.
Regulator problem,
Tracking Problem.
Nonlinear system–Basic concepts and analysis.

Text/References:

1. M.Gopal, 2012, ControlSystems:PrinciplesandDesign, McGrawHillEducation.
2. FaridGolnaraghi ,B. C. Kuo, 2014. Automatic Control System,Wiley.
3. K.Ogata, 2015, ModernControlEngineering,Pearson.
4. I. J. Nagrath and M. Gopal, 2017, Control Systems Engineering, New Age International.

Software required/Weblinks:

https://nptel.ac.in/courses/107/106/107106081/
https://nptel.ac.in/courses/108/103/108103007
https://nptel.ac.in/courses/108/107/108107115/

Instructions for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each PART-A and PART-B (one from each unit) Student needs to attempt two questions out of three from each part. Each question will be of 20 marks.

Sessional- I	**30%**
Sessional- II	**30%**
Assignment	**20%**
Class Performance	**10%**
Attendance	**10%**

Assessment Tools:

Assignment/Tutorials
Sessional tests
Surprise questions during lectures/Class Performance
Term end examination

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Theory Course: Total Marks 200
Internal/Continuous Assessment: 100

- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

COURSE ARTICULATION MATRIX

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
BEE-DS-502.1	3	3	3	3	2	1	-	-	-	-	-	2	-	-	2
BEE-DS-502.2	3	3	3	3	2	2	1	1	1	-	-	2	2	-	2
BEE-DS-502.3	3	3	3	2	3	1	2	1	1	2	-	-	3	2	2
BEE-DS502.4	3	2	2	3	3	2	1	2	1	-	-	2	-	2	3
BEE-DS-502.5	2	2	2	2	-	1	2	1	2	1	1	1	2	2	3

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BEE-DS-552: CONTROL SYSTEM LAB

iods/week	Credits	Max. Marks	: 100
P: 2	1	Internal/Continuous Assessment	: 50
Duration of Examination: 2 Hours		End Semester Exam	50

Pre requisite

Course type: Program Core

Course Outcomes

After completion of this course the students will be able to

BEE-Ds-552.1 find the response of first order system.
BEE-DS-552.2 study the operation of PID controller, Stepper motor, servomotor etc
BEE-DS-552.3 design lead /lag compensators
BEE-DS-552.4 write programs in Matlab for studying the stability and responses of simple systems.
BEE-DS552.5 design controllers for simple systems in state space using Matlab.

LIST OF EXPERIMENTS:

1. Study of PID controller.
2. To plot the frequency response of Lead compensator
3. Study of stepper motor
4. To plot the response of first order system for step input.
5. To plot the frequency response of lag compensators.
6. To plot the response of second order system for step input.
7. Study of Servomotors
8. To check the stability of different order systems in Matlab
9. Plot the root locus of different systems in Matlab and study its stability
10. To model a system in state space and study its stability.
11. Conversion of transfer function model to state space model theoretically as well as using Matlab commands.
12. Design of controllers using Pole placement feedback

Text Books:

1. Kumar S. Swapna, Lenina S V B, 2016, MATLAB: Easy Way of Learning PHI.
2. S. N. Alam , S. S. Alam, 2013, Understanding MATLAB: A Textbook for Beginners, Ik publishers.
3. I.J. Nagrath and M. Gopal,2017, Control Systems Engineering, New Age International.

Instructions for Exam: Every student needs to complete 10 experiments in a semester. One experiment out of 10 given randomly needs to be performed in exams.

Parameter	Weightage
Two Mid-Term Viva	60%
File/Record Keeping	20%
Class Performance	10%
Class Attendance	10%

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Assessment Tools:
Experiments in lab
File work/Class Performance
Viva (Question and answers in lab)
End Term Practical Examination

COURSE ARTICULATION MATRIX

CO Statement (BEE-DS-552)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
BEE-DS-552.1	3	3	3	2	2	1	-	-	-	-	-	-	3	2	3
BEE-DS-552.2	3	3	3	3	3	1	-	-	-	1	1	-	3	2	-
BEE-DS-552.3	3	3	2	2	3	-	1	-	-	1	1	-	3	1	3
BEE-DS-552.4	3	3	2	2	3	1	1	1	-	1	-	-	2	1	1
BEE-DS-552.5	2	3	2	3	2	-	1	1	1	-	-	1	2	1	2

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BEC-DS-603.4	3	3	2	2	2	-	-	-	-	3	-	2	3	2	2
BEC-DS-603.5	3	3	2	2	2	-	-	-	-	-	-	2	3	2	2

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MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH & STUDIES

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BHM-MC-009: QAPD-III

Periods/week Credits
L:0 T:0 P :2 AP
Duration of Exam: 2 Hrs

Max. Marks : 100
Continuous Assessment : 50
End Semester Exam :50

Pre-requisites: BHM-MC-008 QAPD-II
Course Type: HSMC

Course Outcomes: After completion of this course the students will be able to

BHM-MC-009.1**.** Recognize problem based on Modern Mathematics and Algebra
BHM-MC-009.2**.** Solve basic to moderate level problems based on Mensuration and Geometry.
BHM-MC-009.3**.** Calculate solution to logical reasoning.
BHM-MC-009.4**.** Proficient with resume building and will be able to draft effective cover letters.
BHM-MC-009.5**.** Participate effectively and confidently in a Group Discussion
BHM-MC-009.6**.** Manage interviews effectively.

PART – A

Unit 1: Modern Mathematics and Algebra

Permutation and Combination

Principal of counting and Basic formulas
Arrangements, Selection and Selection + Arrangement.
Linear/Circular arrangements, Digits and Alphabetic Problems and Applications.

Probability

Events and Sample Space, Basic Formulas.
Problems on Coins, Cards and Dices.
Conditional Probability, Bayes' Theorem and their Applications.

Algebra

Linear & Quadratic equations 1.3.2 Mathematical inequalities
1.3.3 Maximum & Minimum Values 1.3.4 Integral Solutions

Unit 2: Geometry and Mensuration

Geometry

Basic geometry & Theorems, Lines & Angles
Polygons, Triangle and Quadrilaterals 2.1.3 Circles

Mensuration I- Areas

Different types of Triangles and their area and perimeter.
Different types of Quadrilateral and their area and perimeter.
Circumference and Area of Circle, Area of Sector and length of Sector.
Mixed Figures and their Applications.

Mensuration II- Surface Areas and Volumes

Problems on Cubes & Cuboids, Cone, Cylinder and Sphere.
Prism and Pyramid. 2.3.3 Mixed Figures and their Applications.

Unit 3: Logical Reasoning

3.1 Linear Arrangement 3.2 Circular Arrangement
3.3 Puzzles

Part - B

Unit 4: Professional Writing

Profiling on Social Sites: LinkedIn, Facebook, Instagram
Cover Letter/Emails
Resume Writing

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Unit 5: Group Discussions

Do's and Dont's of a Group Discussion
Roles played in a Group Discussion
Tips for Cracking a Group Discussion

Unit 6: Managing Interviews

Developing the employability mindset
Preparing for Self -Introduction
Researching the employer
Portfolio Management
Answering Questions in an Interview

Text Books/Reference Books:

1. Teach Your Self Quantitative Aptitude: Arun Sharma, 1st Edition, McGraw Hills Education, 2017
2. A Modern Approach to Logical Reasoning: R S Aggarwal, S Chand & Company Pvt Ltd, Edition 2017
3. The Damn Good resume Guide ByYana Parker & Beth Brown
4. Interview Answers ByCeri Roderick & Stephan Lucks

Instructions for paper setting: Fifty MCQ will be set in total. Twenty five MCQ will be set from Part A and twenty five MCQ will be set from Part B. All questions will be compulsory. Each question will be of 1 mark. There will be no negative marking. Calculator will not be allowed.

Assessment Tools:

In general parameters for Internal /Continuous Assessment (Theory Courses):

Parameter	Weightage
Two Sessional (Mid-Term)Tests	60%
Assignments	20%
Class Performance	10%
Class Attendance	10%

Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O 1	PS O 2	PS O 3
BHM-MC-009.1	1	-	-	-	-	1	-	-	-	-	-	1	-	-	-
BHM-MC-009.2	1	-	-	-	-	1	-	-	-	-	-	1	-	-	1
BHM-MC-009.3	1	-	-	2	-	-	-	-	-	-	-	-	-	-	-
BHM-MC-009.4	-	-	-	-	-	-	-	1	-	3	-	1	1	-	-
BHM-MC-009.5	-	-	-	-	-	-	-	1	-	3	-	-	-	-	-
BHM-MC-009.6	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1

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HM 606: FRENCH II

Periods/week	Credits	Max. Marks	100
P:2	2	Continuous Assessment	50
Duration of Examination: 1.5 Hrs		End Semester Examination	50

Course Type: Elective
Course Outcomes

HM-606.1. Exchange greetings and do introductions using formal and informal expressions. Understand and use interrogative and answer simple questions.
HM-606.2. Learn Basic vocabulary that can be used to discuss everyday life and daily routines, using simple sentences and familiar vocabulary. Express their likes and dislikes. Also will have understanding of simple conversations about familiar topics (e.g., greetings, weather and daily activities,) with repetition when needed.
HM-606.3. Identify key details in a short, highly-contextualized audio text dealing with a familiar topic, relying on repetition and extra linguistic support when needed. Describe themselves, other people, familiar places and objects in short discourse using simple sentences and basic vocabulary.
HM-606.4. Describe themselves, other people, familiar places and objects in short discourse using simple sentences and basic vocabulary. Provide basic information about familiar situations and topics of interest.
HM-606.5. Express or/and justify opinions using equivalents of different verbs. Differentiate certain patterns of behavior in the cultures of the French-speaking world and the student's native culture.

PART -A

Unit 1: Se présenter (1)
Les pluriels
Adjectives to describe a person

Unit 2: Se présenter (2)
Professions
Short essay on family & friend
Comprehension

Unit 3: Parler de ses habitudes quotidiennes
Les verbespronominaux
Décrivezvotrejournée

PART -B

Unit 4: Nommez et localiser des lieux dans la ville
Prepositions
Asking & telling the way

Unit 5: Informations simples sur le climat, la météo
Les saisons
Les expressions de la saison
Comprehension

MRIRS

Unit 6: Demander/ indiquer les horaires et les couleurs

Timings
Colours

Text Books/Reference Books/ Suggested Readings:

1. Annie Berthet, Catherine Hugot, Veronique M Kizirian,2006, Alter Ego Level One Textbook, , Hachette Publications
2. Mahitha Ranjit, 2016, Apprenons Le Francais II & III, Saraswati Publications

Weblinks:

www.bonjourfrance.com
www.allabout.com

Instructions for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Student needs to attempt four questions from the remaining six questions. Five questions need to be attempted in total. Each question will be of 10 marks.

Assessment Tools:
Sessional tests
Term end examination scores
Participation in class activities
Home assignments
Class attendance

Distribution of Continuous Assessment:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Course Articulation Matrix

CO Statement (HM–606)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
HM-606.1	-	-	-	-	-	1	1	-	-	1	-	1	-	-	-
HM-606.2	-	-	-	-	-	1	1	-	-	1	-	1	-	-	-
HM-606.3	-	-	-	-	-	1	1	-	-	1	-	1	-	-	-
HM-606.4	-	-	-	-	-	1	1	-	-	1	-	1	-	-	-
HM-606.5	-	-	-	-	-	1	1	-	-	1	-	1	-	-	-

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HM 607: GERMAN II

Periods/week Credits	Max. Marks 100
P:2 2	Continuous Assessment 50
Duration of Examination: 1.5 Hrs	End Semester Examination 50

Course Type: Elective
Course Outcomes

HM-607.1. Students will be able to discuss about various directions, countries and languages they speak.
HM-607.2. Students will be able to write short essays on family and friends. They will have knowledge of tenses.
HM-607.3. Students will be able to identify classroom vocabulary in the German language
HM-607.4. Students will be able to speak ordinal and cardinal numbers and they will also learn months, days in German
HM-607.5. They will be able to express or/and justify opinions using equivalents of different verbs.

PART -A

Unit 1: Ordinal und KardinalZahlen
Ordinal & Cardinal numbers
Months, days, Feiertage and dates

Unit 2: sein und haben
Verbs: to be and to have
helping verbs practice worksheets
Vocabulary (Family) short essay on family, friends etc.

PART-B

Unit 3: GegenständeimKursraum
Vocabulary (classroom)
Definite and indefinite articles

Unit 4: Länder, Sprachen
Countries, languages, directions
Past of the verb 'to be'

Text Books/Reference Books:

1. Rita Maria Niemann, Cornelsen, 2005, Studio d A1: Deutsch alsFremdsprache, Volume 6.
2. Dallapiazza, Rosa-Maria and Jan, Eduard von. Tangram aktuell 1. Deutsch alsFremdsprache Tangram aktuell 1 - Lektion 1-4: Deutsch als. (Hueber Verlag, 2005).
3. Dallapiazza, Rosa-Maria and Jan, Eduard von. Tangram aktuell 1. Deutsch alsFremdsprache Tangram aktuell 1 - Lektion 5-8: Deutsch als. (Hueber Verlag, 2005).
4. Paul Rusch, 2015: Langenscheidt and Klett

Weblinks:

http://www.nthuleen.com/

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Instructions for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Student needs to attempt four questions from the remaining six questions. Five questions need to be attempted in total. Each question will be of 10 marks.

Assessment Tools:
Sessional tests
Term end examination scores
Participation in class activities
Home assignments
Class attendance

Distribution of Continuous Assessment:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Course Articulation Matrix

CO Statement (HM–607)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
HM-607.1	-	-	-	-	-	1	1	-	-	1	-	1	-	-	-
HM-607.2	-	-	-	-	-	1	1	-	-	1	-	1	-	-	-
HM-607.3	-	-	-	-	-	1	1	-	-	1	-	1	-	-	-
HM-607.4	-	-	-	-	-	1	1	-	-	1	-	1	-	-	-
HM-607.5	-	-	-	-	-	1	1	-	-	1	-	1	-	-	-

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(Deemed to be University under section 3 of the UGC Act 1956)

HM 608: SPANISH II

Periods/week Credits	Max. Marks : 100
P:2 2	Continuous Assessment : 50
Duration of Examination: 1.5 Hrs	End Semester Examination 50

Course Type: Elective
Course Outcomes

HM-608.1. Students will be able to know about various color names in Spanish along with various vocabularies related to cloths and wardrobe.
HM-608.2. Students will be able to differentiate between Ser and Estar verbs along with uses.
HM-608.3. Students will be able to have knowledge of adjectives along with telling time.
HM-608.4. Students will be able to count till 1000
HM-608.5. Students will be able to have knowledge of regular –ER and –IR verbs along with its various uses.

PART-A

Unit 1 : Color and Clothing
Introduction of colors
Vocabulary related to clothes and wardrobe

Unit 2 : Ser, Estar and Haber
Difference between the use of Verbo SER and ESTAR and their use with the similar adjective.
Introduction of Verbo HABER

PART-B

Unit 3 : Adjective, Counting and Time
Demonstrative adjectives
Counting till 1000
Time

Unit 4 : Verb ER and IR and Family
Introduction and Usage of –ER Verbs
Introduction and Usage of –IR Verbs
Vocabulary related to the family and marital status

Text Books/Reference Books:

1. Eric V Greenfield, 1971, Barnes and Noble
2. Nuevo Espanol sin fronteras, Jesus Sanchez Lobato and Isabel Santos Gargallo, 2005, Goyal Saab, ELE & SGEL

Weblinks:

http://studyspanish.com/

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Instructions for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Student needs to attempt four questions from the remaining six questions. Five questions need to be attempted in total. Each question will be of 10 marks.

Assessment Tools:
Sessional tests
Term end examination scores
Participation in class activities
Home assignments
Class attendance

Distribution of Continuous Assessment:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Course Articulation Matrix

CO Statement (HM–608)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
HM-608.1	-	-	-	-	-	1	1	-	-	1	-	1	-	-	-
HM-608.2	-	-	-	-	-	1	1	-	-	1	-	1	-	-	-
HM-608.3	-	-	-	-	-	1	1	-	-	1	-	1	-	-	-
HM-608.4	-	-	-	-	-	1	1	-	-	1	-	1	-	-	-
HM-608.5	-	-	-	-	-	1	1	-	-	1	-	1	-	-	-

MITRS

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)
NAAC 'A' Grade University

BEE-DS-635: Energy Storage and Battery Management System

Periods/week	Credits	Max. Marks : 200
L: 3 T: 0	3	Continuous Evaluation : 100
Duration of Examination: 3 Hours		End Semester Exam:100

Prerequisite:

Course type: Domain specific Elective

Course Outcomes: After completion of this course the students will be able to
BEE-DS-635.1 Understand fundamentals of advanced batteries, super capacitors and fuel cells
BEE-DS-635.2 Learn battery sizing and optimization for electrification vehicles
BEE-DS-635.3 Identify battery management systems and state-of-charge estimation.
BEE-DS-635.4 Interpret the concept associated with modelling of battery pack

Unit 1: Energy storage and systems

Role of energy storage systems, applications,
Battery based Energy storage and its analysis
Fuel cell-based energy storage and its analysis,
Flywheel based energy storage,
Electrochemistry and Battery Material,
Efficiency of energy storage systems

Unit 2: Hybrid Energy Storage System

Introduction to Battery Management System,
Super capacitors,
Superconducting Magnetic Energy Storage (SMES),
Hybrid Energy storage systems: configurations and applications,
Storage for renewable energy systems: Solar energy, Wind energy, Pumped hydro energy, fuel cells
Energy storage in Microgrid and Smart grid.

Unit 3: Study of Battery Characteristics

Cells connected in series & parallel, Electrochemical and lithium-ion cells, Rechargeable cell,
Cell total energy and cell total power. Nominal voltage and capacity, C rate,
Battery state of charge estimation (SOC),
voltage-based methods to estimate SOC, Model-based state estimation
Battery Health Estimation ,Lithium-ion aging: Negative electrode, Positive electrode,
Cell Balancing, Causes of imbalance, Circuits of balancing

Unit 4: Battery Management System

Introduction and BMS functionality,
Batter pack topology,
Fundamentals of Battery management systems and controls,
BMS sensing and High voltage Control-Voltage Sensing, Temperature Sensing, Current Sensing,
High-voltage contactor control, Isolation sensing, Thermal control, Protection,
Communication Interface, Range estimation,
Modes of Charging Batteries,

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Unit 5: Modelling and Simulation

Equivalent-circuit models (ECMs),
Physics-based models (PBMs),
Empirical modelling approach,
Physics-based modelling approach,
Simulating an electric vehicle,
Simulating constant power and voltage,
Simulating battery packs

Unit 6 Design of battery BMS:

Design principles of battery BMS,
Battery thermal Management,
Passive Cooling, PCM Systems Active Cooling,
Effect of distance, load, and force on battery life and BMS,
Energy balancing with multi-battery system.

Text Books/ Reference Books:

1. A.G.Ter-Gazarian, 2011, Energy Storage for Power Systems", Second Edition, The Institution of Engineering and Technology (IET) Publication, UK.
2. Plett, Gregory L. ,2015, Battery management systems, Volume I: Battery modeling. Artech House.
3. Plett, Gregory L. 2015, Battery management systems, Volume II: Equivalent-circuit methods. ArtechHouse.
4. Bergveld, H.J., Kruijt, W.S., Notten, P.H.L ,2002 Battery Management Systems -Design by Modelling Philips Research Book Series.
5. Davide Andrea, 2010, Battery Management Systems for Large Lithium-ion Battery Packs" Artech House.
6. R. Pendse,2011, Energy Storage Science and Technology, SBS Publishers & Distributors Pvt. Ltd.,New Delhi.
7. Francisco Díaz-González, Andreas Sumper, OriolGomis-Bellmunt,2016, Energy Storage in PowerSystems" Wiley Publication.
8. B. Scrosati, J.Garche, Tillmetz, 2015, Advances in Battery Technologies For Electric Vehicle, A WoodHead Publishing Series in Energy.

Software required / Web links:

OpenPowerNet https://en.wikipedia.org/wiki/**Electric**_multiple_unit https://nptel.ac.in/courses/108/103/108103009/
https://nptel.ac.in/courses/108/105/108105060/
https://nptel.ac.in/courses/108/106/108106170/

Evaluation Tools:

Assignment/Tutorials 20 Marks
Sessional tests 60 Marks
Class Quiz 20 Marks
Term end examination 100 Marks

Assignments, Sessional and End Semester Examination paper will consist of various difficulty levels to accommodate the different capabilities of students. Assessment should cover all course outcomes and upper limit for lower order skills will be 40% (for knowledge-oriented questions). However, weightage for different cognitive levels in the question papers can vary.

The paper setter must ensure the coverage of the entire syllabus while setting the question papers and mention the learning outcomes across each section to be measured by the examination. Weightage of the sections may vary as per the number of respective lecture hours mentioned in the syllabus. Action verbs should be used from Bloom's Taxonomy while designing question papers.

MRTRS

Course Articulation Matrix:

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
BEE-DS-635.1	2	--	-	-	-	-	-	-	-	-	-	-	2	2	-
BEE-DS-635.2	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-
BEE-DS-635.3	-	-	2	-	-	-	-	-	-	-	2	2	-	-	-
BEE-DS-635.4	-	-	2	-	-	-	-	2	-	-	-	-	3	2	-

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MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES
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NAAC 'A' Grade University

BME-DS-612: Electric Vehicle Testing & Validation Lab

Practicals Credits	Max. Marks : 100
P: 2 1	Continuous Evaluation : 50
Duration of Ext. Exam: 2 Hrs	End Semester Exam : 50

Pre-requisites: Basics of Automobile Engineering
Course Type: Program Core
Students will be able to
BME-DS-612.1: Identify and understand the procedure for Electric Vehicle Testing as per Industry standards.
BME-DS-612.2: Solve problems based on the validation of EV.
BME-DS-612.3: Analyze the functioning of Electric Vehicles as per the Industry standards.
BME-DS-612.4: Select and design the best available part / mechanism after testing for best performance.

List of Experiments

1. Perform Vibration, Shock, short circuit, overcharge, rollover Test for traction batteries (Lead-Acid/Li-ion) as per AIS 048 standard.
2. Perform Test for EVs as per AIS-038 standard
3. Perform Test for EVs as per AIS-039 standard
4. Perform Test for EVs as per AIS-040 standard
5. Perform Test for EVs as per AIS-041 standard
6. Perform Test for EVs as per AIS-49 standard
7. Perform Test for EVs as per AIS-102 standard
8. Perform Test for EVs as per AIS-123 standard
9. To calculate the power requirement from electric motor for EV design
10. To study the wiring harness with respect to Electric Vehicles and Hybrid EV's
11. Observe the charging and discharging process, and plot graph of charging/load current, SOC, temperature, DOC, and terminal voltage

Notes:

1. At least ten experiments are to be performed in the Semester.
2. At least seven experiments should be performed from the above list. Remaining three experiments may either be performed from the above list or designed & set by the concerned faculty as per the scope of the Syllabus.

Marks distribution for Continuous evaluation

Parameter	Weightage
Two Mid-Term Viva	**60%**
File/Record Keeping	**20%**
Class Performance	**10%**
Class Attendance	**10%**

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Assessment Tools:
Quizes
Surprise questions during lab / Class Performance
End Term Viva Voice

Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
BME-DS-612.1	3	1	3	1	3	-	1	1	2	-	-	2	1	1	1
BME-DS-612.2	-	3	1	-	2	-	2	1	1	-	3	1	-	-	2
BME-DS-612.3	3	-	-	1	1	1	-	-	-	2	-	-	1	-	-
BME-DS-612.4	2	3	1	-	-	-	1	-	2	1	-	2	1	-	-

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VIIth Semester

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PROJ-ME-700: PROJECT PHASE - II/INDUSTRIAL PROJECT

Periods/week Credits
L: 0 T: 0 P: 8 5
Duration of Examination: 2 Hrs

Max. Marks : 300
Continuous Assessment : 200
End Semester Exam : 100

Prerequisites: PROJ-ME-600: Project Phase-I
Course Type: Ability Enhancement Course

Course Outcomes:
After completion of this course the students will be able to
PROJ-ME-700.1 Plan the course of action and hypothesize the project work using literature survey.
PROJ-ME-700.2 Formulate the problem statement &invent possible solutions.
PROJ-ME-700.3 Prioritize solutions, select best solution &design the working model.
PROJ-ME-700.4 Fabricate the working model and test it.
PROJ-ME-700.5 Demonstrate the working model and create the report.
PROJ-ME-700.6 Organize and coordinate in a team through effective communication.

Assessment Tools:

Surprise questions during lecture/Class Performance
Term end examination/presentation

Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
VPROJ-ME-700.1	3	3	3	3	3	3	-	-	-	3	3	3	3	3	3
PROJ-ME-700.2	3	3	3	3	3	-	-	-	-	-	2	3	3	3	3
PROJ-ME-700.3	3	3	3	3	3	-	-	-	3	3	3	2	3	3	3
PROJ-ME-700.4	3	3	3	2	-	-	3	3	-	-	2	-	3	3	3
PROJ-ME-700.5	3	3	3	3	3	-	-	-	-	-	-	-	3	3	3
PROJ-ME-700.6	3	3	3	3	3	3	2	-	-	3	3	3	3	3	3

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BME-DS- 703: INDUSTRIAL ENGINEERING AND OPERATIONS RESEARCH

Periods/week Credits
L: 3 T: 1 4
Duration of Examination: 3 Hrs

Max. Marks : 200
Continuous Assessment : 100
End Semester Examination:100

Course Type: Core

Course Outcomes

The students will be able to:

BME-DS-703.1. Understand the requirements of Industry for assignments, Decision making and Projects
BME-DS-.703.2. Decide on optimization of costs and quality without delays in the system
BME-DS-.703.3. Control the defects, inventory and queuing in production

Part-A

Unit-1 Quality and Cost considerations

Basics of TQM, Product life cycle, Lean Manufacturing, Value engineering, Concurrent engineering, Fixed and Variable Costs, Direct, Indirect and Overhead Costs, and Job Costing, Recovery Of Overheads, Standard Costing, Cost Control, Decision Making models.

Unit-2 Work System Design

Productivity – concepts and measurements; Method study, Micro-motion study, Principles of motion economy; Work measurement – time study, Work sampling, Standard data, PMTS; Ergonomics; Job evaluation and merit rating, Gantt Chart, Sequencing - Johnson Algorithm For N-Jobs-2 Machines, N- Jobs-3 Machines, 2 Jobs N-Machines, N-Jobs M-Machines, Hungarian Assignment Model.

Unit-3Materials and Project Management

Strategic Importance Of Materials In Manufacturing Industries, Relevant Costs, Inventory Control Models - Economic Order Quantity (EOQ), MRP-I, MRP-II, JIT, Determination Of Order Point and Safety Stock, Project management: CPM, PERT

Part-B

Unit-4: Statistical Quality Control

Process Control Charts For Variables, X Bar And Range Chart, Variable Inspection And Attribute Inspection, Relative Merits And Demerits, Control Charts For Attribute, P Charts, Np Charts, Varying Control Limits, Defects And Defectives, Control Charts For Defects, C Charts, U Chart, Acceptance Inspection, 100% Inspection, Sampling Inspection, Operating Characteristic Curve (O.C. Curve). Effect of Sample Size and Acceptance Number, Single, Double And Multiple Sampling Plans

Unit-5 Linear Programming

Introduction, Problem identification and formulation, Simplex problem, Duality, Primal-Dual problems and sensitivity analysis, Transportation Model, Balanced and unbalanced problem, Initial feasible solutions by north west rule, Vogel's method, least cost or matrix minimal, Optimality test by Stepping stone and MODI method, Degeneracy

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Unit-6: Queuing and Simulation models

Introduction, Elements of queuing system, Notations of queuing system, Standard Queuing models: M/M/1 queue with infinite and finite population. Introduction, Advantages and limitations of Simulation, Steps in Simulation, Monte Carlo methods.

Text Books/

1. Operation Research-TAHA, PHI, New Delhi.
2. S. L. Narasimhan, D. W. McLeavey, and P. J. Billington, Production, Planning and InventoryControl, Prentice Hall, 1997.
3. Industrial Engineering and Operations Management- Sharma and Sharma, Kataria

Reference Books:

1. Principles of operation Research (with Applications to Managerial Decisions) by H. M. Wagher, Prentice Hall of India
2. Muhlemann, J. Oakland and K. Lockyer, Productions and Operations Management, Macmillan, 1992.
3. Production & Operations Management - Martinich, John Wiely SE

Software required/Weblinks:

https://nptel.ac.in/courses/112/107/112107142/
https://nptel.ac.in/courses/112/107/112107292/

Instructions for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each Part A and Part B (one from each unit). Student needs to attempt two questions out of three from each part. Each question will be of 20 marks.

Distribution of Continuous Assessment:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Assessment Tools:

Assignment/Tutorials
Sessional tests
Surprise questions during lectures/Class Performance
Term end examination

Theory Course: Total Marks 200
Internal/Continuous Assessment: 100

- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

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Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3
BME-DS-703.1	3	-	3	3	-	-	-	-	-	1	2	3	3	3	3
BME-DS-703.2	3	2	2	3	-	-	-	-	-	3	-	2	3	3	3
BME-DS-703.3	3	3	2	2	-	-	2	1	-	2	1	3	-	-	3

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MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH & STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

BCS-ID-004: COMPUTER NETWORK AND COMMUNICATION

Periods/week Credits — Max. Marks : 200
L: 3 T: 0 3 — Internal : 100
Duration of Examination: — External : 100

Pre-Requisites:

Course Type: Program Core

Course Coordinator

Course Outcomes: The students will be able to:

BCS-ID-004.1 Understand basic computer network technology.

BCS-ID-004.2 Describe Data Communications System and its components.

BCS-ID-004.3 Define and identify the different types of network topologies and protocols.

BCS-ID-004.4 Examine functions of the layers of the OSI model and TCP/IP.

BCS-ID-004.5 Organize the different types of network devices.

BCS-ID-004.6 Judge subnetting and routing mechanisms and usage of protocols in network design and implementation.

PART-A

Unit 1: Fundamental of Data Communication and net working

Need for data communication, Data communication components
Digital and analog signals, Properties of signals: amplitude, frequency, and phase
Networks: network criteria,
Applications of Networks
Different types of networks
Introduction to Protocols and standards,
Line configuration: point to point, multipoint
Topology: mesh, star, tree, bus, ring, hybrid

Unit 2: Data Transmission System

Data encoding
Transmission Media:
Wired media Twisted pair-, co-axial-, fiber optic-cables
wireless media

Unit 3: Standards and security in data communications

Switching systems: circuit switching; packet switching
Multiplexing
Transmission errors
Error detection; Parity check, block sum check
Error correction: hamming codes, cyclic redundancy check

PART-B

Unit 4: **TCP/IP**

4.1 TCP/IP reference model
4.2OSI reference model
Internet Protocol, Transmission Control Protocol , User Datagram Protocol
IP Addressing, IP address classes, Subnet Addressing
Internet Control Protocols, ARP, RARP, ICMP 183

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Unit 5: Routing

Basic routing concepts
Routing methods (static and dynamic)
RIP
OSPF
BGP
Congestion Control

Unit 6:Introduction to Network Management

Performance Management
Class of Service
Quality of Service
Firewalls
VLANs
Proxy Servers

Text Books / Reference Books:

1. Data communication and Networking: Behrouz A. Frouzan, 5thEd., 2013, Tata McGraw-Hill.
2. Data & Computer Communications: W.Stallings, 10thEd.,2014, Pearson
3. Introduction to Data Communication and Networking: Wayne Tomasi, 2ndEd., 2007, Pearson
4. Computer Networks : Tanenbaum Andrew S., 5thEd., 2011, Prentice Hall.
5. Computer Networks – A System Approach: Larry L. Peterson & Bruce S. Davie, 4thEd., 2007,Morgan Kaufmann Publishers.
6. Digital Data Communication systems: Roden 1992, PHI
7. Data Communications, Computer Networks and Open Systems: Halsall Fred, 4thEd., 2000, Addison Wesley.
8. Data Communications and Computer Networks: Michael Duck, Richard Read, 2ndEd. , 2003 Pearson

Software required/Weblinks:

www.tutorialspoint.com/computer_network.html
www.techopedia.com

Instructions for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each Part A and Part B (one from each unit). Student needs to attempt two questions out of three from each part. Each question will be of 20 marks.

Distribution of Continuous Assessment:	30%
Sessional- I	
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

MRTRS

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEACH AND STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

BME-DS-751: MECHATRONICS SYSTEMS & CONTROL LAB

Periods/week Credits:	MAX. MARKS: 100
L: 0 T: 0 P: 2 1	Internal 50
Duration of Ext. Exam: 2 Hrs	External 50

Pre-requisites: Basics of Electrical and Electronics

Course Type : Engineering Science

Course Outcome:

On completion of this course, the students will be able to:

BME-DS-751.1 Acquire knowledge about sensors and actuators for engineering applications.

BME-DS-751.2 Develop various projects using mechatronics based concepts.

BME-DS-751.3 Explain various applications of design of mechatronic systems.

List of Experiments:

1. Introduction to sensors using a modular sensor kit and board.
2. Introduction to the Arduino Microcontroller.
3. Traffic light control system using Arduino.
4. Range measurement using ultrasonic sensor.
5. Demonstration of hydraulic actuators using trainer kit.
6. Demonstration of pneumatic actuators using trainer kit.
7. Demonstration of electric actuators using trainer kit.
8. Demonstration of data presentation elements.
9. Automatic light control using Arduino.
10. Digital electronic weighting scale.
11. Rain sensing automatic car wiper system using Arduino.

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Note: 10 experiments are to be performed in the Semester.

Assessment Tools:

Surprise questions during lab/Class Performance

Term end examination/viva

Course Articulation Matrix

CO Statement (**BME-DS-752**)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
BME-DS-751.1	**3**	**2**	**1**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**2**	**3**
BME-DS-751.2	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**-**	**2**	**-**	**3**	**3**	**3**	**2**	**3**
BME-DS-751.3	**3**	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**3**

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(Deemed to be University under section 3 of the UGC Act 1956)

BME-DS-711: Electric Vehicle Charging and Infrastructure

Periods/week Credits — Max. Marks : 200
L: 3 T: 0 — Continuos Evaluation : 100
Duration of Examination: 3 Hours — End Semester Exam : 100

Pre requisites: NIL

Course Type: Program Core

Course Outcomes:

After completion of this course, student will be able to

BME-DS-711.1. Elaborate various grind connected converter for EV battery charging
BME-DS-711.2. Analyse impact of battery charging converter on power system
BME-DS-711.3. Analyse the EV Charger Integration with Solar Power Plant.
BME-DS-711.4. Analyse the requirements for Battery swapping station

PART-A

Unit 1. Types of EV Chargers

Basic charging Block Diagram of Charger
Difference between Slow charger and fast charger
Slow charger design rating, Fast charger design rating
AC charging and DC charging, Inboard and off board charger specification
Type of Mode of charger Mode -2 , Mode-3 and Mode-4
EVSE associated charge times calculation

Unit 2. Selection and sizing of fast and slow charger (AC & DC)

AC Pile Charger, DC Pile Charger, EVSE Power Module selection and technical specification
Selection of EVSE Communication Protocol (PLC / Ethernet / Modbus/ CAN Module)
Communication gateway, Specification of open charge point protocol (OCCP 1.6/2.0)
Bharat DC001 & AC001 Charger specification, Communication Interface between charger and CMS (central management system)
Payment apps

Unit 3. Selection and sizing of Common types of connectors and applications

Selection of AC charger type-1 , type -2 and type -3
Communication between AC charger and EV
Selection of DC charger connector GB/T, CHAdeMO , CCS-1 and CSS-2
Communication methodology of DC fast chargers
IS/ IEC/ARAI/ standard of Charging topology ,Communication and connectors (IEC 61851-1, IEC 61851-24,62196-2)
Selection sizing of Charger connector cable

PART-B

Unit 4. Public Charging infrastructure / Electrical system design

Assessment of site Location for Public charging station
Selection and Sizing of Distribution transformer, HT Equipment (VCB , CT , PT , Metering)
Selection and Sizing HT Cables and LT cables, Distribution Board / feeders
Sizing calculation of LT and HT cable
Selection and of Compact Substation (CSS for EV CS)/ Power Sub station)
Selection of relay and calculation

Preparation of EV Charger Single Line Diagram

Unit 5. EV Charger Integration with Solar Power Plant

Selection of PV module technology
Crystalline technology, Thin film technology, Bi-facial technology
Comparison between PV module technology
Comparison between solar power plant energy out put
Selection and Sizing inverter, Cable and Earthing

Unit 6. Battery swapping stations (BSS)

Introduction to Battery swapping stations
Comparison with Charging stations
Challenges and Adavantages
BSS Configuartion and Equipment requirement
BSS Assessment of site Location

Source https://www.advanceelectricaldesign.com/Syllabus-EV-Charging-Station-Design-Training

References:

1. James Larminie Oxford Brookes University, Oxford, UKJohn Lowry Acenti Designs Ltd., UK,Electric Vehicle Technology Explained
2. C.C Chan, K.T Chau: Modern Electric Vehicle Technology, Oxford University Press Inc., New York 2001
3. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
4. MehrdadEhsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
5. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
6. Chris Mi, M. AbulMasrur, David WenzhongGao, Hybrid Electric Vehicles Principles And Applications With Practical Perspectives, Wiley Publication, 2011.
7. SumedhaRajakaruna, FarhadShahnia, Arindam Ghosh, Plug in Electric Vehicle in Smart Grids, Springer Singapore Heidelberg New York Dordrecht London 8. DeshangSha, GuoXu, HFrequency Isolated Bidirectional Dual Active Bridge DC–DC Converters with Wide Voltage Gain, Springer Nature Singapore Pte Ltd. 2019.

Evaluation Tools:

Assignment/Tutorials 20 Marks
Sessional tests 60 Marks
Class Quiz 20 Marks
Term end examination 100 Marks

Assignments, Sessional and End Semester Examination paper will consist of various difficulty levels to accommodate the different capabilities of students. Assessment should cover all course outcomes and upper limit for lower order skills will be 40% (for knowledge-oriented questions). However, weightage for different cognitive levels in the question papers can vary.

The paper setter must ensure the coverage of the entire syllabus while setting the question papers and mention the learning outcomes across each section to be measured by the examination. Weightage of the sections may vary as per the number of respective lecture hours mentioned in the syllabus. Action verbs should be used from Bloom's Taxonomy while designing question papers.

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Course Articulation Matrix:

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
BME-DS-711.1	2	-	-	-	-	-	-	-	-	-	-	-	2	2	-
BME-DS-711.2	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-
BME-DS-711.3	-	-	2	-	-	-	-	-	-	-	2	2	-	-	-
BME-DS-711.4	-	-	2	-	-	-	-	2	-	-	-	-	3	2	-

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(Deemed to be University under section 3 of the UGC Act 1956)

BME-DS-712: Electric Vehicle Charging Station lab

Periods/week	Credits	Max. Marks : 100
P: 2	1	Continuous Evaluation : 50
Duration of Examination: 2 Hours		End Semester Exam : 50

Pre requisite

Course type: Program Core

Course Outcomes: After completion of this course the students will be able to

BME-DS-712.1. Develop battery charger for an EV

BME-DS-712.2. Simulate batter energy management

BME-DS-712.3. Compare different charging methodologies.

BME-DS-712.4. Understand charging station safety standards

LIST OF EXPERIMENTS:

1. Level one charging component requirements and testing.
2. Testing of level two Charging with the help of suitable equipment
3. Testing of level fast DC Charging.
4. Verification and control of electric car charging stations (EVSE) in accordance with the IEC / EN 61851-1 and IEC / EN60364-7-722 standards, (MACROEVTEST
5. EVSE safety tests in environments civil and industrial CEI 64.8. (MACROEVTEST)
6. Development of Wireless Power Transfer System for Charging of Electric two and three wheelers
7. Testing of SAE J1772, CHAdeMO and Tesla connectors for EV charging.
8. Study of hardware requirement for V2G application
9. Design lay out of battery swapping station
10. Study of EV Charger hardware for Integration with Solar Power Plant
11. Simulation of Battery Energy management

Text Books:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2. Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
3. JamesLarminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

Instructions for Exam: Every student needs to complete 10 experiments in a semester. One experiment out of 10 given randomly needs to be performed in exams.

Parameter	Weightage
Two Mid-Term Viva	60%
File/Record Keeping	20%
Class Performance	10%
Class Attendance	10%

Assessment Tools:

Experiments in lab

File work/Class Performance

Viva (Question and answers in lab)

End Term Practical Examination

Course Articulation Matrix:

CO Statement (BME-DS-712)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
BME-DS-712.1	2	-	-	-	-	-	-	-	-	-	-	-	2	2	-
BME-DS-712.2	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-
BME-DS-712.3	-	-	2	-	-	-	-	-	-	-	2	2	-	-	-
BME-DS-712.4	-	-	2	-	-	-	-	2	-	-	-	-	3	2	-

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DEPARTMENTAL ELECTIVES

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MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH & STUDIES
(Deemed to be University under section 3 of the UGC Act 1956)

BME-DS-531: COOLING TOWERS AND CHILLERS

Periods/week Credits	Max. Marks : 200
L: 3 T: 0 P: 0 3	Continuous Assessment : 100
Duration of Examination: 3 Hrs	End Semester Exam : 100

Prerequisites: Fluid Mechanics and Machines& Heat Transfer
Course Type: Elective Course
Course Outcomes: **The students will be able to**

BME-DS-531.1 Understand the fundamentals of cooling towers and chillers
BME-DS-531.2 Analyze the working of different types of cooling towers and chillers
BME-DS-531.3 Design the cooling towers and chilling machines as per the requirement of the process
BME-DS-531.4 Understand and apply the maintenance aspects of cooling towers and chilling machines

Part-A

Unit 1: Introduction

Fundamentals of cooling towers and chillers, Classification of cooling towers and chillers, Applications of cooling towers and chillers

Unit 2: Chilled Water Loop and Heat Rejection Loop

Chilled water distribution - constant volume, constant primary – variable secondary, variable primary flow, tertiary pumping systems, chilled water cooling coils for various applications, Piping – Direct return and reverse return, district cooling piping systems (concept only); Air cooled, water cooled – condensing units, compressors and condensers – Cooling towers

Unit 3: Cooling Towers

Types and performance evaluation, efficient system operation, Flow control strategies and energy saving opportunities, Assessment of cooling towers

Part-B

Unit 4: Chillers

Air and water cooled chillers – compressors, types and capacities range and applications,Refrigerant Piping Design: Criteria for sizing suction, liquid, hot gas line, pressure drop, oil return, schematic layout of systems, and best practices, pressure testing parameters, Accessories

Unit 5: Compound Compression,Testing and Commissioning of Chillers

Necessity of compound compression, compound vapor compression cycle, Intercooling with liquid subcooling, Multistage compression with flash Intercooling; systems with individual or multiple expansion valves; Individual compression systems with individual or multiple expansion valves but with and without intercoolers.

Installation, Testing and Commissioning of chillers and cooling towers

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Unit 6: Performance Enhancement and Maintenance Aspects

Preventive and breakdown maintenance of chillers and cooling towers, performance enhancement and efficiency calculations

Note:

1. **The students to be taught this course in a hybrid mode (Theory and Industry visit) and be taken to the Cooling Tower & Chiller Plant for demonstrating the different component of Cooling Towers and Chillers in the semester to get a hand on experience of the physical system.**
2. **The student to submit a report of the visit in the form of a case study for internal assessment**

Text Books:

1. Ananthanarayanan, P. N. (2013). Basic refrigeration and air conditioning. Tata McGraw-Hill Education.
2. Arora, C. P. (2000). Refrigeration and air conditioning. Tata McGraw-Hill Education. Heat Exchangers, CRC Press, A Kakac, H Liu, 2002.
3. Prasad, M. (2011). Refrigeration and air conditioning. New Age International. Compact Heat Exchangers, Pergamon, J.E. Hesselgreaves, 2001.

Instructions for setting of Paper Seven questions are to set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each part A and part B (one from each unit). Student needs to attempt two questions out of three questions from each part. Each question will be of 20

Distribution of Continuous Assessment:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Assessment Tools:
Assignment/Tutorials
Sessional tests
Surprise questions during lectures/Class Performance
Term end examination

Theory Course: Total Marks 200
Internal/Continuous Assessment: 100

- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
BME-DS-531.1	1	1	2	1	1	-	-	2	-	-	-	3	2	-	2

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BME-DS-531.2	2	2	2	2	1	-	-	2	3	-	-	3	-	2	2
BME-DS-531.3	3	2	2	2	3	3	-	3	3	2	2	3	2	-	2
BME-DS-531.4	3	3	3	3	3	2	3	-	-	3	2	3	2	2	-

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MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH & STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

BME-DS-532: REFRIGERATION SYSTEMS AND BASICS OF AIR-CONDITIONING

Periods/week Credits:	Max. Mark: 200
L: 2 T: 0 2	Internal 100
Duration of Ext. Exam: 3 Hrs	External 100

Pre-requisites:Thermodynamics, Heat Transfer

Course Type : Program Elective

Course Outcomes: Student will be able to

BME-DS-532.1: Understand the basics of refrigeration systems and other refrigeration cycle and its application in the field of engineering which will help in high research.

BME-DS-532.2: Understand the basic vapor compression cycle and Air refrigeration system used in refrigeration and air conditioning.

BME-DS-532.3 Meet the growing demand of quality RAC Engineers.

Part-A

Unit 1:Introduction: Basic terms and units for Refrigeration System, Methods of refrigeration, Refrigerants:-Nomenclature, desirable properties, Eco friendly refrigerants, ODP, GWP

Air Refrigeration System: Reverse Carnot cycle Bell Coleman refrigeration cycle; Aircraft refrigeration system- Simple and evaporative type, Boot Strap and Boot Strap evaporative type, Regenerative and Reduced Ambient type system; problems.

Unit 2:Vapour Compression Refrigeration system (VCRS), D-X System: Vapour Compression Refrigeration System, Limitation of reverse Carnot Cycle with VCRS, analysis of VCR cycle considering degree of Sub-cooling and superheating, VCR cycle on P-V, T-S and P-H plots, effect of operating conditions on COP; Actual VCR cycle, problems. D-X System: FCUs, Application in FCUs & general systems, Refrigerant piping design as per vapour compression system

Unit 3:Miscellaneous Refrigeration System: Working principle of Vapour Absorption Refrigeration System, COP of the system; Electrolux Refrigeration, aqua ammonia properties, merits and demerits, Study of Lithium Bromide Water System; Steam Jet Refrigeration System- Introduction, Analysis, relative merits demerits and performance; Cryogenics and Cascade Refrigeration System and applications, problem.

Part-B

Unit 4:Psychrometry: Properties of moist air- specific humidity, Relative humidity, Enthalpy, Wet bulb temperature, dew point temperature, Degree of saturation. Psychrometric terms and definitions, Psychrometric chart, Psychrometric processes- Mixing process and other basic processes in conditioning of air, By pass factor of coil, sensible heat factor, ADP of cooling coil; Comfort chart

Unit 5:Air-Conditioning Load Evaluation & Heat Recovery Wheel (HRW): Summer, Winter and Year round air conditioning system, Air Conditioning Systems with Controls & Accessories. Sources of heating and cooling ,Infiltrations, Ventilation and heat generation inside conditioning space; Air distribution system; Duct system design; Methods of Duct system design, temperature, pressure, humidity sensors,

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actuators, safety controls. Heat Recovery Wheel (HRW): Functions ,Enthalpy transfer with sensible & latentheat transfer, Energy savings

Unit 6: Refrigeration and Air Conditioning Equipment:

Compressors, condensers, evaporators and expansion devices, classification and working principles, cooling and dehumidifying coils, Food preservation, Cold storage, Ice plant, Basic difference between Comfort and Industrial air conditioning, Expansion Tank

Note: The students be taught this course in a hybrid mode (Theory and Lab) and be taken to the RAC Lab for demonstrating the different component of refrigeration system to the students during the theory classes in the semester to get a hand on experience of the physical system.

1. Study of vapour compression refrigeration system and determine its COP and draw P-H diagram.
2. Study of mechanical heat pump and find its COP.
3. Study of Air and Water cooled heat pump .
4. Study of cut sectional model of reciprocating & rotary refrigerant compressors.
5. Study of the various controls used in refrigeration & air-conditioning system ,i.e,High Pressure, Low Pressure cut off switch ,expansion valves & thermostat.
6. Study of the ice plant and its working cycle.
7. Study of the humidification & dehumidification of cooling & heating process and plot them on psychrometric chart.
8. To determine bypass factor of cooling coil and plot them on different inlet conditions..
9. To determine the sensible heat factor of air on recirculated air-condition set up

Text Books:

1. Refrigeration and Air Conditioning, D.S. Kumar, Manav Rachna Publications
2. Refrigeration and Air Conditioning, C.P. Arora, Tata McGrawHill

Reference Books

1. Refrigeration and Air Conditioning, Arora and Domkundwar, Dhanpat Rai Publications
2. Refrigeration and Air Conditioning, R.S. Khurmi, Eurasia Publishers
3. Refrigeration and Air Conditioning, P.L.Ballaney, Khanna Publishing House
4. Refrigeration and Air Conditioning, Ahmadul Ameen, PHI

Instructions for setting of Paper Seven questions are to set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each part A and part B (one from each unit). Student needs to attempt two questions out of three questions from each part. Each question will be of 20 marks

Software required / Web links:

http://nptel.ac.in/courses/112105128

http://nptel.ac.in/downloads/112105129

Distribution of Continuous Assessment:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Assessment Tools:

Assignment/Tutorials
Sessional tests
Surprise questions during lectures/Class Performance
Term end examination

Theory Course: Total Marks 200
Internal/Continuous Assessment: 100

- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

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Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3
BME-DS-532.1	3	3	3	3	2	2	2	2	3	3	2	3	3	3	3
BME-DS-532.1	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3
BME-DS-532.1	3	3	3	2	3	2	2	2	2	2	2	3	3	3	3

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MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH & STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

BME-DS-625: RENEWABLE ENEGY & RESOURCE UTILIZATION

Periods/week Credits	Max.Marks: 200
L:3T:0P:0 3	ContinuousAssessment:100
Duration of Examination : 3 Hrs	EndSemesterExam:100

Course Outcomes:

After completion of this course the students will be able to

BME-DS-625.1 Understand the need of energy conversion and the various methods of energy storage

BME-DS-625.2 Outline division aspects and utilization of renewable energy sources for both domestics and industrial application

BME-DS-625.3 To equip students in working with projects and to take up research work in connected areas.

Part-A

Unit 1: Introduction

Renewable and non-renewable energy sources, their availability and growth in India; energy consumption as a measure of Nation's development; strategy for meeting the future energy requirements. Energy Storage and its methods, Concept of smart energy systems

Unit2:Solar Energy

Solar radiation - beam and diffuse radiation; earth sun angles, attenuation and measurement of solar radiation; Optical properties of materials and selective surfaces; Principles, general description and design procedures of flat Platte and concentrating collectors; Performance analysis of cylindrical and parabolic collectors; Solar energy storage systems - their types, characteristics and capacity; solar ponds. Applications of solar energy in water, space and process heating, solar refrigeration and air conditioning; water desalination and water pumping; solar thermal power generation; solar cells and batteries; economic analysis of solar systems

Unit3:Wind Energy

Principle of wind energy conversion; Basic components of wind energy conversion systems; wind mill components, various types and their constructional features; design considerations of horizontal and vertical axis wind machines: analysis of accodynamic forces acting on wind mill blades and estimation of power output; wind data and site selection considerations

Part-B

Unit 4: Direct Energy Conversions System

types and working of different MHD systems – their relative merits; MHD materials and production of magnetic fields. Thermo-electric generators: Thermo-electric effects and materials; thermo-electric devices and types of thermo-electric generators; thermo-electric refrigeration. Thermionic generators: thermionic emission and materials; working principle of thermionic convertors Fuel Cells: thermodynamic aspects; types, components and working of fuel cells.

Unit5: Energy from Biomass

Calorific value of Biomass samples, Pyrolysis, Biomass conversion technologies, Biogas generation plants, classification, advantages and disadvantages, constructional details, site selection, digester design consideration, filling a digester for starting, maintaining biogas production, Fuel properties of biogas, utilization of biogas.

Unit6: Geothermal and Ocean Energy

Estimation and nature of geothermal energy, geothermal sources and resources like hydrothermal, geo-pressured hotdryrock,magma.Advantages,disadvantages,andapplicationofgeothermalenergy, Ocean Thermal Electric Conversion systems like open cycle, closed cycle, Hybrid cycle. Energy from tides, basic principle of tidal power, single basin and double basin tidal power plants, advantages, limitation and scope of tidal energy. Wave energy and power from wave, wave energy conversion devices, advantages and disadvantages of wave energy.

Text Books:

1. G.D. Rai, Non-Conventional Energy Sources ,Khanna Publishers, New Delhi, 2011.
2. B H KHAN, Non-Conventional Energy Resources, McGraw Hill, 2nd Edition, 2009.
3. Ashok Desai V, Non-Conventional Energy, Wiley Eastern Ltd, 1990.
4. Mittal K.M, Non-Conventional Energy Systems, Wheeler Publishing Co. Ltd, 1997.

Reference Books:

1. Energy Conversion by Chang; Prentice Hall
2. Direct Energy Conversion by Soo; Prentice Hall
3. Fuel Cells by Bockris and Srinivasan; McGraw Hill
4. Magneto Hydrodynamics by Kuliovsky and Lyubimov, Addison

Weblinks:

https://nptel.ac.in/courses/122104015https://nptel.ac.in/courses/11210 3109https://onlinecourses.nptel.ac.in/noc19_me01/preview

Instructions for setting of Paper Seven questions are to set in total. First question will be conceptual coveringentire syllabus and will be compulsory to attempt. Three questions will be set from each part A and part B (one fromeach unit). Student needs to attempt two questions out of three questions from each part. Each question will be of 20marks.

AssessmentTools:

IngeneralparametersforInternal/ContinuousAssessment(TheoryCourses):

Parameter	Weightage
TwoSessional(Mid-Term)Tests	60%
Assignments	20%
ClassPerformance	10%
ClassAttendance	10%

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Theory Course: Total Marks 200Internal/Continuous
Assessment: 100
Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
Assignments: 20 Marks
Class Work/ Performance: 10 Marks
Attendance: 10 Marks End Semester Exams: 100 Marks

CourseArticulationMatrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
BME-DS-625.1	3	3	2	2	2	3	3	-	-	-	-	3	3	3	2
BME-DS-625.2	3	3	3	3	3	3	3	-	-	-	-	3	3	3	3
BME-DS-625.3	3	3	3	3	3	3	3	-	2	-	1	3	3	3	3

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MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH & STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

BME-DS-631: HEAT EXCHANGERS

Periods/week Credits	Max. Marks : 150
L: 3 T: 0 P: 0 3	Continuous Assessment : 50
Duration of Examination: 3 Hrs	End Semester Exam : 100

Prerequisites: Fluid Mechanics and Machines
Course Type: Elective Course

Course Outcomes:
After completion of this course the students will be able to
BME-DS-631.1 Understand the fundamentals of heat exchangers
BME-DS-631.2 Analyze the working of different types of heat exchangers
BME-DS-631.3 Design the heat exchangers as per the requirement of the process
BME-DS-631.4 Understand and apply the maintenance aspects of heat exchangers

Part-A

Unit 1: Introduction

Types, Shell and Tube Heat Exchangers, Regenerators and Recuperators, Industrial applications. Temperature distribution and its implications, LMTD, Effectiveness.

Unit 2: Flow Distribution and Stress Analysis

Effect of Turbulence, Friction factor, Pressure loss, Channel divergence. Thermal Stress in tubes, Types of failures.

Unit 3: Design Aspects of Heat Exchangers

Concept of mean temperature difference, LMTD Method, NTU Method, Design of counter and parallel flow heat exchangers, Heat Transfer and pressure loss, Flow Configuration, Effect of Baffles, effect of Deviations from ideality, Design of Typical liquid, Gas-Gas-Liquid Heat Exchangers, Plate Heat Exchangers.

Part-B

Unit 4: Condensers and Evaporators Design

Design of surface and evaporative condensers, Design of shell and tube, plate type evaporators.

Unit 5: Construction Details and Heat Transfer
Construction details of various types of heat exchangers, shell and tube, double pipe, jet condensers, cooling towers, Regenerative heat exchangers, Positioning and calculations pertaining to fins in a heat exchanger.

Unit 6: Performance Enhancement, Testing and Evaluation of Heat Exchangers

Concept of fouling in heat exchangers, Descaling of heat exchanger tubes, Efficiency and Effectiveness of heat exchangers, Testing and commissioning of Heat exchangers.

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Text Books:

1. Process Heat Transfer, CRC Press, G F Hewuttm G L Shires and T R Bott,1994.
2. Fundamentals of Heat Exchanger Design, John Wiley & Sons., R K Shah and D P Sekulic,2003.
3. Heat Exchangers, CRC Press, A Kakac, H Liu, 2002.
4. Handbook for Heat Exchangers and Tube Banks Design, D. Annaratone , Springer Verlag, 2010.
5. Compact Heat Exchangers, Pergamon, J.E. Hesselgreaves, 2001.
6. Advances in Thermal Design of Heat Exchangers, Eric M Smith, John Wiley & Sons, Ltd., 2005.
7. Literature from Web.

Instructions for setting of Paper Seven questions are to set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each part A and part B (one from each unit). Student needs to attempt two questions out of three questions from each part. Each question will be of 20

Distribution of Continuous Assessment:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Assessment Tools:
Assignment/Tutorials
Sessional tests
Surprise questions during lectures/Class Performance
Term end examination

Theory Course: Total Marks 200
Internal/Continuous Assessment: 100

- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
BME-DS-631.1	3	3	3	3	3	1	1	-	2	-	-	2	2	-	2
BME-DS-631.2	3	3	3	3	2	3	-	-	-	-	-	3	2	2	-
BME-DS-631.3	3	3	3	3	3	-	-	-	1	-	-	1	-	2	-
BME-DS-631.4	3	3	3	3	3	3	3	-	-	-	-	-	2	-	-

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BME-DS-632: Green Building Technologies

Periods/week Credits	Max. Marks : 200
L: 3 T: 0 P: 0 3	Continuous Assessment : 100
Duration of Examination: 3 Hrs	End Semester Exam : 100

Prerequisites: BME-DS-302:Thermodynamics, BME-DS-401:Applied Thermodynamics
Course Type: Domain Specific Elective Course
Programme: Elective Course

Course outcomes: The students will be able to:

BME-DS-632.1 Learn the concepts and strategies for lowering environmental impactof buildings and neighbourhoods.
BME-DS-632.2 Learn the concepts and projects that have been developed in response to thermal challenges.
BME-DS-632.3 Gain experience in the application of Green Building to real engineering designs.

PART A

Unit 1- Introduction

Green Building Design Strategies and Building Codes: Energy use in Buildings, Factors effecting Energy use, Energy Conservation options. External Factors – Climate, Building Orientation, Shading, types of shading devices, benefits of green buildings towards sustainable development.

Unit 2 -Thermal Comfort:

Criteria and various Parameters, Psychometric Chart, Thermal Indices. Indoor air quality; Requirements in residential, Commercial, Hospital Buildings.

Unit 3- Heating &cooling concepts

: Direct gain, indirect gain, isolated gains and suspense Passive cooling concepts: Evaporative Cooling, Evaporative Air and Water Coolers, Radiative Cooling, Application of Wind, Water and Earth for Cooling ,use of isolation, Shading, Paints and cavity walls for cooling

PART B

Unit 4-Passive heating and cooling concepts:

Roof pond/sky therm, roof radiation trap, vary-therm wall, earth sheltered or earth based structures and earth air tunnels; selective ventilation, components- windows and thermal storage

Unit 5-Heat Transmission in Buildings:

Surface Coefficient, Air cavity, Internal and External Surface, Overall Thermal Transmittance Walls and Windows, and Packed Roof-thatched Heat Transfer; Heat transfer due to ventilation/ infiltration, Building loss coefficient Internal Heat gains, Solar Temperature, Steady State Method (for Trombe Wall, Water wall and Solarium), Degree Day method.

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Unit 6-Heat Transmission in Buildings:

Correlation methods - solar load ratio, load collector ratio, thermal time constant method, Analytical methods - thermal circuit analysis, admittance procedure of metrics. The periodic solutions - thermal modeling of AC / Non AC buildings, software application. ASHRAE Methods and standards for estimates of Heating and cooling and Ventilation, Requirements of Different use Buildings, Air Quality control Equipments.

Recommended Books :

1. M S Sodha, N.K. Banaal, P.K.Bansal, A.Rumaar and M.A.S. Malik, Solar Passive: Building Science and Design, Pergamon Preen (1986).
2. Jamee; L. Threlked, Thermal Environment Engineering, Prentice Hall, INC-, Raglevood Cliffs, New Jersey (1970)
3. T.A. Markus and R.N. Morris, Building, Climate and Energy Spottwoode Ballantype Ltd-, London U.K. (1980)
4. Solar Thermal Energy Storage, H. P. Garg et.al, D. Reidel Publishing Company (1985)
5. Mathematical Modeling of Melting and Freezing Process, V Alexiades & A.D. Solomon, Hemisphere Publishing Corporation, Washington (1993)
6. Energy storage technologies, a reading material prepared by Dr. D. Buddhi, School Of Energy And Environmental Studies, DAVV, Indore.

Instructions for setting of Paper Seven questions are to set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each part A and part B (one from each unit). Student needs to attempt two questions out of three questions from each part. Each question will be of 20 marks.

Assessment Tools:

In general parameters for Internal /Continuous Assessment (Theory Courses):

Parameter	Weightage
Two Sessional (Mid-Term)Tests	60%
Assignments	20%
Class Performance	10%
Class Attendance	10%

Theory Course: Total Marks 200
Internal/Continuous Assessment: 100

- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 10 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

COURSE ARTICULATION MATRIX

CO Statement	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO3**
BME-DS-632.1	3	3	3	2	2	3	3	-	-	-	-	3	3	3	3
BME-DS-632.2	3	3	3	3	3	3	3	-	1	-	-	3	3	3	3
BME-DS-632.3	3	3	3	3	3	3	3	-	1	-	-	3	3	3	3

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(Deemed to be University under section 3 of the UGC Act 1956)

BME-DS-633: HEATING, VENTILATION& AIR-CONDITIONING (HVAC) SYSTEM

Periods/week	Credits	Max. Marks : 200
L: 2 T: 0 P: 2	3	Continuous Assessment : 100
Duration of Examination: 3 Hrs		End Semester Exam : 100

Pre-requisites: Thermal Engineering-I, Thermal Engineering-II, Heat Transfer , Refrigeration& Air conditioning

Course Type : Program Elective

Course Outcomes: The student will be able to

BME-DS-633.1 Understand the basics of Air-conditioning Systems and its application in the field of engineering which will help in high research.

BME-DS-633.2 Understand the basic cooling, heating, chilled water/condenser water system ,ducting etc used in HVAC System.

BME-DS-633.3 Generate smart, innovative and employable engineering graduates to meet the growing demand of quality HVAC Engineers in India & Abroad.

Part-A

Unit 1: Introduction

Psychrometry - Psychrometric chart, basic problems, numerical, Heat Load Estimation-Introduction to heat load estimation, Its requirement, Different components of heat load estimation, heat load sheet explanation, numerical Duct Design and Air distribution-Air flow through ducts, duct sizing ,duct adjustment with aspect ratio with respect to other services above false ceiling, diffuser grille adjustment with false ceiling drawing & lighting plan, aesthetics, Human Comfort-Metabolism, heat production by human body, comfort conditions

Unit 2: Air-conditioning systems & selection

Air Conditioning Systems, Applications and Selections Scope-Central , Package, Window, Split, VRV etc. Application depending on requirements, Selection scope-Selection made on the basis of TR, air flow rate, pump selection, AHU selection, FCU selection, coil design & fitment, Fans & Blowers - Orientation, cfm ,Static pressure, BHP, IHP, Motor

Unit-3: Ducting, Insulation, Ducting Accessories

Insulation-Supply duct insulation, Return duct insulation, acoustic lining of ducts, Clearance space after insulation with false ceiling, Installation, Charging and Maintenance of Air Conditioning Systems, Accessories-Introduction to fire damper, volume control damper, Supply air diffuser/grille with VCD, Return air grille without VCD, proportional thermostat

Part-B

Unit-4:HVAC Equipment & Applications

Central Air Conditioning- Concept of Variable Chilled water system, description, Air Handling Units-Concept, description, Filters-Pre, Micro& HEPA filters, Fan Coil Unit-Concept, description, numerical, Air conditioning of Houses, Offices, Hotels, Restaurants, Departmental stores. Theater, Auditoriums, Hospitals, Automobiles, Operation Theatre, Vibrations & Noise Control, Variable Frequency / speed drive.

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Unit-5:Heating System, Pipes & Valves

Heating System-With strip heaters & boilers, Cooling Tower-Types & description, 3-Wayvalve-Concept,modulation,CHW/CDWValves-Arrangement,Function,Schematic representation of total HVAC System, pipe sizing, numerical

Unit-6: Plant room, Coordination, Vertical Shaft Layout

Plant room location/layout, AHU Room location/ layout, Adjustment of CHW/CDW piping, ducting, insulation with other services, Vertical shaft layout for different services, Visiting site under construction.

Note:

1. The students to be taught this course in a hybrid mode (Theory and Industry visit) and be taken to the industry/HVAC installation centre for demonstrating the different component of HVAC System in the semester to get a hand on experience of the physical system.
2. The student to submit a report of the visit in the form of a case study for internal assessment

Instructions for setting of Paper Seven questions are to set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each part A and part B (one from each unit). Student needs to attempt two questions out of three questions from each part. Each question will be of 20 marks

Software required / Web links:

http://nptel.ac.in/courses/ 112105128
http://nptel.ac.in/downloads/112105129

Distribution of Continuous Assessment:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Assessment Tools:
Assignment/Tutorials
Sessional tests
Surprise questions during lectures/Class Performance
Term end examination

Theory Course: Total Marks 200
Internal/Continuous Assessment: 100

- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

Course Articulation Matrix

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CO Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BME-DS-633.1	3	3	3	3	3	3	2	2	3	3	2	3	3	3	3
BME-DS-633.2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
BME-DS-633.3	3	3	3	2	3	3	3	2	2	2	2	3	3	3	3

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MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH & STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

BME-DS-731: BUILDING SAFETY,INSULATION, ACOUSTICS

Periods/week Credits:	Max. Marks: 200
L: 3 T: 0 P:0 3	Internal Examination : 100
Duration of Ext. Exam: 3 Hrs	External Examination : 100

Pre-requisites: Thermal Engineering-I (M-302), Thermal Engineering-II (M-401A), HVAC()

Course Type : Program Elective

Course Outcomes: The Student will be able to

BME-DS-731.1: Understand the basics of fire classifications and its application in the field of engineering which will help in high research.

BME-DS-731.2: Understand the basic thermal &accoustic applications in HVAC System

BME-DS-731.3: Understand ventilation, its requirements & corresponding safety measures taken in the HVAC System

Part-A

Unit 1:Vertical Transportation: Lifts,Grouping of Lifts,Return Travel Time(RTT),Design of lift banks for carrying capacity & travel time

Unit 2:Fire: Causes of fire,classifications of fire,fire extinguishers & application

Unit 3: Thermal Insulation:

Thermal insulation in supply/return air duct,Chilled water pipe line ,Heat transfer analysis of walls with insulation

Part-B

Unit 4:Acoustic& acoustic Insulation:

Sound, propagation of sound,Resonance,Reverberation,Quality of good acoustics

Acoustic insulation of plant room & AHU Room,quiet air application like library,exam hall

Unit 5:Ventilation:

Ventilation requirement for building safety,basement ventilation as per fire regulation,toilet ventilation,Restaurant & Kitchen Ventilation

Unit 6:Fire Safety Devices:

Fire damper,types,fire withstanding capacity,stair case pressurization

Text Books :

1.Book of air-conditioning byAnanthanarayan

2.Refrigeration& air-conditioning by C.P.Arora

Reference books:

1. General Specifications for Heating, Ventilation &Air-conditioning (HVAC) Works (2017)

2. Commentary on National Building Code (Part 4) – Fire and Life Safety by G.B.Menon Fire Adviser, Govt. of India {Retd.} Cochin Ex-Chairman CED-22 Fire Fighting Sectional Committee Bureau of Indian Standards. J.N.VakilAsst.General Manager{Retd},TAC/GIC,Ahmedabad ExChairman CED-36 Fire Safety Sectional Committee Bureau of Indian Standards.

3. National Building Code of India 2016

4.Carrier handbook by Carrier

5.ISHRAE Handbook by ISHRAE

Instructions for setting of Paper Seven questions are to set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each part A and part B (one from

each unit). Student needs to attempt two questions out of three questions from each part. Each question will be of 20 marks

Software required / Web links:

http://nptel.ac.in/courses/ 112105128

http://nptel.ac.in/downloads/112105129

Distribution of Continuous Assessment:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Assessment Tools:

Assignment/Tutorials
Sessional tests
Surprise questions during lectures/Class Performance
Term end examination

Theory Course: Total Marks 200
Internal/Continuous Assessment: 100

- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3
BME-DS-731.1	2	2	3	3	3	3	2	2	3	3	2	3	3	3	3
BME-DS-731.2	3	3	3	3	3	3	3	3	3	2	3	3	2	3	3
BME-DS-731.3	3	2	3	2	3	3	3	2	2	2	2	3	3	3	3

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MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH & STUDIES

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BME-DS-732: Computational Fluid Dynamics

Periods/week Credits	Max. Marks : 200
L: 2 T: 0 P: 2 3	Continuous Assessment : 50
Duration of Examination: 3 Hrs	End Semester Exam : 100

Prerequisites: Fluid Mechanics and Machines & Heat Transfer

Course Type: Elective Course

Course outcomes: The students will be able to:

BME-DS-732.1: Develop an understanding for the major theories, approaches and methodologies used in CFD

BME-DS-732.2:Build up the skills in the actual implementation of CFD methods (e.g. boundary Conditions, turbulence modeling etc.) in using commercial CFD codes.

BME-DS-732.3: Gain experience in the application of CFD analysis to real engineering designs

Part-A

Unit 1: Introduction

Introduction: History and Philosophy of computational fluid dynamics, CFD as a design and research tool, Applications of CFD in engineering, Programming fundamentals, Numerical Methods.

Unit 2: Governing equations

Governing Equations of Fluid Dynamics: The continuity equation, The momentum equation, Theenergy equation, Navier-Stokes equations for viscous flow, Euler equations for inviscid flow, Physical boundary conditions, Forms of the governing equations suited for CFD.

Unit 3: Partial differential equations

Mathematical Behavior of Partial Differential Equations: Classification of quasi-linear partial differential equations, Methods of determining the classification, General behavior of Hyperbolic, Parabolic and Elliptic equations.

Part-B

Unit 4: Navier Stokes Equations

Solution of Navier-Stokes equations: methods for compressible flow; need for special methods for incompressible flows. Finite Difference Method, application of FDM to model problems

Unit 5: grid generation

Transformation of coordinates. General principles of grid generation – structured grids in two and three dimensions, algebraic grid generation, and differential equations based grid generation. Introduction to FVM method.

Note: The unit-5 to be covered by using ANSYS fluent . Students will be exposed to the ANSYS software and hands on practice with a CASE STUDY

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Unit 6: Applications of CFD

Introduction and application of FVM in diffusion and convection problems, Application of FEM to ID and 2D problems in fluid flow and heat transfer.Simulation of flow in 2D merging pipes and Pipe joints.

Note: The Unit-6 to be covered by using ANSYS fluent. Students will be exposed to the ANSYS software and hands on practice with a CASE STUDY

Text Books:

1. J. D. Anderson, "Computational Fluid Dynamics", McGraw-Hill Inc. (1995).
2. S. V. Patankar, "Numerical Heat Transfer and Fluid Flow", Hemisphere Pub. (1980).
3. K. Muralidhar, and T. Sundarajan, "Computational Fluid Flow and Heat Transfer", Narosa (2003).
4. D. A. Anderson, J. C. Tannehill and R. H. Pletcher, "Computational Fluid Mechanics and Heat Transfer", Hemisphere Pub. (1984).
5. M. Peric and J. H. Ferziger, "Computational Methods for Fluid Dynamics", Springer (2001).

Instructions for setting of Paper Seven questions are to set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each part A and part B (one from each unit). Student needs to attempt two questions out of three questions from each part. Each question will be of 20 marks.

Distribution of Continuous Assessment:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Assessment Tools:
Assignment/Tutorials
Sessional tests
Surprise questions during lectures/Class Performance
Term end examination

Theory Course: Total Marks 200
Internal/Continuous Assessment: 100

- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
BME-DS-732.1	**3**	**1**	**1**	**1**	**-**	**2**	**-**	**-**	**-**	**3**	**-**	**3**	**3**	**3**	**2**

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BME-DS-732.2	**3**	**2**	**2**	**2**	**3**	**2**	**1**	**-**	**1**	**3**	**-**	**3**	**3**	**3**	**3**
BME-DS-732.3	**3**	**1**	**2**	**3**	**3**	**1**	**1**	**-**	**1**	**2**	**1**	**3**	**3**	**3**	**2**

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(Deemed to be University under section 3 of the UGC Act 1956)

BME-DS-733: Building Management System (BMS) for HVAC

Periods/week	Credits	Max. Marks : 200
L: 3 T: 0 P: 0	3	Continuous Assessment : 100
Duration of Examination: 3 Hrs		End Semester Exam : 100

Program type:Elective Course

Course Outcomes: **The students will be able to**

BME-DS-733.1 Understand Building Management system and Automation.

BME-DS-733.2 Describe various Sensors and Transducers - Automation components in BMS

BME-DS-733.3 Explain control panel and communication such as HVAC and Modbus.

Part -A

UNIT I: Introduction To Building Management System And Automation

Concept and application of Building Management System (BMS) and Automation, requirements and design considerations and its effect on functional efficiency of building automation system, architecture and components of BMS.

UNIT 2: Automation Components In BMS

Temperature Sensors: RTD, Thermistor, Thermocouple, Bimetallic strip - Pressure Sensors: Diaphragm type, piezoelectric sensors – Different types of mounting of pressure sensors in duct, rooms and pipes – Air flow sensor: Anemometer, velocity pressure sensors – Flow sensors

UNIT 3: Flow Measuring Devices

Turbine flow meter, Orifice, Venturi, Pitot tube, ultrasonic flow meter – Different types of mounting for air & water flow meters.

Part-B

UNIT 4: Control Panel and Communication

HVAC Control Panel, MCC Basics, Panel components; Communication Basics, Networks, BACNet, Modbus, LON.

UNIT 5: FAS and Security Systems

Fire, Fire modes – Fire Alarm Systems components: Field components, panel components – FAS Architectures – Access Components, Access control system Design - CCTV camera types and operation

UNIT 6: Energy Management

Energy Savings concept & methods, lightning control, Building Efficiency improvement, Green Building (LEED) Concept & Examples

Text Books

1. Understanding Building Automation Systems (Direct Digital Control, Energy Management, Life safety, Security, Access Control, Lightning, Building Management Programs) (Hardcover), Reinhold A. Carlson and Robert A. Di Giandomenico.

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2. HVAC Systems Design Handbook, Fifth Edition, Roger W. Haines. 3. CCTV (Newnes), Vlado Damjanovski (1999). 4. Process control – Instrument Engineers Handbook by Bela G. Liptak, Chilton book co.

Reference Books:

1. Building Control Systems, Application Guide (CIBSE Guide), CIBSE, 2000.
2. Smart Buildings by Jim Sinopoli, Butterworth-Heinemann imprint of Elsevier, 2 nd ed., 2010
3. Design of Special Hazards and Fire Alarm Systems, Robert Gagnon, 2007

Instructions for setting of Paper Seven questions are to set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each part A and part B (one from each unit). Student needs to attempt two questions out of three questions from each part. Each question will be of 20 marks.

Instructions for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each Part A and Part B (one from each unit). Student needs to attempt two questions out of three from each part. Each question will be of 20 marks.
Distribution of Continuous Assessment:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Assessment Tools:
Assignment/Tutorials
Sessional tests
Surprise questions during lectures/Class Performance
Term end examination

Theory Course: Total Marks 200
Internal/Continuous Assessment: 100

- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3
BME-DS-733.1	3	3	2	2	3	3	2	2	2	2	2	3	3	3	3
BME-DS-733.2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3
BME-DS-733.3	3	1	3	2	3	2	2	2	2	2	2	3	3	3	3

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Course Code	Title of Course	SEMESTER
BME-DS-527	Design Thinking	**V**
BME-DS-528	Plastic Technology	**V**
BME-DS-529	Tool Engineering & Design	**V**
BME-DS-627	CNC Technology & Programming	**VI**
BME-DS-628	Metrology & Quality Assurance	**VI**
BME-DS-629	Digital Manufacturing (Industry 4.0)	**VI**
BME-DS- 727	Mould and Press Tool Design	**VII**
BME-DS-728	Product Design & Development	**VII**
BME-DS-729	Computer Aided Design	**VII**

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BME-DS-527: DESIGN THINKING

Periods/week Credits
L: 3 T: 0 P: 0 3
Duration of Examination: 3 Hrs

Max. Marks : 200
Continuous Assessment : 100
End Semester Exam : 100

Prerequisites: Industrial Management, Ergonomics, Industrial Engineering.
Course Type: Domain Specific Elective Course

Course Outcomes:
After completion of this course the students will be able to
BME-DS-527.1: Understand the basics of design: creativity and innovation in products
BME-DS-527.2: Identify the consumer needs and translate it into the fruitful products/services
BME-DS-527.3: learn about the product architecture

Part-A

Unit-I: Understanding the basics of Design Thinking

Industry 4.0: Historical development, Recognizing the opportunities, idea generation and concept development, sources for new ideas. Basics of design concept, importance, objectives, and myths for designs, design processes and practical implications associated to design.

Unit-2: Human ergonomics in designs

Understanding the consumer needs: market research & analysis, human factor and ergonomics consideration for industrial designs, systematic approach in solution development: brainstorming, visual thinking, and challenges study in concept generation process for designing the desired needs solution.

Unit-3 Creativity and Innovation for design solutions

Unleashing the creativity, the creative v/s design solutions, Innovation: Need, basics, steps, process for developing innovative solutions and the art of Innovation: importance of teams and organizational culture for innovation. Solution finding methods: Conventional, intuitive, discursive, methods for combining solution, decision making for new design.

Part-B

Unit-4: Reverse Engineering

Introduction to reverse engineering, importance, objectives, advantages, reasons for reverse engineering and processes for reverse engineering. Environmental and safety considerations in products development.

Unit-5: Prototyping: Product Architecture& Development

Introduction to product development, steps to product development, considerations in product development, utility of design thinking in product development. Developing prototype: Introduction, concept, prototyping methods, strategies, and real-life examples.

Unit-6: Design methodology and methods

Evolution of design method from craftsmanship to design by drawing, Emergence of new design methods, Problem exploration and investigating users

Text Books:

1. Design Thinking Methodology Book Paperback, EmrahYacici, ArtBiz Tech

2. Philip Kosky, Robert T. Balmer, William D. Keat, George Wise, "Exploring Engineering: An Introduction to Engineering and Design", 4th edition, Elsevier, 2016.
3. David Ralzman, "History of Modern Design", 2nd edition, Laurence King Publishing Ltd., 2010
4. Marketing Management: Philip B. Kotler, 15th Edition, Pearson Publication, 2017.
5. G. Pahl, W.Beitz, J. Feldhusen, KH Grote, "Engineering Design: A Systematic Approach", 3rd edition, Springer, 2007.

Reference Books:

1. Running Lean: Iterate from Plan A to a Plan That Works, O'Really Press, 2016.

Weblinks:

Instructions for setting of Paper Seven questions are to set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each part A and part B (one from each unit). Student needs to attempt two questions out of three questions from each part. Each question will be of 20 marks.

Assessment Tools:

In general parameters for Internal /Continuous Assessment (Theory Courses): Parameter	Weightage
Two Sessional (Mid-Term)Tests	60%
Assignments	20%
Class Performance	10%
Class Attendance	10%

CO-PO Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
BME-DS-527.1	1	-	-	3	3	2	3	1	2	-	-	3	3	-	3
BME-DS-527.2	-	2	-	-	3	1	-	-	3	3	-	3	2	1	-
BME-DS-527.3	3	-	3	-	2	-	-	1	-	1	1	-	-	3	1

MITS

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(Deemed to be University under section 3 of the UGC Act 1956)

BME-DS-528: Plastic Technology

Periods/week Credits
L: 3 T: 0 P: 0 3
Duration of Examination: 3 Hrs.

Max. Marks: 200
Continuous Assessment: 100
End Semester Exam : 100

Prerequisites: Engineering drawing, Manufacturing processes
Course Type: Domain Specific Elective Course

Course Outcomes:
After completion of this course the students will be able to
BME-DS-528.1: Identify polymeric materials, their properties and applications.
BME-DS-528.2: Identify and apply various plastic processing techniques
BME-DS-528.3: Apply critical parameters of related to various plastic processing techniques.

Part-A

Unit-I: Introduction to Polymer Science

Concept of Monomer and Polymer, Classification of polymer, Types of Polymerization, Polymerization techniques, Molecular Weight and Degree of Polymerization, Molecular weight distribution, Number average and Weight average molecular Weight , Effect of Molecular Weight, linearity, non-linearity, crystallinity and polarity of polymer on properties, Glass Transition Temperature.

Unit-2:Plastic Materials:-

Introduction to Plastic Materials, General properties and applications of plastics – Polyethylene , Polypropylene, Polyvinyle Chloride, polystyrene, Acrylonitrile Butadiene Styrene, Polyamides (Nylon 66), Polycarbonates, Polyacetals, Polyurethanes , Phenolic Resins and Melamine Resins.

Unit-3 :Additives and compounding of plastics:

Functions and Working Mechanism- fillers, antioxidants, thermal stabilizers, lubricants, plasticizers, toughening agents, colourants, fire retardants, blowing agents, ultraviolet stabilizers, Impact Modifier, Antistatic Agents, Processing Aids and compounding of plastics.

Part-B

Unit-4: Plastic Processing Techniques (injection moulding)

Introduction, injection molding for thermoplastic, Machine types , injection molding machines specifications - projected area, plasticizing capacity, shot weight, Day light, mould clamping system – toggle and hydraulic system. Common moulding defects, causes and remedies.

Unit-5:Plastic Processing Techniques (Extrusion)

Introduction, Types of extruders, extrusion screw design features, breaker plate–screen pack & its functions, extrusion faults - causes and remedies.

Unit-6: Plastic Processing Techniques (Blow Moulding)

Introduction to blow moulding, Types of blow moulding operations, concept of extrusion blow moulding and injection blow moulding.

Text Books:

1. Premamoy Ghosh, "Polymer Science and Technology, Plastics, Rubbers, Blends and Composites", McGraw Hill Education (India) Private Limited, 2013.
2. M. Berins, "Plastics Engineering Handbook of the Society of the Plastics Industry", Springer, 1991.

Reference Books:

1. Irvin I. Rubin," Handbook of plastic materials and technology" New York: Wiley, 1990.Weblinks:
2. Harper, "Handbook of Plastic Processes", MGH Publication, 2006.
3. J.P. Beaumont, R. Nagel, R. Sherman, "Successful Injection Molding: Process, Design and Simulation", Hanser Gardner Publications, 2002 .

Instructions for setting of Paper Seven questions are to set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each part A and part B (one from each unit). Student needs to attempt two questions out of three questions from each part. Each question will be of 20 marks.

Assessment Tools:

In general parameters for Internal /Continuous Assessment (Theory Courses): Parameter	Weightage
Two Sessional (Mid-Term)Tests	60%
Assignments	20%
Class Performance	10%
Class Attendance	10%

CO-PO Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
BME-DS-528.1	1	-	-	3	3	2	3	1	2	-	-	3	3	-	3
BME-DS-528.2	-	2	-	-	3	1	-	-	3	3	-	3	2	1	-
BME-DS-528.3	3	-	3	-	2	-	-	1	-	1	1	-	-	3	1

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BME-DS-529: Tool Engineering and Design

Periods/week Credits — Max. Marks: 200
L: 3 T: 0 P: 0 3 — Continuous Assessment: 100
Duration of Examination: 3 Hrs. — End Semester Exam : 100

Prerequisites: Engineering drawing, Manufacturing Technology.
Course Type:

Course Outcomes:
After completion of this course the students will be able to
BME-DS-529.1 Selection of tool material, tool coatings and interpret ISO designation for carbide inserts, tool holders for carbide inserts
BME-DS-529.2 Understanding the specification design features, various components of single and multiple point cutting tools and gauges
BME-DS-529.3 Apply themselves in selecting cutting tools as per work material compositions for machining. They will be able to recommend tool material and the tool coatings for manufacturing of various cutting tools like drill, milling cutter, broach and gauge designing.
BME-DS-529.4 Design and synthesis of single point cutting tool, drill bit, milling cutters, broach design & Gauges.

Part-A

Unit-I: Cutting Tool Material & Tool Holders

Selection and specification of tool steels for tooling, Specification of tool materials as per various standards (IS, BS, AISI, APS etc.) Cold work tool steels, hot work tool steels, high speed tool steels. Cutting Tool Materials: Properties, Composition & Applications of HSS, Carbides, PCD, Ceramics and Cubic Boron Nitride Tools. Common insert shapes with advantages, Purpose and types of Chip Breaker and their purposes. Carbide inserts-types, ISO-designation and applications. Tool holders for turning and milling carbide inserts-types, ISO designationand applications.

Unit-2: Cutting Tool Performance

Effect of cutting tool micro and macro-geometry, tool coating in cutting tool performance. Coating of Tools: Methods for coating cutting tools (CVD & PVD) process. Types of common material coating, coating layer structures, Right tool coatings for various machining application. Coating for improved performances in wet and dry machining.

Unit-3 : Drill bit & single point cutting Tool Design

Single Point Cutting Tool: Design of shank dimension using strength and rigidity considerations for rectangular, square and round cross section and selection of tool geometry. Drill bit design of elements like back taper, web thickness, land width, margin, flute length and cross section and selection of tool geometry, modification of chisel edges, types of web cores

Part-B

Unit-4: Design of Milling Cutter

Types of Milling Cutter and their applications, milling cutter nomenclature, significance of gemetry angles of milling cutters. Design of milling cutter: Design of elements like number of teeth and height circular pitch, body thickness, chamfer width, fillet radius and selection of tool geometry, numerical

Unit-5: Design of Broach Tool

Broaching Machine types, component of broaching machines, broaching application. Design and construction of internal broaches and design of elements like pitch of teeth, broach allowances, depth of cutting tooth, tooth fillet radius, width land, rake and relief angles, total length of broach.

Unit-6: Design of Gauges

Design of Gauges: Introduction, Types of gauges-plug gauge, snap gauge, profile gauge, Gauge design Practices, Design principles of gauges

Text Books:

1. B. S. Raghuwansi, "Workshop Technology-II", Dhanpat Rai Publication
2. P. N. Rao, "Manufacturing Technology-I & II", TMH Publication
3. P.C.Sharma, "A Textbook of Production Engineering", S.Chand Publication

Reference Books:

1. Kalpakjian and Schmid, "Manufacturing processes for engineering materials", Pearson India
2. G.K. Lal, "Introduction to Machining Science", New Age International Publishers.
3. Mikell P. Groover, "Fundamentals of Modern Manufacturing: Materials, Processes, and Systems", Pearson Publication.
4. Degarmo, Black &Kohser, Materials and Processes in Manufacturing

Evaluation Tools:

Assignment/Tutorials 20 Marks
Sessional tests 60 Marks
Class Quiz 20 Marks
Term end examination 100 Marks

Assignments, Sessional and End Semester Examination paper will consist of various difficulty levels to accommodate the different capabilities of students. Assessment should cover all course outcomes and upper limit for lower order skills will be 40% (for knowledge-oriented questions). However, weightage for different cognitive levels in the question papers can vary.

The paper setter must ensure the coverage of the entire syllabus while setting the question papers and mention the learning outcomes across each section to be measured by the examination. Weightage of the sections may vary as per the number of respective lecture hours mentioned in the syllabus. Action verbs should be used from Bloom's Taxonomy while designing question papers.

CO-PO Articulation Matrix

CO Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BME-DS-529.1	1	-	-	3	3	2	3	1	2		-	3	3	-	3
BME-DS-529.2	-	2	-	-	3	1	-	-	3	3	-	3	2	1	-
BME-DS-529.3	3	-	3	-	2	-	-	1	-	1	1	-	-	3	1
BME-DS-529.4	3	-	3	3	3	2		1		1	1		2	1	-

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BME-DS-626: FUNDAMETNALS OF ROBOTICS

Periods/week Credits	Max. Marks : 200
L: 3 T: 0 P: 0 3	Continuous Assessment : 100
Duration of Examination: 3 Hrs	End Semester Exam : 100

Prerequisites: BME-DS-501: Theory of Machines
Course Type: Domain Specific Elective Course

Course Outcomes:
After completion of this course the students will be able to
BME-DS-626.1 Understand the robotic structure and its link movements
BME-DS-626.2 Identify the sensors, actuators and programming to maintain safety and precautions
BME-DS-626.3 Program a robot for work cell designed for single and multiple robots' layout
BME-DS-626.4 Use the elements of a work cell control as per industrial applications

Part-A

Unit 1: Introduction

Brief history, robot terminology, robot components and classification, characteristic, physical configuration, structure of industrial robot, robot joints, robot coordinates, Robot Workspace Design, robot application, advantages and disadvantages. Justification considerations in applying industrial robots.

Unit 2: Robot Drives, Control and Effectors

Robot drives and control- controlling the robot motion, position and velocity sensing devices, design of drive systems, hydraulic and pneumatic drives, linear and rotary actuators and control valves, electro hydraulic servo valves, electric drives, motors, magnetostrictive actuators, design consideration of end effectors-mechanical, vacuum, magnetic and air operated grippers, tools as end effectors, Robot/end effectors interface.

Unit 3: Sensors and Machine Vision

Transducers and sensors, sensor characteristics, sensors in robotics- tactile, touch, position, velocity, acceleration, force, pressure, torque sensors, proximity and range finders, sniff sensors, light and infra red sensor, RCC devices and micro switches, Robotic vision system: sensing and digitizing function in machine vision, image gripping, image processing and analysis, image segmentation and pattern recognization, vision system robotic applications.

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Part-B

Unit 4: Robot Cell Design and Applications

Robot work cell design and control, safety in robotics, robot cell layouts, multiple robots and machine interference. Application -Welding, electro-plating, painting, spraying, assembling, material handling, inspection, Future applications

Unit 5: Robot Programming

Robot programming: Types of programming, lead through programming, motion Programming, interlocks, advantages and disadvantages.

Robot languages: Motion programming, simulation and off-line programming, work cell control elements of artificial intelligence in robots.

Unit 6: Industrial Applications of Robots

For material transfer, machine loading / unloading, welding, assembly and spray painting operations.

Text Books:

1. Introduction to Robotics, Analysis, Systems, Application Saeed B. Niku, Pearson Education.
2. Industrial Robotics: Ganesh S. Hegde Laxmi Publication (P) Limited.
3. Robotics – An introduction By Douglas R. Malcolm. Jr Delmar Publisher Inc.
4. Fundamentals of robotics–analysis and control By Robert J. Schilling (PHI) edition.

Reference Books:

1. Robotics-Control, sensing, vision and Intelligence By K.S.Fy., R.C.Gonzaler, C.S.G.Lee, Mc Graw Hill editions.
2. Introduction to Robotics by John J. Craig, Pearson

Weblinks:

http://nptel.ac.in/courses/112101099
http://nptel.ac.in/courses/112101098

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Assessment Tools:

In general parameters for Internal /Continuous Assessment (Theory Courses):

Parameter	Weightage
Two Sessional (Mid-Term)Tests	60%
Assignments	20%
Class Performance	10%
Class Attendance	10%

Theory Course: Total Marks 200
Internal/Continuous Assessment: 100

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- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
BME-DS-626.1	3	3	3	2	3	-	-	-	-	-	-	2	3	3	-
BME-DS-626.2	3	3	3	3	2	2	1	-	-	-	-	1	3	3	1
BME-DS-626.3	3	3	3	2	2	-	2	-	3	-	2	-	3	3	-
BME-DS-626.4	3	3	3	3	1	3	2	-	2	-	-	-	-	-	3

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BME-DS-627: CNC TECHNOLOGY AND PROGRAMMING

Periods/week Credits — Max. Marks: 200
L: 3 T: 0 P: 0 3 — Continuous Assessments: 100
Duration of Examination: 3 Hrs. — End Semester Exam : 100

Prerequisites: Engineering drawing, Manufacturing processes
Course Type: Domain Specific Elective Course

Course Outcomes:
After completion of this course the students will be able to

BME-DS-627.1: Apply the concepts of machining for selection of appropriate machining centers, machining parameters, select appropriate cutting tools for CNC milling and turning equipment, set-up, program, and operate CNC milling and turning equipment.
BME-DS-627.2: Demonstrate Programme for NC machining using part programming
BME-DS-627.3: Able to apply knowledge of CNC for various real-life applications

Part-A

Unit-I: An overview of CNC machines

Need, benefits & limitations, classification of CNC machines, Constructional features of CNC machines, elements of CNC machine & systems, precision measuring & positioning of CNC, Function of MCU, machining centre, Turning centre.

Unit-2:Manual part programming -

Preparatory and miscellaneous functions- Fanuc, Sinumeric, Hass controls. Linear interpolation, circular interpolation, canned cycles, cycles of threading & grooving operations, tool compensation, sub-program, main program, part programming structure, work co-ordinate system, absolute & incremental commands, feed, program zero-point, co-ordinate system, process planning & flow chart for part programming, scaling, rotating, mirroring, copy & special cycles for CNC lathe and milling and part programming.

Unit-3:Tooling for CNC machine

Introduction, cutting tool materials, types of cutting tools for NC machines, tool selection, ISO specification of cutting tools, different clamping system in tool holders, tooling for milling, angle plates, CNC vices, work holding devices, clamps, rotary tables.

Part-B

Unit-4: System drives and devices

Hydraulic and pneumatic motors and their features, Electrical motors AC/DC and their features ,stepper motor and encoders.

Unit-5: Interpolators

Hardware Interpolators, Software Interpolators, NC/CNC controllers.

Unit-6: Latest developments

Machining center, Turing center, Communication networking, recent developments of CNC systems, Virtual NC systems.

(Note: The course to be covered in Hybrid Mode with students be exposed to both CNC trainers and Programming and getting hands on experience with feeding programm and running the machines via and Controllers)

Text Books:

1. T. K. Kundra, P. N. Rao and N. K. Tiwari, "Numerical Control and Computer Aided Manufacturing" TMH.
2. P. Radhakrishnan, "Computer Numerical Control Machine & Computer Aided Manufacturing", New Academic Science Limited.
3. John Stenerson and Kelly Curran, Computer Numerical Control: Operation and Programming, PHI, New Delhi, 2009

Reference Books:

1. Tilak Raj, "CNC Technology & Programming", Dhanpat Rai publishing Company (P) ltd., N Delhi.
2. M. Adithan& B. S. Pabla, CNC Machines, New Age International Publishers, N Delhi.
3. Krak S. & Gill A., "CNC Technology & Programming, Tata McGraw-Hill Publishing Co., N Delhi

Weblinks:

Instructions for setting of Paper Seven questions are to set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each part A and part B (one from each unit). Student needs to attempt two questions out of three questions from each part. Each question will be of 20 marks.

Assessment Tools:

In general parameters for Internal /Continuous Assessment (Theory Courses): Parameter	Weightage
Two Sessional (Mid-Term)Tests	60%
Assignments	20%
Class Performance	10%
Class Attendance	10%

CO-PO Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
BME-DS-627.1	1	-	-	3	3	2	3	1	2	-	-	3	3	-	3
BME-DS-627.2	-	2	-	-	3	1	-	-	3	3	-	3	2	1	-
BME-DS-627.3	3	-	3	-	2	-	-	1	-	1	1	-	-	3	1

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(Deemed to be University under section 3 of the UGC Act 1956)

BME-DS-628: Metrology and Quality Assurance

Periods/week Credits
L: 3 T: 0 P: 0 3
Duration of Examination: 3 Hrs
Prerequisites:
Course Type: Domain Specific Elective Course

Max. Marks : 200
Continuous Assessment : 100
End Semester Exam : 100

Course Outcome

BME-DS-628.1: Understand the perception of measurement in engineering
BME-DS-628.2: Identify methods and devices for measurement of length, angle, gear & thread parameters, surface roughness and geometric features of part
BME-DS-628.3: Select quality control techniques and its applications

Unit 1: Principles of measurement:

Definition of Metrology, difference between precision and accuracy. Sources of errors: Controllable and Random Errors, Effects of Environment and Temperature, Effects of support, alignment errors, errors in measurement of a quality which is function of other variables. Introduction to Coordinate Measuring Machine (CMM). Length Standards: Line standards, end standards and wavelength standards, transfer from line standards to end standards. Numerical based on-line standards. Limits, fits and Tolerances: Different types of fits and methods to provide these fits. Numerical to calculate the limits, fits and tolerances as per IS 919-1963. ISO system of limits and fits;

Unit 2: Gauge's

Slip gauges – its use and care, methods of building different heights using different sets of slip gauges. Gauges and its types, limit gauges – plug and ring gauges. Gauge Design – Taylor's Principle, wear allowance on gauges. Different methods of giving tolerances on gauges.

Unit 3: Types of inspection

Inspection by Gauging: limit gauging, plug gauges, Ring gauges, position gauges Inspection by Measurement: Direct measurement such as Vernier Calliper, Vernier Height gauge, Vernier Depth gauge Outside Micrometre, Inside Micrometre, Depth Micrometre, Slip gauges (gauge blocks), length bars , Bevel protractor etc. Indirect Measurement such as Mechanical, optical, & pneumatic comparators, Angular Measurements- Sine bar, angle gauges, precision levels, Introduction to Autocollimator, Interferometers, NPL Flatness Interferometer etc.

PART-B

Unit 4: Straightness and Flatness

Straightness and flatness: Feature inspection such as flatness, roundness, straightness, parallelism, etc. Surface texture, different types of irregularities, Measurement of various surface roughness parameters. Tomlinson surface meter, Taylor-Hobson talysurf.

Unit 5: Need for Quality Assurance

Need of quality, Aspects of quality, Quality specification, Quality function Shewhart's control charts for variables: X bar and R charts, operating characteristics curves, producer's risk,consumer's risk, Sampling inspection , single double and multiple sampling plan

Unit 6: Thread Measurement

Screw Thread Measurement: Error in threads, Measurement of elements of screw threads –major dia, minor dia, pitch, flank angle and effective diameter. Various thread gauges. Gear Measurement: Gear terminology, measurement of gear thickness, Gear tooth vernier caliper Parkinson gear tester.

(Note: The course to be covered in Hybrid Mode with students be exposed to both Metrology devices and their operations and getting hands on experience in determining measurement)

Text Books:

1. R.K. Jain, —Engineering Metrology, Khanna Publishers, Delhi
2. I.C. Gupta, —Engineering Metrology, Dhanpat Rai Publications, Delhi
3. EL Grant & RS Leavenworth, —Statistical Quality Control, McGraw Hill & Co, 1988.

Reference Books:

1. F.W. Galyer& C.R. Shotbolt, —Metrology for Engineer, ELBS Edition
2. Beckwith, Buck, Lienhard, Mechanical Measurements, Pearson Education Asia.
3. Anand K Bewoor, Vinay A Kulkarni —Metrology and Measurement, TMH

Referred From: Indraprastha University Delhi

CO-PO Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
BME-DS-628.1	1	-	-	3	3	2	3	1	2	-	-	3	3	-	3
BME-DS-628.2	-	2	-	-	3	1	-	-	3	3	-	3	2	1	-
BME-DS-628.3	3	-	3	-	2	-	-	1	-	1	1	-	-	3	1

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(Deemed to be University under section 3 of the UGC Act 1956)

BME-DS-629: Digital Manufacturing

Periods/week Credits
L: 3 T: 0 P: 0 3
Duration of Examination: 3 Hrs.

Max. Marks: 200
Continuous Assessment: 100
End Semester Exam : 100

Prerequisites: CNC Technology, Manufacturing processes
Course Type: Domain Specific Elective Course
Course Outcomes:
After completion of this course the students will be able to

BME-DS-629.1: Impart the knowledge of basic working principle of a 3D printer, how to use a 3D printer and how to assemble a 3D printer
BME-DS-629.2: Understand the working principle of various sensors and sensor-based control of electro-mechanical equipment's as well as devices
BME-DS-629.3: Introduce the smart connected systems design using Internet of Things, Cloud storage and industrial automation.

Part-A

Unit-I: Conception and development of products

Design processes and methods, CAD/CAM/CAE technologies and product lifecycle management (PLM), Concepts generation and embodiment, Expression of product design ideas using 2D sketches.

Unit-2:3D printers

3D Printers and Printable Materials, 3D Printer Workflow and Software, selecting a printer: Comparing Technologies, working with a 3D Printer, 3D Models, Applications, Building Projects.

Unit-3 :Robotics

Definition and Advantages , law of robotics, types of industrial robot, robot end effector, types of sensor, robot control control system, robot drives.

Part-B

Unit-4: Additive Manufacturing

General methodology, stages and components of the process. Main technologies, principles and applications. Strengths, weaknesses, challenges, and limitations of additive manufacturing technologies. Main brands and suppliers available. Design for Additive Manufacturing (DFAM). Design for functionality and 3D printability. Planning and slicing additive manufacturing software.

Unit-5: Industrial Internet of Things

The Internet of Things: An overview; Design Principles for Connected Devices; Internet Principles. Automatic Storage Management in a Cloud World: Introduction to Cloud, Relational Databases in the Cloud, Automatic Storage Management in the Cloud.

Unit-6: Industry 4.0

Core idea of Industry 4.0, origin concept of industry 4.0, Industry 4.0 production system, Globalization, The Fourth Revolution, Drivers, Enablers, Compelling Forces and Challenges for Industry 4.0. Comparison of Industry 4.0 Factory and Today's Factory, Trends of Industrial Big Data and Predictive Analytics for Smart Business Transformation. Security issues within Industry 4.0 networks.

Text Books:

1. Joan Horvath, Rich Cameron, Mastering 3D Printing in the Classroom, Library and Lab, Apress, 2018.

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2. J. Vetelino and A .Reghu, Introduction to sensors, CRC Press, 2010, ISBN: 9781439808528.
3. A. McEwen and H. Cassimally, Designing the Internet of Things, 1st edition, Wiley, 2013, ISBN-10: 111843062X.
4. I. Zeid, CAD/CAM Theory and Practice, Tata McGraw Hill, 2006.
5. Ian Gibson, David W. Rosen, Brent Stucker , "Additive Manufacturing Technologies" ,Springer,2009

Reference Books:

1. Kalpakjian and Schmid, "Manufacturing processes for engineering materials", Pearson IndiaWeblinks:
2. B. K. Ghosh, T. J. Tarn and N. Xi, Control in Robotics and Automation: Sensor-Based Integration, Academic Press, 1999, ISBN: 978-0-12-281845-5.
3. N. Vengurlekar and P. Bagal, Database Cloud Storage: The Essential Guide to Oracle Automatic Storage Management, 1st edition, McGraw-Hill Education, 2013, ISBN-10: 0071790152.
4. M. E. Mortenson, Geometric Modeling, John Wiley & Sons, 1985.

Instructions for setting of Paper Seven questions are to set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each part A and part B (one from each unit). Student needs to attempt two questions out of three questions from each part. Each question will be of 20 marks.

Assessment Tools:

In general parameters for Internal /Continuous Assessment (Theory Courses): Parameter	Weightage
Two Sessional (Mid-Term)Tests	60%
Assignments	20%
Class Performance	10%
Class Attendance	10%

CO-PO Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
BME-DS-629.1	1	-	-	3	3	2	3	1	2	-	-	3	3	1	3
BME-DS-629.2	-	2	-	-	3	1	-	-	3	3	-	3	2	1	-
BME-DS-629.3	3	-	3	-	2	-	-	1		1	1			2	1

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MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

BME-DS-603: ROBOTIC ANALYSIS

Periods/week Credits	Max. Marks 200
L: 3 T: 0 3	Continuous Assessment 100
Duration of Examination: 3 Hrs	End Semester Examination:100

Course Type: Core

Course Outcomes

The students will be able to:

BME-DS-603.1. Apply the fundamental aspects of Robotics.
BME-DS-603.2. Comprehend various methodologies to be taken into account for development of robotic systems.
BME-DS-603.3. Explain the contextual architecture of robotics.
BME-DS-603.4. Analyze the motions and trajectory of a robot.
BME-DS-603.5 Explore the industrial applications of a robot

Part-A

Unit-1 Structure of Robotic System

Anatomy of Robot**,** Classification of Robot**,** Robot Configuration & Robotic system**,** Robot Specification: Number of axes, Payloads Capacity, Repeatability, Attachment precision, Reach & Stroke

Unit-2 Robot Motion Analysis (Part-I)

Robot arm kinematics, transformation, rotation matrix, geometric interpretation of rotation matrix, inverse transformation, numerical, rotation matrix about an arbitrary axis, Euler Angle representation

Unit-3Robot Motion Analysis (Part-II)

Homogeneous transformation and geometric interpretation, inverse and composite homogeneous transformations, Denavit-HartenbergRepresentation, arm matrix, kinematic (arm) equations, inverse kinematics problem

Part-B

Unit-4 Design of Gripper Fingers

1. Force Analysis of gripper mechanism, Linkage analysis (Numerical)
2. Gripper and Jaw Design Geometry, Gripper Design Procedure
3. Gripper Design: A case study

Unit-5 Robot Arm Dynamics

Joint velocities, the kinetic energy, potential energy, lagrangian equation of motion, the dynamic equation, dynamic equation for a general manipulator, numerical

Unit-6 Trajectory Planning

Introduction, path control modes, general consideration in trajectory planning, general consideration of joint interopolated trajectory, trajectory generation planning, linear path with parabolic bend, trajectory planning with 3rd order and 5th order polynomial

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Text Books/ Reference Books:

1. Yoram Koren, 1985, Robotics for Engineers, 1st Edition, McGraw Hill Book Company.
2.John J. Craig, 2004, Introduction to Robotics, 3rd Edition, Pearson.
3. Ganesh S. Hegde, 2006, A textbook on Industrial Robotics, Laxmi Publications.

Software required/Weblinks:

Keil, FlashMagic
http://nptel.ac.in/video.php?subjectId=112101099
http://freevideolectures.com/Course/2373/Robotics

Instructions for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each Part A and Part B (one from each unit). Student needs to attempt two questions out of three from each part. Each question will be of 20 marks.
Distribution of Continuous Assessment:

Sessional- I	30%
Sessional- II	30%
Assignment/Tutorial	20%
Class Work/ Performance	10%
Attendance	10%

Assessment Tools:
Assignment/Tutorials
Sessional tests
Surprise questions during lectures/Class Performance
Term end examination

Theory Course: Total Marks 200
Internal/Continuous Assessment: 100

- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks
Course Articulation Matrix

CO Statement (BEC-DS-603)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
BME-DS-603.1	3	3	2	2	2	-	-	1	-	3	-	2	3	2	3
BME-DS-603.2	3	3	2	2	2	-	-	-	-	-	-	2	-	2	3
BME-DS-603.3	3	3	2	2	2	-	-	-	-	3	-	2	-	2	3
BME-DS-603.4	3	3	2	2	2	-	-	-	-	3	-	2	3	2	2
BME-DS-603.5	3	3	2	2	2	-	-	-	-	-	-	2	3	2	2

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(Deemed to be University under section 3 of the UGC Act 1956)

BME-DS-727: Mould and Press Tool Design

Periods/week Credits
L: 3 T: 0 P: 0 3
Duration of Examination: 3 Hrs

Max. Marks: 200
Continuous Assessment: 100
End Semester Exam : 100

Prerequisites: Engineering drawing, Manufacturing processes
Course Type: Domain Specific Elective Course

Course Outcomes:
After completion of this course the students will be able to
BME-DS-727.1: Identify and differentiate types of sheet metal operation and applications.
BME-DS-727.2: Identify and apply various Sheet metal Design techniques
BME-DS-727.3: Apply critical parameters related to injection mould techniques.

Part-A

Unit-I: Sheet Metal Operations:

Blanking, piercing, bending operation, Shearing Theory, Analysis of cutting force and stripping force, calculation of press tonnage, designing of cutting clearance. Method of reducing the cutting force.

Unit-2:Progressive Dies and Secondary Operation:

Definition of Progressive dies, introduction to the progressive dies, Types of Progressive Dies, Progressive strip layouts, Mechanical and automatic feed, Secondary Operations-shear form operation, Notching, Side action Dies, combination Dies, Flanging Dies, De-Burring operation, Restrike operation, concept of Design of progressive Dies.

Unit-3:Drawing Dies and Forming Dies

Difference between drawing and other forming operation, Introduction to Draw Dies, Selection of material for Draw Dies, no of draws, Deep drawing process, Drawability, Redraw and reverse redraw dies, Blank development range of draw, Defects in drawing.

Part-B

Unit-4: Moulds and Dies:

introduction, Basic terminology, Bolsters and its types, guide pillars and guide bushes, mould plate fastening, attachment of mould to platen, concept of design, design principles, types of moulds, construction of core and cavities, consideration of safety factor while designing.

Unit-5: Ejection and Feed system:

Ejection, ejection techniques, ejection from fixed half. ejection grid design, ejector plate assembly, return system, Types of gates, position of gate, gate balancing, runner, runner cross sectional shape, efficiency of various runner profiles. Rising, Razor design and its placements.

Unit-6: Parting surface and Mould temperature control:

Parting line, stepped parting line, irregular parting surface, angled surface, local stepped and profile parting surface, complex edge forms, venting. Mould cooling methods – integral cooling circuit, baffle cooling, spiral insert cooling, cooling through heat pipes, heat rods and its applications. Plugs, o-rings, Mould temperature, melt temperature, heat removal, re - calculation of filling and cooling time, case studies.

Text Books:

1.P.C.Sharma, "A Textbook of Production Engineering", S.Chand Publication

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2.P. N. Rao, "Manufacturing Technology-I & II", TMH Publication

Reference Books:

1.WAJ PYE "A Textbook of Injection Mould Design"

Weblinks:

Instructions for setting of Paper Seven questions are to set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each part A and part B (one from each unit). Student needs to attempt two questions out of three questions from each part. Each question will be of 20 marks.

Assessment Tools:

In general parameters for Internal /Continuous Assessment (Theory Courses): Parameter	Weightage
Two Sessional (Mid-Term)Tests	60%
Assignments	20%
Class Performance	10%
Class Attendance	10%

CO-PO Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
BME-DS-727.1	1	-	-	3	3	2	3	1	2	-	-	3	2	-	3
BME-DS-727.2	-	2	-	-	3	1	-	-	3	3	-	3	3	1	-
BME-DS-727.3	3	-	3	-	2	-	-	1	-	1	1	-	-	3	1

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(Deemed to be University under section 3 of the UGC Act 1956)

BME-DS-728: Product Design and Development

Periods/week Credits
L: 3 T: 0 P: 0 3
Duration of Examination: 3 Hrs

Max. Marks: 200
Continuous Assessment: 100
End Semester Exam: 100

Prerequisites: Computer Aided Design, Manufacturing processess

Course Type: Domain Specific Elective Course

Course Outcomes:
After completion of this course the students will be able to
BME-DS-728.1: Competence with a set of tools and methods for product design and development.
BME-DS-728.2: Competence with a set of tools and methods for product design and development.
BME-DS-728.3: Ability to coordinate multiple, interdisciplinary tasks in order to achieve a common objective

Part-A

Unit-I: Introduction

Introduction, Product life-cycle, Product policy of an organization. Selection of a profitable product, Product design process,Product analysis.

Unit-2:Innovation

The process of technological innovation - factors contributing to successful technological innovation - the need for creativity and innovation - creativity and problem solving - brain storming - different techniques. Collection of ideas and purpose of project - Selection criteria - screening ideas for new products (evaluation techniques).

Unit-3 :Product Design

Value engineering in product design; Advantages, Applications in product design, Problem identification and selection, Analysis of functions, Anatomy of function. Primary versus secondary versus tertiary/unnecessary functions, Functional analysis: Functional Analysis System Technique (FAST), Case studies.

Part-B

Unit-4: Product lifecycle Management

Product Data and Product Workflow, Company's PLM vision, The PLM Strategy, Principles for PLM strategy, preparing for the PLM strategy, developing a PLM strategy, Strategy identification and selection, Change Management for PLM.

Unit-5: Product development

Research and new product development - Patents - Patent search - Patent laws - International code for patents - Intellectual property rights (IPR). Design of proto type - testing - quality standards - marketing research - introducing new products.

Unit-6: Case study

Integrated Product development process (Case study) - Conceive – Specification, Concept design, Design - Detailed design, Validation and analysis (simulation), Tool design, Realize – Plan manufacturing , Manufacture, Build/Assemble , Test (quality check) , Service - Sell and Deliver , Use , Maintain and Support, Dispose. Bottom-up design, Top-down design, Front loading design workflow, Design in context, Modular design. Concurrent engineering - work structuring

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and team Deployment - Product and process systemization - problem, identification and solving methodologies. Product Reliability, Mortality Curve. Design for Manufacturing, Design for Assembly. Design for Six Sigma.

Text Books:

1. Kevin otto and Kristin wood "Product Design" Techniques in reverse engineering and NPD-Pearson.
2. Karl T. Ulrich and Steven D. Eppinger " Product Design and Development" by Mc Graw Hill.

Reference Books:

1. The Mechanical Design Process –by David G. Ullman
2. Product Design & Process Engineering –Benjamin W Nishel& Alan B Draker-McGraw Hill Publishers
3. Product Life Cycle Management - by Antti Saaksvuori, AnselmiImmonen, Springer.

Instructions for setting of Paper Seven questions are to set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each part A and part B (one from each unit). Student needs to attempt two questions out of three questions from each part. Each question will be of 20 marks.

Assessment Tools:

In general parameters for Internal /Continuous Assessment (Theory Courses): Parameter	Weightage
Two Sessional (Mid-Term)Tests	60%
Assignments	20%
Class Performance	10%
Class Attendance	10%

CO-PO Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O 1	PS O 2	PS O 3
BME-DS-728.1	1	-	-	3	3	2	3	1	2	-	-	3	3	-	3
BME-DS-728.2	-	2	-	-	3	1	-	-	3	3	-	3	2	1	-
BME-DS-728.3	3	-	3	-	2	-	-	1	-	1	1	-	-	3	1

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BME-DS-729: Computer Aided Design

Periods/week Credits
L: 3 T: 0 P: 0 3
Duration of Examination: 3 Hrs.

Max. Marks: 200
Continuous Assessments: 100
End Semester Exam: 100

Prerequisites: Engineering drawing, Manufacturing processes
Course Type: Domain Specific Elective Course
Course Outcomes:
After completion of this course the students will be able to

BME-DS-729.1: Understand the engineering design process and its role in graphic communication process
BME-DS-729.2: Generate and interpret engineering technical drawings of parts and assemblies according to engineering design standards.
BME-DS--729.3: Fluent application of engineering techniques, tools and resources

Part-A

Unit-I: Introduction to CAD

Introduction to CAD: Design process, Fundamentals of CAD: Role of computers in design. Computer Graphics: Raster scans graphics, Coordinate system, Database structure for graphic modeling Transformation of geometry: Translation, Rotation, Reflection, Scaling, Homogenous representation, Projection: Orthographic projection, Isometric Projection.

Unit-2:Geometric Modeling:

Geometric Modeling: Requirement of Geometric Modelling, Geometric models, Geometric Construction Methods, Wireframe modeling, Curves representation, Curve fitting, Synthetic Curves: Cubic splines, Bezier curve. Surfacing: Surface of revolution, ruled surface. Solid Representation concepts: B-Rep, CSG. CAD Standards: Standardization in graphics, Exchange of modeling data- IGES, Standard for the exchange of product model data (STEP), Drawing Exchange Format, DMIS.

Unit-3 :Introduction Product Design:

Introduction Product Design: Definition, Design by Evolution, Design by Innovation, Essential factors of Product Design, Morphology of Design, Role of Allowance, Primary design phases and flow charting, Process capability and Tolerance in detailed design and assembly, Product strategies, Product characteristics, Designer and his role, Basic design considerations, Types of Models designed by designers.

Part-B

Unit-4: Role of Computer in Design

Product cycle & CAD/CAM, Role of computer in design process. Modern approaches to Product Design: Concurrent Design, Quality function deployment. New Product Development: New product development, Model utilized in various phases, Managing product life cycle, Diffusion models: Models of first purchase.

Unit-5: Newer Techniques of CAD

Rapid prototyping, laser and non-laser process of rapid prototyping, STL formal of CAD file, introduction to reverse engineering and related software's viz. rapid form.

Unit-6: Introduction to FEA

Introduction, procedure for finite element analysis, types of finite element analysis, types of forces, one dimensional problem, Two dimensional problems, FEM software, preprocessor,postprocessing, boundary conditions

(Note: The course to be covered in Hybrid Mode with students be exposed to both CAD Softwares and getting hands on experience. The lesson plan to be prepared in advance for the various topics to be covered using software at the beginning of the semester. Student to submit a report of the project work/assignment for internal assessment)

Text Books:

1. Computer Graphics Hearn & Baker Prentice Hall of India
2. Computer Aided Engineering Design Anupam Saxena & B. Sahay Anamaya Publishers

Reference Books:

1. Zeid I., "CAD / CAM problem & practice", 3rd Edition, Tata McGraw Hill, 2001.
2. Newman, Sproull. "Principles of interactive computer graphics", Mc Graw Hill Co., 1981.
3. Bathe K.K., "Finite Element Procedures",Prentice Hall of India, 1996.
4. Kuthe A.M., "Computer Graphics including CAD, AutoCAD & C", 1st Edition,S.Chand, 2005
5. Rao P.N., "CAD/CAM principles &applications", Tata Mc Graw Hill, 2002.

Weblinks:

Instructions for setting of Paper Seven questions are to set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each part A and part B (one from each unit). Student needs to attempt two questions out of three questions from each part. Each question will be of 20 marks.

Assessment Tools:

In general parameters for Internal /Continuous Assessment (Theory Courses): Parameter	Weightage
Two Sessional (Mid-Term)Tests	60%
Assignments	20%
Class Performance	10%
Class Attendance	10%

CO-PO Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
BME-DS-729.1	1	-	-	3	3	2	3	1	2	-	-	3	3	-	3
BME-DS-729.2	-	2	-	-	3	1	-	-	3	3	-	3	2	1	-
BME-DS-729.3	3	-	3	-	2	-	-	1	-	1	1		2	-	1

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BME-DS-702 INDUSTRY AUTOMATION

Periods/week	Credits	Max. Marks: 200
L :3 T: 0	3	Internal/Continuous Assessment: 100
Duration of Examination: 3 Hrs		End Semester Exam: 100

Pre-Requisite: Control systems

Course Type: Core

Course Outcomes: After completion of this course the students will be able to

BME-DS-702.1 Understand the need for automation in manufacturing industry.

BME-DS-702.2 Apply automation in material handling and manufacturing systems

BME-DS-702.3 Implement different control technologies in automation.

BME-DS-702.4 Identify the parts best suited for automated assembly line

BME-DS-702.5 Design an automated assembly line using PLCs, sensors, actuators and valves.

Part- A

UNIT-I Motion Actuators

1. Types of motion: Linear and angular motion, Intermittent rotary motion (Geneva Wheel), conversion of rotary to linear motion (power lead screw)
2. Electric linear actuators: Solenoids, Linear induction motors, Electric rotary actuators, stepper motor and their control, DC Brushless Motor
3. Fluid power Linear Actuator: Fluid Power (Pneumatic verses Hydraulic), Types of pneumatic cylinders

UNIT-II Sensors

1. Binary (on-off) versus Analog (Proportional) sensors
2. Electric positioning sensors: Limit switches, mercury switches, reed switches, Inductive/capacitive/magnetic proximity switches
3. Pneumatic positioning sensors: pneumatic limit valves, back pressure sensors, coiled-spring sensors, annular back pressure sensors, interruptible jet sensors.
4. Point sensors for variables other than position: Level switches, pressure switches, temperature switches, flow switches.

UNIT-III Pneumatic valves and cylinder: Compressed air supplies, pneumatic valve symbols and constructions, common valve actuation methods, simple cylinder actuating methods, obtaining logic functions from pneumatic valves, Fluidic elements. electric to pneumatic interfacing, interfacing pneumatic and hydraulic. Comparison between different switching element.

Part-B

UNIT-IV Electric Ladder Diagrams

Ladder Diagram symbols, sequence charts: ladder-diagram using sequence charts, relay circuit for actuating two cylinders, pneumatic-cylinder circuit controlled by the ladder diagramSynthesis and design of circuits (up to 3 cylinders):-pneumatic, electro-pneumatics and hydraulics

Unit-V Flexible Automation

Architecture of Industrial Automation system, Introduction of PLC and supervisory control and data acquisition (SCADA) , Industrial bus systems: modbus&profibus., PLC Constructions, PLC programming ladder-diagram based and relay diagram.Microcomputers for control applications, microprocessors versus microcomputers, PLCs versus Relay panels (Cost considerations).

Unit-VI Assembly line Automation

Assembly line Automation: automated assembly systems, transfer systems, vibratory bowl feeders, non-vibratory feeders, part orienting, feed track, part placing & part escapement systems.

Material storage/ handling and transport systems, and its automation using AS/RS, AGVS and conveyors etc.

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Text Books / Reference Books:

1. Groover M.P., "Automation, Production Systems and Computer Integrated Manufacturing", Pearson Education, 5th edition, 2009.
2. Kant Krishna, "Computer Based Industrial Control", EEE-PHI, 2ndedition,2010
3. Chang Tiess Chiu & Richard A. Wysk, "An Introduction to Automated Process Planning Systems"

Software required/Weblinks:

https://nptel.ac.in/courses/108/105/108105063/

Instructions for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each Part A and Part B (one from each unit) Student needs to attempt two questions out of three from each part. Each question will be of 20 marks.

Assessment Tools:

Theory Course: Total Marks 200
Internal/Continuous Assessment: 100

- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

Sessional- I	**30%**
Sessional- II	**30%**
Assignment	**20%**
Class Performance	**10%**
Attendance	**10%**

COURSE ARTICULATION MATRIX:

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
BME-DS-702.1	3	3	2	3	3	-	-	-	-	-	-	1	3	3	-
BME-DS-702.2	3	3	-	3	3	2	-	-	-	-	-	-	3	3	-
BME-DS-702.3	3	3	3	-	3	-	-	-	-	2	-	-	1	2	-
BME-DS-702.4	3	3	3	3	2	-	-	-	-	-	-	-	1	-	2
BME-DS-702.5	3	3	3	3	3	2	3	1	-	1	-	2	3	2	-

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(Deemed to be University under section 3 of the UGC Act 1956)
BEE-DS-751: INDUSTRY AUTOMATION LAB

Periods/week Credits	Max. Marks 100
P: 2 1	Internal/Continuous Assessment: 50
Duration of Examination: 2 Hours	End Semester Exam 50

Pre-requisite: NIL
Course Type: Program Core

Course Outcomes
After completion of this course the students will be able to
BEE-DS-751.1 Explicate the basic sensors and its applications
BEE-DS-751.2 Implement the relay logics and wiring .
BEE-DS-751.3 Examine the analog and digital function blocks in PLC.
BEE-DS-751.4 Design of various application in PLC.
BEE-DS-751.5 Apply robot applications.

List of experiments:

1. Use industrial grade sensors and transducer introduction and characteristics like proximity detector, linear encoder, rotary encoder, touch sensor, force sensor, accelerometer, RTDs, loadcells and LVDT for measurement
2. Use Various actuators such as relay, solenoid valve, process control valve and motors for control applications
3. Simulate analog and digital function blocks using iQ-R PLC
4. Relay logic diagram and ladder logic diagram using iQ-R PLC
5. Understand and perform experiments on timers and counters using iQ-R PLC
6. Logic implementation for traffic Control Application using iQ-R PLC
7. Logic implementation for Bottle Filling Application using iQ-R PLC
8. Tune PID controller for heat exchanger using DCS using iQ-R PLC
9. Write a Ladder for pick and place operation using iQ-R PLC
10. Introduction to Robot programming using MELFA Robot.

Value Added Experiment

1. Build a pneumatic circuit for Stamping operation by using single acting cylinder being controlled by 3 way 2 position directional control valves
2. Build a pneumatic circuit for automatic opening and closing of a door by using double acting cylinder being controlled by 4 way 2 position directional control valves.
3. Build a pneumatic and hydraulic circuit for a water jet machining using double acting cylinder and a hydraulic pump.

Text Books:

1. Groover M.P., "Automation, Production Systems and Computer Integrated Manufacturing", Pearson Education, 5th edition, 2009

Software required/Weblinks:
https://nptel.ac.in/courses/108/105/108105062/
Assessment Tools:

MRIIRS

Experiments in lab
File work/Class Performance
Viva (Question and answers in lab)
End Term Practical Exam

Projects :

1. Design of hardware Stair case light application
2. Design of hardware traffic light control
3. Design of hardware Conveyer control application
4. Design of hardware Lift control application
5. Design of hardware Water level controller application

Note: B.Tech Mechanical Engineering specialization with Mechatronics students will perform all three value added experiment out of the 10 experiments in the semester.

Instructions for Exam: Every student needs to complete 10 experiments in a semester. One experiment out of 10 given randomly needs to be performed in exams.

Parameter	Weightage
Two Mid-Term Viva	60%
File/Record Keeping	20%
Class Performance	10%
Class Attendance	10%

Assessment Tools:
Experiments in lab
File work/Class Performance
Viva (Question and answers in lab)
End Term Practical Examination

COURSE ARTICULATION MATRIX

CO Statement (BEE-DS-751)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O 1	PS O 2	PS O 3	PS O 4
BEE-DS-751.1	1	-	1	-	-	-	-	-	-	-	-	-	1	-	1	-
BEE-DS-751.2	2	2	3	2	-	-	-	-	-	-	-	1	2	-	1	2
BEE-DS-751.3	2	-	2	-	1	-	-	-	-	-	-	-	2	-	1	-
BEE-DS-751.4	1	-	-	-	-	-	-	-	-	1	-	-	1	-	-	2
BEE-DS-751.5	1	1	2	-	-	1	-	-	-	-	-	1	3	-	-	2

MRIRS

DEPARTMENTAL ELECTIVES

BME-DS-521	IC Engines
BME-DS-523	Welding & Forging Technology
BME-DS-525	Power Plant Engineering
BME-DS-526	Production Engineering
BME-DS-622	CAD/CAM
BME-DS-623	Advanced Strength of Material
BME-DS-624	Process Planning and Cost Estimation
BME-DS-626	Fundamentals of Robotics
BME-DS-722	Modern Machining Methods
BME-DS-723	Gas Dynamics & Jet Propulsion
BME-DS-724	Mechanical Vibrations
BME-DS-725	Design of Machine Tools
BME-DS-726	Additive Manufacturing

MERS

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH & STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

BME-DS-521: IC ENGINES

Periods/week Credits — Max. Marks : 200
L: 3 T: 0 P: 0 3 — Continuous Evaluation : 100
Duration of Examination: 3 Hrs — End Semester Exam : 100

Prerequisites: BME-DS-302: Thermodynamics, BME-DS-401: Applied Thermodynamics
Course Type: Domain Specific Elective Course (Compulsory)

Course Outcomes:
After completion of this course the students will be able to

BME-DS-521.1 Describe various types of I.C. Engines and cycles of operation.
BME-DS-521.2 Understand fuel supply systems, types of fuels, emissions formation.
BME-DS-521.3 Illustrate the role of lubrication and cooling systems in reducing friction and wear and also interpret data of alternative fuels and its emission which effect the environment.
BME-DS-521.4 Analyze combustion process and the effect of various operating variables on engine performance.
BME-DS-521.5 Evaluate performance of IC Engine and justify the suitability of IC Engine for different application.
BME-DS-521.6 Develop understanding of environment impacts of wide-spread use of internal combustion engines and ratification through advancements.

Part-A

Unit 1: Air Standard Cycles

Internal and external combustion engines; classification and nomenclature of I.C. Engines, working of four stroke and two stroke I.C. Engines, assumptions made in air standard cycle; Otto cycle; diesel cycle, dual combustion cycle, comparison of Otto, diesel and dual combustion cycles; air standard efficiency, deviation of actual engine cycle from ideal cycle.

Unit 2: Carburetion, Fuel Injection and Ignition Systems

Mixture requirements for various operating conditions in S.I. Engines; MPFI, Requirements of a diesel injection system; types of inject systems; petrol injection, Requirements of ignition system; types of ignition systems ignition timing; firing order; spark plugs.

Unit 3: Combustion in IC Engines

Stages of combustion in S.I. Engines; Ignition lag; velocity of flame propagation; detonation; effects of engine variables on detonation; theories of detonation; pre-ignition; S.I. engine combustion chambers, Stages of combustion in C.I. Engines; delay period; variables affecting delay period; knock in C.I. engines, C.I. engine combustion chambers.

Part-B

Unit 4: Lubrication & Cooling Systems, Emissions

Functions of a lubricating system, Types of lubrication system; mist, wet sump and dry sump systems; properties of lubricating oil; SAE rating of lubricants, engine performance and lubrication, Necessity of engine cooling; cooling systems : air-cooling, water cooling and their comparison; radiators. Pollutants from S.I. and C.I. Engines, Methods of emission control

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Unit 5: Engine Testing and Performance

Performance parameters: BHP, IHP, mechanical efficiency, brake mean effective pressure and indicative mean effective pressure, torque, volumetric efficiency; specific fuel consumption (BSFC, ISFC), thermal efficiency; heat balance; Basic engine measurements; fuel and air consumption, brake power, indicated power and friction power, heat lost to coolant and exhaust gases; performance curves.

Unit 6: Fuels for IC Engines and Advances in IC Engines

Fuels for SI and CI engine, important qualities of SI and CI engine fuels, octane rating of fuels; Cetane rating; Dopes, Additives, Gaseous fuels, Alternative fuels for IC engines.

Stratified charge, direct injection systems Homogeneous charge, compression ignition Low temperature diesel combustion; Advanced electronic-controlled engine Hybrids and fuel cells

Text Books:

1. V. Ganesan,2017, Internal Combustion Engines, 4th Edition, Tata McGraw-Hill.

2. Willard W. Pulkrabek, 2003, Engineering fundamental of the I.C.Engine, 2nd Edition, PHI,India.

3. E.F Obert, 1973, Internal Combustion Engines and Air pollution, 3rd Edition, Hopper and Row Pub., New York.

Reference Books:

1. John B. Heywood, 2017, Internal Combustion Engines Fundamentals-, Pub.-McGraw Hill, New York.

2. M.L Mathur and M.Sharma, 2018, Internal Combustion Engines, Dhanpat Rai Publication.

3. Charles Fayette Taylor, 1985, The Internal Combustion Engine in Theory and Practice: Vol. 1 - 2nd Edition, MIT Press.

Weblinks:

http://nptel.ac.in/courses/114105029/24

http://nptel.ac.in/courses/103105110

Instructions for setting of Paper Seven questions are to set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each part A and part B (one from each unit). Student needs to attempt two questions out of three questions from each part. Each question will be of 20 marks.

Evaluation Tools:

In general parameters for Internal /Continuous Evaluation (Theory Courses):

Parameter	Weightage
Two Sessional (Mid-Term)Tests	60%
Assignments	20%
Class Performance	10%
Class Attendance	10%

Theory Course: Total Marks 200

Internal/Continuous Evaluation: 100

- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

MRIPS

Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PS02	PS03
BME-DS-525.1	2	3	2	3	2	2	-	2	1	2	1	3	3	3	3
BME-DS-525.2	2	-	3	1	-	2	2	-	1	-	1	2	3	3	1
BME-DS-525.3	2	-	2	1	-	1	2	-	1	-	1	2	3	3	3
BME-DS-525.4	2	-	3	1	-	1	3	2	1	-	1	2	3	3	3
BME-DS-525.5	2	-	2	1	-	1	2	-	1	-	1	2	3	3	3
BME-DS-525.6	2	2	1	2	1	2	1	1	2	1	1	3	3	3	3

MRIIRS

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH & STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

BME-DS-523: WELDING & FORGING TECHNOLOGY

Periods/week Credits — Max. Marks : 200

L: 3 T: 0 P: 0 3 — Continuous Assessment : 100

Duration of Examination: 3 Hrs — End Semester Exam : 100

Prerequisites: BME-DS-304: Manufacturing Processes

Course Type: Domain Specific Elective Course

Course Outcomes:**After completion of this course the students will be able to**

BME-DS-523.1 Understand the fundamental concept and engineering of welding and forging technology

BME-DS-523.2 Classify the various welding and forging processes, understand the equipment used in various processes along with their terminology

BME-DS-523.3 Selection of the welding parameters, equipments, design consideration and apply themselves to recommend the welding process based on the work material.

BME-DS-523.4 Evaluate the stock requirement and design consideration of dies/product to be incorporated to produce an appropriate forging.

Part-A

Unit 1: Gas and Arc Welding Processes

Acetylene welding, Oxyacetylene welding, Carbon arc welding, Shielded metal arc welding, Submerged arc welding, TIG & MIG welding, Plasma arc welding and Electroslag welding processes – advantages, limitations and applications.

Unit 2: Resistance Welding Processes

Spot welding, Seam welding, Projection welding, Resistance Butt welding, Flash Butt welding, Percussion welding and High frequency resistance welding processes – advantages, limitations and applications.

Unit 3: Solid State Welding Processes

Cold welding, Diffusion bonding, Explosive welding, Ultrasonic welding, Friction welding, Forge welding, Roll welding and Hot pressure welding processes – advantages, limitations and application

Part-B

Unit 4: Forging Equipment and Operations

Open and closed die forging Technology, Classification of forging dies, Hot Forging Equipments: Hammers, Presses and Upsetters, Comparisons of Forging equipments. preliminary forging operations: Fullering, Edging, Bending, drawing, flattening, blocking, finishing and cutt-off operations. Selection of sizes of forging equipment, forging of gear block and coupling hook, shape of the forging and pre-form design

Unit 5: Forging/Die Design Factor

Draft, fillet radius, parting line, shrinkage and die wear, mismatch, finish allowance, dimensional tolerances, webs and ribs. Die Design for press forging, Die design for machine forging. determination of stock size, tools for flash trimming and hole piercing.

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Unit 6: Recent Forging Technologies

Plastic deformation processes; warm forging, flashless forging, no draft forging, cold forging, Super plastic forming, powder metal forging, liquid forging, rheo-forging and isothermal forging processes.

Text Books:

1. P.C. Sharma "A Text Book of Production Engineering" S. Chand.
2. P.C. Sharma "A Text Book of Production Technology" S. Chand.
3. P. N. Rao, Manufacturing Technology-I &II , PHI.

Reference Books:

1. S. Kalpakjian& S R Schimd "Manufacturing Engineering and Technology" Pearson
2. B. S. Raghuwansi, Workshop Technology-I, Dhanpat Rai Publication
3. Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems

Weblinks:

https://nptel.ac.in/courses/122104015
https://nptel.ac.in/courses/112103109
https://onlinecourses.nptel.ac.in/noc19_me01/preview

Instructions for setting of Paper Seven questions are to set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each part A and part B (one from each unit). Student needs to attempt two questions out of three questions from each part. Each question will be of 20 marks.

Assessment Tools:
In general parameters for Internal /Continuous Assessment (Theory Courses):

Parameter	Weightage
Two Sessional (Mid-Term)Tests	60%
Assignments	20%
Class Performance	10%
Class Attendance	10%

Theory Course: Total Marks 200
Internal/Continuous Assessment: 100

- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

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Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PS02	PS03
BME-DS-523.1	3	3	3	3	2	1	1	1	-	-	-	-	2	1	-
BME-DS-523.2	2	2	2	3	3	2	1	1	-	-	1	-	3	1	-
BME-DS-523.3	1	2	3	3	2	2	2	2	-	-	1	1	3	1	1
BME-DS-523.4	1	3	2	3	-	-	-	-	-	-	1	-	3	1	-

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MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH & STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

BME-DS-525: POWER PLANT ENGINEERING

Periods/week Credits	Max. Marks : 200
L: 3 T: 0 P: 0 3	Continuous Assessment : 100
Duration of Examination: 3 Hrs	End Semester Exam : 100

Prerequisites: BME-DS-405: Thermal engineering
Course Type: Domain Specific Elective Course

Course Outcomes:
After completion of this course the students will be able to

BME-DS-525.1 Describe sources of energy and classify the types of power plants available, their layout and site selection.

BME-DS-525.2 Illustrate an understanding towards energy storage, power plant economics and combining different thermodynamic cycles to improve performance aspects.

BME-DS-525.3 Evaluate performance, load factor, capacity factor, average load and peak load on a power plant.

BME-DS-525.4 Extend their knowledge to power plant economics and environmental hazards

Part-A

Unit 1: Introduction

Energy resources and their availability, types of power plants, selection of the plants, review of basic thermodynamic cycles used in power plants. Concept of energy storage, methods of energy storage

Unit 2: Hydro and Non Conventional Power Plants

Rainfall and run-off measurements and plotting of various curves for estimating stream flow and size of reservoir, power plants design, construction and operation of different components of hydro-electric power plants, site selection, comparison with other types of power plants.Principles of wind, tidal, solar PV and solar thermal, geothermal, biogas and fuel cell power systems.

Unit 3: Steam Power Plants

General layout of steam power plant, boilers including critical and super critical boilers, Fluidized bed boilers, boilers mountings and accessories, Different systems such as coal handling system, pulverizes and coal burners, combustion system, draft, ash handling system, Dust collection system, Feed water treatment and condenser and cooling towers and cooling ponds, heat balance and efficiency, Site selection of a steam power plant..

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Part-B

Unit 4: Gas Turbine and Diesel Power Plant

Layout of gas turbine power plant, Elements of gas turbine power plants, Brayton Cycle, Combined cycle power plants, Site selection of gas turbine power plant, Integrated Gasifier based Combined Cycle (IGCC) systems.

General layout, Components of Diesel power plant, Performance of diesel power plant, fuel system, lubrication system, air intake and admission system, supercharging system, exhaust system, diesel plant operation and efficiency, heat balance, Site selection of diesel power plant ,Comparative study of diesel power plant with steam power plant.

Unit 5: Nuclear Power Plants

Principles of nuclear energy, basic nuclear reactions, nuclear reactors-PWR, BWR, CANDU, Sodium graphite, fast breeder, homogeneous; gas cooled. Advantages and limitations, nuclear power station, waste disposal.

Unit 6: Power Plant Economics

Load estimation, load curves, various terms and factors involved in power plant calculations. Effect of load variation on power plant operation, Selection of power plant units, Power plant economics and selection, Effect of plant type on costs, rates, fixed elements, energy elements, customer elements and investor's profit; depreciation and replacement, theory of rates. Economics of plant selection, other considerations in plant selection

Text Books:

1. Power Plant Engineering by P.K. Nag, Tata McGraw Hill.
2. Steam & Gas Turbines & Power Plant Engineering by R.Yadav, Central Pub.House.
3. Power Plant Engineering by Gupta, PHI India
4. Power Plant Engineering. Mahesh Verma, Metropolitan Book Company Pvt. Ltd.

Reference Books:

1. Power Plant Engineering, by F.T. Morse, Affiliated East-West Press Pvt. Ltd.
2. Power Plant Engineering by Hedge, Pearson India.
3. Power Plant Technology, by Wakil, McGraw Hill.

Weblinks:

http://nptel.ac.in/courses/108105058/8
http://nptel.ac.in/courses/112106133

Instructions for setting of Paper Seven questions are to set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each part A and part B (one from each unit). Student needs to attempt two questions out of three questions from each part. Each question will be of 20 marks.

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Assessment Tools:

In general parameters for Internal /Continuous Assessment (Theory Courses):

Parameter	Weightage
Two Sessional (Mid-Term)Tests	60%
Assignments	20%
Class Performance	10%
Class Attendance	10%

Theory Course: Total Marks 200
Internal/Continuous Assessment: 100

- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PS02	PS03
BME-DS-525.1	2	3	1	1	2	1	2	2	1	2	1	3	2	2	-
BME-DS-525.2	2	2	1	1	-	-	-	-	1	-	1	-	1	-	-
BME-DS-525.3	2	2	2	2	-	-	-	-	1	-	1	-	1	2	-
BME-DS-525.4	2	2	3	2	-	-	-	-	1	-	1	-	2	-	-

MRIIRS

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH & STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

BME-DS-526: PRODUCTION ENGINEERING

Periods/week Credits — Max. Marks : 200

L: 3 T: 0 P: 0 3 — Continuous Assessment : 100

Duration of Examination: 3 Hrs — End Semester Exam : 100

Prerequisites: BME-DS-403: Manufacturing Technology

Course Type: Domain Specific Elective Course

Course Outcomes:**After completion of this course the students will be able to**

BME-DS-526.1 Understanding the manufacturing sequence to generate the process planning sheet for mechanical components.

BME-DS-526.2 Analyse the machine tool elements, materials and jigs and fixtures as per the manufacturing requirements.

BME-DS-526.3 Classify and compare the various thread manufacturing processes and gear manufacturing process and identify the most economical way for the industries with minimum material and time loss.

BME-DS-526.4 Able to provide cost effective and unique solutions of manufacturing and fabrication of various mechanical components.

Part-A

Unit 1: Process Planning

Importance of process planning, steps of process planning, part print analysis, tolerance stacking, operation selection. Selection of sequence of operation, machines, tools, gauges, measuring instruments, etc, process sheets.

Unit 2: Jigs and Fixture

Purpose of using jigs and fixture, degrees of freedom, locating devices, clamping devices, Drill Bushes, principle of methods of locating, supporting and clamping blanks and tool guidance in jigs and fixtures, types of jig and fixture.

Unit 3: Machine Tool Elements

Design of machine tool elements, machine body, elements of design, guideways, materials for machine body and guideways, spindles and bearings, machine tool testing: idle-run tests, accuracy test, measuring tools used in geometrical accuracy test, acceptance test

Part-B

Unit 4: Thread Manufacturing

Thread chasing and cutting, thread rolling, die-threading and threads tapping, solid taps, thread milling, thread grinding

Unit 5: Gear Manufacturing

Methods of manufacturing gears, Gear cutting by milling, gear planner, gear shapers, gear hob, gear hobbing, gear finishing.

Unit 6: Cost Estimation

Estimation of cost elements, Principle elements of metal machining and their selection, procedure for assigning cutting variables, calculation of machining times for turning, drilling and milling operation, estimation of total unit time.

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Text Books:

1. P.C. Sharma "A Text Book of Production Engineering" S. Chand
2. P.C. Sharma "A Text Book of Production Technology" S. Chand
3. P. N. Rao, Manufacturing Technology-I &II , PHI.
4. B.S. Raghuwanshi "Workshop Tecnology-II" S.Chand

Reference Books:

1. S. Kalpakjian& S R Schimd "Manufacturing Engineering and Technology" Pearson
2. B. S. Raghuwansi, Workshop Technology-I, Dhanpat Rai Publication
3. Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems

Weblinks:

http://nptel.ac.in/courses/112105127
http://nptel.ac.in/courses/112107144
http://nptel.ac.in/courses/112107145

Instructions for setting of Paper Seven questions are to set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each part A and part B (one from each unit). Student needs to attempt two questions out of three questions from each part. Each question will be of 20 marks.

Assessment Tools:

In general parameters for Internal /Continuous Assessment (Theory Courses):

Parameter	Weightage
Two Sessional (Mid-Term)Tests	60%
Assignments	20%
Class Performance	10%
Class Attendance	10%

Theory Course: Total Marks 200
Internal/Continuous Assessment: 100

- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PS02	PS03
BME-DS-526.1	3	3	2	3	3	1	2	1	1	2	1	2	3	3	1
BME-DS-526.2	3	2	2	3	3	2	-	-	1	1	1	1	3	2	1
BME-DS-526.3	3	2	2	1	-	-	2	-	-	1	1	2	3	2	1
BME-DS-526.4	3	3	3	2	2	2	2	1	1	1	1	2	3	3	1

MRIPS

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH & STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

BME-DS-622: CAD/CAM

Periods/week Credits	Max. Marks: 200
L: 3 T: 0 P: 0 3	Continuous Assessment: 100
Duration of Examination: 3 Hrs	End Semester Exam : 100

Prerequisites: BME-DS-353: CAD Lab, BME-DS-403: Manufacturing Technology

Course Type: Domain Specific Elective Course (Compulsory)

Course Outcomes:

After completion of this course the students will be able to

BME-DS-622.1 Develop mathematical equation of CAD modeling through various transformations and curves that will assist in creation and modification of designs.

BME-DS-622.2 Classify and Compare the different types of modeling techniques in surface and solid modelsfor the successful completion of CAD/CAM-based modeling.

BME-DS-622.3 Apply knowledge of industrial automation system used in manufacturing. Basic concepts and generation of part programming skills for computer numerical control (CNC) machines.

BME-DS-622.4 Understand the concept of group technology, CAPP, MRP and their importance in the field of production, planning and automation required in manufacturing.

Part-A

Unit 1: Introduction and transformations

Introduction to CAD/CAM, Historical developments, Industrial look at CAD/CAM, Introduction to CIM; coordinate systems, transformation of points and line, 2-D and 3D rotation, reflection, scaling and combined transformation, homogeneous coordinates, orthographic and perspective projections.

Unit 2: Curves

Algebraic and geometric forms, tangents and normal, blending functions reparametrization, straight lines, conics, cubic splines, Bezier curves and B-spline curves.

Unit 3: Introduction to Surfaces and Solids

Algebraic and geometric forms, tangents and normal, and blending functions of plane surface, ruled surface, surface of revolution, tabulated cylinder, bi-cubic surface, bezier surface, B-spline surface. Solid models and representation scheme, boundary representation, constructive solid geometry, sweep representation, cell decomposition, spatial occupancy enumeration.

Part-B

Unit 4: Automation and Numerical Control

Introduction, fixed, programmable and flexible automation, types of NC, CNC, AND DNC systems, MCU and other components, Coordinate system.

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Unit 5: Part Programming

NC manual part programming, coordinate systems, G and M codes, Part program for simple parts, computer assisted part programming.

Unit 6: Introduction to other processes

Group Technology**,** Part families, part classification and coding, Conventional process planning, types of CAPP, Steps in variant process planning, planning for CAPP, MRPI, II, MPS, BOM.

Text Books:

1. CAD/ CAM by Groover and Zimmer, Prentice Hall.
2. CAD/ CAM Theory and Practice by Zeid, McGraw Hill
3. Numerical Control and Computer Aided Manufacturing by Kundra, Rao and Tiwari, TMH.
4. CAD/CAM (Principles, Practice and Manufacturing Management) by Chirs Mc Mohan and Jimmie Browne, Published by Addison- Wesley.

Reference Books:

1. Fundamentals of CAD/CAM by Vikram Sharma, International Book House.
2. CAD/CAM Computer Aided Design and Manufacturing by M.Groover, Pearson.

Weblinks:

http://nptel.ac.in/courses/112102101/1
http://nptel.ac.in/courses/112102103

Instructions for setting of Paper Seven questions are to set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each part A and part B (one from each unit). Student needs to attempt two questions out of three questions from each part. Each question will be of 20 marks.

Assessment Tools:

In general parameters for Internal /Continuous Assessment (Theory Courses):

Parameter	Weightage
Two Sessional (Mid-Term)Tests	60%
Assignments	20%
Class Performance	10%
Class Attendance	10%

Theory Course: Total Marks 200
Internal/Continuous Assessment: 100

- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS01	PSO2	PSO3
BME-DS-622.1	3	3	2	2	1	2	1	-	2	2	-	3	1	2	2
BME-DS-622.2	3	3	3	3	1	2	1	-	2	2	-	3	1	2	2
BME-DS-622.3	3	3	3	3	3	2	2	-	2	1	1	3	1	2	2
BME-DS-622.4	3	2	1	2	1	2	1	-	2	3	1	1	1	2	2

MRIIRS

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH & STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

BME-DS-623: ADVANCED STRENGTH OF MATERIAL

Periods/week Credits	Max. Marks : 200
L: 3 T: 0 P: 0 3	Continuous Assessment : 100
Duration of Examination: 3 Hrs	End Semester Exam : 100

Prerequisites: BME-DS-403: Strength of Materials

Course Type: Domain Specific Elective Course

Course Outcomes:

After completion of this course the students will be able to

BME-DS-623.1 Classify shells, springs and compare stresses for different loading conditions and estimate the strength of different structures.

BME-DS-623.2 Interpret real world problem on bending of bars, plates and applying theory and principles of strength of material.

BME-DS-623.3 Examine and compare strength of different structures and material for the design of components.

BME-DS-623.4 Evaluate stress system due to rotation and for different loading conditions.

Part-A

Unit 1: Thin shells and thick shells

Thin shells: circumferential / Hoop stress, longitudinal stress, maximum shear stress, design of thin cylindrical shell, cylindrical shell with hemispherical ends, built-up cylindrical shell, wire wound cylinders

Thick shells: Lame's theory, special cases, longitudinal and shear stress, design of thick cylindrical shells, compound cylinders, thick spherical shells

Unit 2: Bending of curved bars

Winkler-Bach theory, values of h2 for various sections (rectangular, circular, triangular), stresses in a ring, stresses in a chain link, deflection of a closed ring, deflection of a chain link

Unit 3: Springs

Helical springs, closed- coiled helical springs subjected to axial load and axial twist, open coiled helical spring with axial load and axial thrust, springs in series & parallel connection, leaf spring, flat spiral spring

Part-B

Unit 4: Torsion of circular shaft

Torsion of shafts, torsion equation, hollow circular shafts, torsional rigidity, power transmitted, comparison of solid and hollow shaft, shafts in series and parallel, torsional resilience, combined bending and torsion, modulus of rupture, various stresses in the shafts

Unit 5: Stresses due to rotation

Rotating ring, rotating thin disc, disc of uniform strength, rotating long cylinders

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Unit 6: Advanced Topics

Introduction, beams on elastic foundation, differential equation of the elastic line, concentrated load on an infinite beam, principle of superposition, UDL over part of beam, force and couple on a beam, Bending of plates:Cylindrical bending of thin rectangular plates, bending of circular plates

Text Book:

1. Sadhu Singh, " Strength of Material", Khanna Publication.
2. R. Subramanian, "Strength of Material", Oxford University Press.
3. Gere J. M., Timoshenko S.P., "Mechanics of Materials", CBS Publication.
4. B.C Punamia, "Mechanics of Materials", Laxmi Publications

Reference Book:

1. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India,
2. Ferdinand P. Been, Russell Johnson Jr and John J. Dewole, Mechanics of Materials, Tata McGraw-Hill Publishing Co. Ltd.
3. HibbelerR.C.,"Mechanics of Materials", Prentice Hall, New Delhi
4. Fenner, Roger.T, "Mechanics of Solids", U.K. B.C. Publication

Weblinks:

https://nptel.ac.in/courses/112107146
https://nptel.ac.in/courses/112107147

Instructions for setting of Paper Seven questions are to set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each part A and part B (one from each unit). Student needs to attempt two questions out of three questions from each part. Each question will be of 20 marks.

Assessment Tools:

In general parameters for Internal /Continuous Assessment (Theory Courses):

Parameter	Weightage
Two Sessional (Mid-Term)Tests	60%
Assignments	20%
Class Performance	10%
Class Attendance	10%

Theory Course: Total Marks 200
Internal/Continuous Assessment: 100

- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

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Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS01	PSO2	PSO3
BME-DS-623.1	3	1	1	1	2	1	3	2	1	-	2	-	3	3	1
BME-DS-623.2	2	2	3	1	2	3	1	3	2	1	-	3	3	3	3
BME-DS-623.3	3	3	2	2	1	2	1	1	1	2	-	1	3	3	2
BME-DS-623.4	2	3	2	2	3	2	2	1	1	1	-	2	3	3	3

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MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH & STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

BME-DS-624: PROCESS PLANNING AND COST ESTIMATION

Periods/week Credits	Max. Marks : 200
L: 3 T: 0 P: 0 3	Continuous Assessment : 100
Duration of Examination: 3 Hrs	End Semester Exam : 100

Prerequisites: BME-DS-502: Industrial Engineering
Course Type: Domain Specific Elective Course

Course Outcomes:
After completion of this course the students will be able to

BME-DS-624.1 Select the process, equipment and tools for various industrial applications.
BME-DS-624.2 Estimate various elements of cost in Various Manufacturing Processes.
BME-DS-624.3 Corelate the process parameters with time and cost estimation
BME-DS-624.4 Prepare process planning activity chart and estimate of cost effectively.

Part-A

Unit 1: Introduction to Process Planning

Introduction- methods of process planning, Drawing interpretation, Material evaluation, steps in process selection- Production equipment and tooling selection

Unit 2: Process Planning Activities

Process parameters calculation for various production processes-Selection jigs and fixtures election of quality assurance methods – Set of documents for process planning-Economics of process planning- case studies.

Unit 3: Cost Elements

Material cost – Determination of material cost, Labour cost - Determination of labour cost, Expenses — Analysis of overhead expenses – Factory expenses, Administrative expenses – Selling and Distributing expenses – Allocation of over head expenses. Cost of product – Illustrative examples Depreciation: Depreciation – Causes of Depreciation – Methods of Depreciation.

Part-B

Unit 4: Introduction to Cost Estimation

Importance of costing and estimation –methods of costing-elements of cost estimation –Types of estimates – Estimating procedure- Estimation labor cost, material cost- allocation of over head charges- Calculation of depreciation cost

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Unit 5: Production Cost Estimation

Estimation of Different Types of Jobs – Estimation of Forging Shop, Estimation of Welding Shop, Estimation of FoundryShop.

Unit 6: Machining Time Calculation

Estimation of Machining Time – Importance of Machine Time Calculation- Calculation of Machining Time for Different Lathe Operations ,Drilling and Boring – Machining Time Calculation for Milling, Shaping and Planning -Machining Time Calculation for Grinding.

Text Books:

1. M.Adithian and B.S. Pabla, Estimation and Costing, Konark publishers Pvt. Ltd., 1989.
2. A.K.Chitale and R.9C.Gupta, Product Design and Manufacturing, Prentice Hall Pvt. Ltd.., 2005
3. Peter scalon, "Process planning, Design/Manufacture Interface", Elsevier science technology Books, Dec 2002.
4. Sinha B.P, "Mechanical Estimating and Costing", Tata-McGraw Hill publishing co, 1995.

Reference Books:

1. Namua Singh, System Approach to computer integrated Design and Manufacturing, John Wiley &Sons,Inc.,1996.
2. Joseph G Monks, Operation Management, Theory & Problems, McGraw Hill Book Company, 1987.
3. T.R.Banga and S.C.Sharma, Estimations and Costing, Khanna Publishers,1988.
4. G.B.S.Narang and V.Kumar, Production and Costing, Khanna Publishers, 1995.

Weblinks:

https://nptel.ac.in/courses/112107238/

https://books.google.com/books?id=A9-ZXblNrPoC

Instructions for setting of Paper Seven questions are to set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each part A and part B (one from each unit). Student needs to attempt two questions out of three questions from each part. Each question will be of 20 marks.

Assessment Tools:

In general parameters for Internal /Continuous Assessment (Theory Courses):

Parameter	Weightage
Two Sessional (Mid-Term)Tests	60%
Assignments	20%
Class Performance	10%
Class Attendance	10%

Theory Course: Total Marks 200
Internal/Continuous Assessment: 100

- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks

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- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS01	PSO2	PSO3
BME-DS-624.1	3	-	3	3	2	1	-	-	1	1	2	1	3	-	3
BME-DS-624.2	3	3	3	2	1	1	-	-	1	-	1	2	3	3	3
BME-DS-624.3	3	2	2	3	2	2	-	-	2	-	2	2	3	2	2
BME-DS-624.4	3	3	2	2	3	1	2	-	1	-	1	3	3	3	2

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MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH & STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

BME-DS-626: FUNDAMETNALS OF ROBOTICS

Periods/week Credits	Max. Marks : 200
L: 3 T: 0 P: 0 3	Continuous Assessment : 100
Duration of Examination: 3 Hrs	End Semester Exam : 100

Prerequisites: BME-DS-501: Theory of Machines
Course Type: Domain Specific Elective Course

Course Outcomes:
After completion of this course the students will be able to
BME-DS-626.1 Understand the robotic structure and its link movements
BME-DS-626.2 Identify the sensors, actuators and programming to maintain safety and precautions
BME-DS-626.3 Program a robot for work cell designed for single and multiple robots' layout
BME-DS-626.4 Use the elements of a work cell control as per industrial applications

Part-A

Unit 1: Introduction

Brief history, robot terminology, robot components and classification, characteristic, physical configuration, structure of industrial robot, robot joints, robot coordinates, Robot Workspace Design, robot application, advantages and disadvantages. Justification considerations in applying industrial robots.

Unit 2: Robot Drives, Control and Effectors

Robot drives and control- controlling the robot motion, position and velocity sensing devices, design of drive systems, hydraulic and pneumatic drives, linear and rotary actuators and control valves, electro hydraulic servo valves, electric drives, motors, magnetostrictive actuators, design consideration of end effectors-mechanical, vacuum, magnetic and air operated grippers, tools as end effectors, Robot/end effectors interface.

Unit 3: Sensors and Machine Vision

Transducers and sensors, sensor characteristics, sensors in robotics- tactile, touch, position, velocity, acceleration, force, pressure, torque sensors, proximity and range finders, sniff sensors, light and infra red sensor, RCC devices and micro switches, Robotic vision system: sensing and digitizing function in machine vision, image gripping, image processing and analysis, image segmentation and pattern recognization, vision system robotic applications.

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Part-B

Unit 4: Robot Cell Design and Applications

Robot work cell design and control, safety in robotics, robot cell layouts, multiple robots and machine interference. Application -Welding, electro-plating, painting, spraying, assembling, material handling, inspection, Future applications

Unit 5: Robot Programming

Robot programming: Types of programming, lead through programming, motion Programming, interlocks, advantages and disadvantages.

Robot languages: Motion programming, simulation and off-line programming, work cell control elements of artificial intelligence in robots.

Unit 6: Industrial Applications of Robots

For material transfer, machine loading / unloading, welding, assembly and spray painting operations.

Text Books:

5. Introduction to Robotics, Analysis, Systems, Application Saeed B. Niku, Pearson Education.
6. Industrial Robotics: Ganesh S. Hegde Laxmi Publication (P) Limited.
7. Robotics – An introduction By Douglas R. Malcolm. Jr Delmar Publisher Inc.
8. Fundamentals of robotics–analysis and control By Robert J. Schilling (PHI) edition.

Reference Books:

3. Robotics-Control, sensing, vision and Intelligence By K.S.Fy., R.C.Gonzaler, C.S.G.Lee, Mc Graw Hill editions.
4. Introduction to Robotics by John J. Craig, Pearson

Weblinks:

http://nptel.ac.in/courses/112101099
http://nptel.ac.in/courses/112101098

Instructions for setting of Paper Seven questions are to set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each part A and part B (one from each unit). Student needs to attempt two questions out of three questions from each part. Each question will be of 20 marks.

Assessment Tools:

In general parameters for Internal /Continuous Assessment (Theory Courses):

Parameter	Weightage
Two Sessional (Mid-Term)Tests	60%
Assignments	20%
Class Performance	10%
Class Attendance	10%

Theory Course: Total Marks 200
Internal/Continuous Assessment: 100

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- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
BME-DS-626.1	3	3	3	2	3	-	-	-	-	-	-	2	3	3	-
BME-DS-626.2	3	3	3	3	2	2	1	-	-	-	-	1	3	3	1
BME-DS-626.3	3	3	3	2	2	-	2	-	3	-	2	-	3	3	-
BME-DS-626.4	3	3	3	3	1	3	2	-	2	-	-	-	-	-	3

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(Deemed to be University under section 3 of the UGC Act 1956)

BME-DS-722: MODERN MACHINING METHODS

Periods/week Credits	Max. Marks : 200
L: 3 T: 0 P: 0 3	Continuous Assessment : 100
Duration of Examination: 3 Hrs	End Semester Exam : 100

Prerequisites: BME-DS-304: Manufacturing Processes

Course Type: Domain Specific Elective (Compulsory)

Course Outcomes:

After completion of this course the students will be able to

BME-DS-722.1 Understand the modern machining methods with special emphasis on mechanical based, chemical and electrochemical based, electrical energy based, thermal energy based and hybrid processes.

BME-DS-722.2 Understand various MMMs with respect to classification, working, equipment, process parameters and material removal rates.

BME-DS-722.3 Apply the principles of engineering to develop models for various modern machining methods.

BME-DS-722.4 Synthesize novel advanced manufacturing approaches based upon knowledge acquired from study of current systems.

PART-A

Unit 1: Introduction to Modern Machining and Ultrasonic Machining

Modern Machining Processes classification, Need for modern machining methods, comparative analysis of modern machining processes.USM process and working principle, element of the process, cutting tool design consideration, effect of process parameters, process capability. Rotary ultrasonic machining

Unit 2: Abrasive and Water Jet Machining

AJM process: working principle, process set-up, abrasives slurry, liquid media, effect of process parameters on MMR, applications, advantages and limitation, process capability

WJM process: working principle, description and operation of the process, applications, advantages and limitation, process capability, comparison between AJM and WJM.

Unit 3: Electro-Chemical Machining

ECM: Working principle and process, equipment, element and process capability of ECM. Selection, characteristics and working life of electrolyte. Derivation of MRR, factors governing accuracy of the parts. Electro chemical grinding, electro-chemical honing.

Chemical Machining: Definition and principle, Introduction to chemical blanking, chemical milling and photo-chemical blanking, application of the processes

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PART-B

Unit 4: Electric Discharge Machining

EDM Machine, mechanism of metal removal, MRR, spark erosion generator and power circuits, process parameters, selection of tool electrode and dielectric fluids, flushing fundamentals and methods, EDM process characteristics, accuracy, surface finish, Heat affected zone of machined surface. Wire cut EDM, electro-chemical spark machining.

Unit 5: Laser and Electron Beam Machining

LBM: Laser principle and process, types of lasers, description of LB process, beam parameters, applications, advantages and limitation, process capabilities.
EBM: EBM apparatus, control and generation of electron beam by electron gun, effect of process parameters, advantages and limitation, process capabilities. Comparison between EBM and LBM.

Unit 6: Plasma Arc Machining

PAM: Types of plasma system, plasma torch, equipments, description of the process, power requirements, selection of plasmogen, analysis of PAM parameters, safety and precaution, applications, advantages and limitation.

Text Book

1. V. K. Jain "Advanced Machining Processes" Allied Publishers Pvt. Ltd
2. Jagadeesha T "NontraditionalMacining Processes" I K International Publishing House Pvt. Ltd.
3. Pandey P.C. and Shan H.S. "Modern Machining Processes" Tata McGraw-Hill

References

1. Benedict. G.F. "Non traditional Manufacturing Processes" Marcel Dekker Inc.
2. Mc Geough, "Advanced Methods of Machining" Chapman and Hall,
3. P.N. Rao " Manufacturing Technology II, PHI

Weblinks:

https://nptel.ac.in/courses/112/104/112104028/
https://nptel.ac.in/courses/112107078/

Instructions for setting of Paper Seven questions are to set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each part A and part B (one from each unit). Student needs to attempt two questions out of three questions from each part. Each question will be of 20 marks.

Assessment Tools:
In general parameters for Internal /Continuous Assessment (Theory Courses):

Parameter	Weightage
Two Sessional (Mid-Term)Tests	60%
Assignments	20%
Class Performance	10%
Class Attendance	10%

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Theory Course: Total Marks 200
Internal/Continuous Assessment: 100

- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS01	PSO2	PSO3
BME-DS-722.1	3	3	1	1	-	1	-	1	-	1	-	2	3	3	3
BME-DS-722.2	3	3	2	2	2	2	-	1	-	-	-	2	3	3	2
BME-DS-722.3	3	3	3	2	1	1	-	1	-	-	1	2	3	2	2
BME-DS-722.4	3	3	3	2	3	1	2	1	1	2	-	2	3	3	3

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MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH & STUDIES

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BME-DS-723: GAS DYNAMICS & JET PROPULSION

Periods/week Credits — Max. Marks : 200
L: 3 T: 0 P: 0 3 — Continuous Evaluation : 100
Duration of Examination: 3 Hrs — End Semester Exam : 100

Prerequisites: BME-DS-303: Fluid Mechanics & Machines, BME-DS-602: Heat Transfer

Course Type: Domain Specific Elective

Course Outcomes:

After completion of this course the students will be able to

BME-DS-723.1 Define the basic difference between incompressible and compressible flow and properties of gases.

BME-DS-723.2 Understand the one, dimensional steady compressible fluid flow.

BME-DS-723.3 Apply the gas dynamics principles in the jet and space propulsion.

BME-DS-723.4 Analyze the flow properties on shock waves in various flow regions.

BME-DS-723.5 Evaluate the adiabatic and isentropic properties in various regions of flow and under various conditions.

BME-DS-723.6 Determine propulsion efficiency and design inlets and nozzles

Part-A

Unit 1: Introduction to Gas Dynamics

Control volume and system approaches acoustic waves and sonic velocity , mach number , classification of fluid flow based on mach number, mach cone, compressibility factor, general features of one dimensional flow of a compressible fluid , continuity and momentum equations for a control volume.

Unit 2: Isentropic Flow of an Ideal Gas

basic equation , stagnation enthalpy, temperature, pressure and density, stagnation, acoustic speed , critical speed of sound, dimensionless velocity, governing equations for isentropic flow of a perfect gas, critical flow area, stream thrust and impulse function. Steady one dimensional isentropic flow with area change, effect of area change on flow parameters, chocking, convergent nozzle , performance of a nozzle under decreasing back pressure, De lavel nozzle, optimum area ratio effect of back pressure, nozzle discharge coefficients, nozzle efficiencies.

Unit 3: Simple Friction Flow

Adiabatic flow with friction in a constant area duct, governing equations, fanno line limiting conditions, effect of wall friction on flow properties in an Isothermal flow with friction in a constant area duct, governing equations , limiting conditions. Steady one dimensional flow with heat transfer in constant area ducts, governing equations Rayleigh line entropy change caused by heat transfer, conditions of maximum enthalpy and entropy.

Part-B

Unit 4: Effect of Heat Transfer on flow parameters

Intersection of Fanno and Rayleigh lines. Shock waves in perfect gas, properties of flow across a normal shock, governing equations , Rankine Hugoniat equations, Prandtl's velocity relationship , converging diverging nozzle flow with shock thickness , shock strength

Unit 5: Propulsion: Aircraft Propulsion

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Types of jet engines, energy flow through jet engines, thrust, thrust power and propulsive efficiency turbojet components, diffuser, compressor, combustion chamber, turbines, exhaust systems

Unit 6: Performance of turbo propeller engines

Ramjet and pulsejet, scramjet engines, Rocket propulsion , rocket engines, Basic theory of equations , thrust equation , effective jet velocity , specific impulse , rocket engine performance , solid and liquid propellant rockets, comparison of various propulsion systems.

Text Books:

1. J.D. Anderson, 2003, Modern Compressible flow, 3rd Edition, McGraw Hill.
2. H. Cohen, G.E.C. Rogers and Saravanamutto, , 1980, Gas Turbine Theory, Longman Group Ltd.
3. S.M. Yahya,1996,Fundamentals of Compressible Flow, New Age International (P) Limited, New Delhi.
4. N.J. Zucrow,1970,Principles of Jet Propulsion and Gas Turbines, John Wiley, New York.

Reference Books:

1. G.P. Sutton, 1986,Rocket Propulsion Elements, John wiley, New York.
2. A.H. Shapiro, 1953, Dynamics and Thermodynamics of Compressible fluid Flow, , John wiley, New York.
3. P R.S.L. Somasundaram, 1996, Gas Dynamics and Jet Propulsions, New Age International Publishers.
4. V. Babu, 2008, Fundamentals of Gas Dynamics, ANE Books India.

Weblinks:

https://nptel.ac.in/courses/122104015
https://nptel.ac.in/courses/112103109
https://onlinecourses.nptel.ac.in/noc19_me01/preview

Instructions for setting of Paper Seven questions are to set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each part A and part B (one from each unit). Student needs to attempt two questions out of three questions from each part. Each question will be of 20 marks.

Evaluation Tools:

In general parameters for Internal /Continuous Evaluation (Theory Courses):

Parameter	Weightage
Two Sessional (Mid-Term)Tests	60%
Assignments	20%
Class Performance	10%
Class Attendance	10%

Theory Course: Total Marks 200

Internal/Continuous Evaluation: 100

- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

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Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS01	PS O2	PS O3
BME-DS-723.1	2	1	2	1	2	2	3	1	1	-	1	-	3	3	3
BME-DS-723.2	3	2	2	2	3	1	3	1	1	-	2	-	3	3	2
BME-DS-723.3	3	3	2	2	3	3	1	2	2	1	-	3	3	3	3
BME-DS-723.4	3	3	3	3	3	2	2	2	1	2	-	1	3	3	3
BME-DS-723.5	2	2	3	3	3	2	2	3	1	1	-	2	3	3	3
BME-DS-723.6	1	3	3	2	3	1	3	3	3	2	3	2	3	3	3

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BME-DS-724: MECHANICAL VIBRATIONS

Periods/week Credits — Max. Marks : 200

L: 3 T: 0 P: 0 3 — Continuous Assessment : 100

Duration of Examination: 3 Hrs — End Semester Exam : 100

Prerequisites: Theory of Machines,: Design of Mechanical System

Course Type: Domain Specific Elective Course

Course Outcomes: **After completion of this course the students will be able to**

BME-DS-724.1 Understand the concept of free, forced and damped vibrations.
BME-DS-724.2 Apply the laws of theory of machines and machine design to solve the vibration problems.
BME-DS-724.3 Examine the effect of vibrations in systems having various degrees of freedom.
BME-DS-724.4 Explain about vibration noise and control.

Part-A

Unit 1: Fundamentals

Importance of Study of Vibrations, Definitions and Terminologies, Classifications of Vibrations, Free and Forced, Un-damped and Damped, Linear and Non-linear, Deterministic and Random, Harmonic Motion, Vector and Complex Number Representations, Periodic Functions, Harmonic Analysis, Fourier Series Expansion.

Unit 2: Free and Damped Vibrations

Single Degree of Freedom systems, D'Alemberts Principal, Energy Methods, Rayleigh's Method, Application of these Methods, Damped Free Vibrations, Under Damping, Critical and Over Damping, Logarithmic Decrement, Viscous and Coulomb Damping.

Unit 3: Forced Vibrations of Single Degree of freedom System

Forced vibrationswith constant harmonic excitation, with rotating and reciprocating unbalance and due to excitation of support. Energy dissipated by damping, Forced vibrations with coulomb, viscous and structural damping. Vibration isolation and transmissibility. Vibration measuring instruments.

Part-B

Unit 4: Two Degrees of Freedom Systems

Introduction, principal modes of vibration, other cases of simple two degrees of freedom systems i.e two mass fixed on tightly stretched string, double pendulum, torsional system, Coordinate Coupling, undamped forced vibrations with harmonic excitation, vibration absorbers i.e undamped dynamic vibration absorber, centrifugal pendulum absorber, Dry friction damper, unturned viscous damper Vibration Isolation.

Unit 5: Multi degrees of Freedom Systems

Introduction, free vibration equations of motion, Influence Coefficients and Maxwell's reciprocal theorem, natural frequencies and mode shapes, orthogonal properties of normal modes. Rayleigh Method Dunkerley's method, Method of Matrix Iteration, Holzer method.

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Unit 6: Critical speeds of shafts

Introduction, Critical speeds of shaft having single disc with and without damping, multiple disc problems.

Text Books:

1. Mechanical Vibration : G.K. Grover and S.P. Nigam, Nem Chand and Sons.
2. Mechanical Vibration : V. P. Singh, Dhanpat Rai and company.
3. Mechanical Vibrations: S.S. Rao, Addison-Wesely Publishing Company.
4. Mechanical Vibration Practice with Basic Theory: V. Ramamurti, Narosa, New Delhi

Reference Books:

1. Mechanical Vibrations Theory and Applications: S. Graham Kelly, Global Engineering
2. Theory and problems of Mechanical Vibrations: William. W. Seto, Schaum Outline Series, Mc Graw Hill Inc.
3. Theory of Vibration with Applications: W.T Thomson, Nelson Thomas Ltd.

Weblinks:

https://nptel.ac.in/courses/112103111/
https://nptel.ac.in/courses/112107212/

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Assessment Tools:

In general parameters for Internal /Continuous Assessment (Theory Courses):

Parameter	Weightage
Two Sessional (Mid-Term)Tests	60%
Assignments	20%
Class Performance	10%
Class Attendance	10%

Theory Course: Total Marks 200
Internal/Continuous Assessment: 100

- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS01	PSO2	PSO3
BME-DS-724.1	3	2	2	1	1	-	-	1	1	1	-	2	-	1	2
BME-DS-724.2	3	3	3	3	2	1	1	1	2	1	2	3	1	3	1
BME-DS-724.3	2	1	3	2	3	2	1	-	2	1	1	3	2	3	2
BME-DS-724.4	3	2	2	2	3	-	2	-	1	2	1	2	-	2	3

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(Deemed to be University under section 3 of the UGC Act 1956)

BME-DS-725: DESIGN OF MACHINE TOOLS

Periods/week Credits	Max. Marks : 200
L: 3 T: 0 P: 0 3	Continuous Assessment : 100
Duration of Examination: 3 Hrs	End Semester Exam : 100

Prerequisites: BME-DS-403: Manufacturing Technology, BME-DS-601: Design of Mechanical System
Course Type: Domain Specific Elective Course

Course Outcomes: **After completion of this course the students will be able to**

BME-DS-725.1 Define the basic concepts and state the general requirement of Machine tools.

BME-DS-725.2 Understand modern design techniques, they can choose the suitable drive as per the motion requirement i.e. rectilinear motion, periodic motion, linear motion etc.

BME-DS-725.3 Familiar about the gearing diagram of lathe, milling, drilling. The students will know about the various gear drives, gear boxes, gear ratio, load carrying capacity and their applications

BME-DS-725.4 Develop, modify and design the various machine tools able to evaluate cutting forces and tool chatter.

.

Part-A

Unit 1: Introduction

General requirements to machine tools, Machine tool design recommendations, Classification of motions to shape surface, Machine tool drives for rectilinear motion, Periodic motion, reversing motion etc.

Unit 2: Kinematics of Machine Tools

Kinematics or gearing diagram of Lathe, drilling Machine, Milling Machine etc. Main drive and feed drive, principles specification of Machine tool.

Unit 3: Design of Kinematics Scheme

Methods to determine transmission ratios for drives,. Development of Kinematics scheme, minimum of transmission transmission groups, Determination of number of teeth on gears.

Part-B

Unit 4: Speed and Feed Boxes

General requirement Design of gear trains, speed boxes types, speed changing devices Feed boxes characteristics of feed mechanism, types of Rapid traverse mechanisms, variable devices.

Unit 5: Spindle Design and Spindle Bearings

Main requirement, Materials and details of spindle design, Spindle bearings, bearings, types of bearings and their selections, Bearing Materials BED, COLUMNS, TABLES AND WAYS; Materials, typical constructions and design.

Unit 6: Machine Tool Dynamics

Dynamic performance, dynamic and elastic system of Machine, tools. Dynamics of cutting forces, tool chatter.

Text Books:

1. Sen and Bhattacharya, Machine Tools Design., CBS Publishers

MRIRS

2. N.K. Mehta Machine Tool Design, Tata Mc Graw Hill.

Reference Books:

1. N. Acherkan Machine Tool Design, Four Volumes,.Mir Publishers.,
2. S.K. Basu and D.K. Pal, Design of machine tools, Oxford and IBH 51

Weblinks:

https://nptel.ac.in/courses/122104015
https://nptel.ac.in/courses/112103109
https://onlinecourses.nptel.ac.in/noc19_me01/preview

Instructions for setting of Paper Seven questions are to set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each part A and part B (one from each unit). Student needs to attempt two questions out of three questions from each part. Each question will be of 20 marks.

Assessment Tools:

In general parameters for Internal /Continuous Assessment (Theory Courses):

Parameter	Weightage
Two Sessional (Mid-Term)Tests	60%
Assignments	20%
Class Performance	10%
Class Attendance	10%

Theory Course: Total Marks 200
Internal/Continuous Assessment: 100

- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS01	PSO2	PSO3
BME-DS-725.1	3	2	-	3	3	-	2	1	3	1	3	3	3	2	1
BME-DS-725.2	3	3	3	3	3	1	1	1	2	1	-	2	2	3	1
BME-DS-725.3	3	3	3	3	2	-	-	2	1	3	2	3	3	2	2
BME-DS-725.4	3	1	2	-	1	2	3	-	2	3	1	2	2	3	1

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MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH & STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

BME-DS-726: ADDITIVE MANUFACTURING

Periods/week Credits
L: 3 T: 0 P: 0 3
Duration of Examination: 3 Hrs

Max. Marks : 200
Continuous Assessment : 100
End Semester Exam : 100

Prerequisites: BME-DS-304: Manufacturing Processes
Course Type: Domain Specific Elective Course

Course Outcomes: After completion of this course the students will be able to

BME-DS-726.1 Understand the working principle and process parameters of AM techniques
BME-DS-726.2 Explore the applications and suitable material and methodology for fabrication of given component.
BME-DS-726.3 Recognize industrial applications and advancements in AM
BME-DS-726.4 Design and develop new components with intricate geometries

Part-A

Unit 1: Introduction

Introduction, Advantages of Additive Manufacturing Processes, Limitations of Additive Manufacturing Processes, Types of Additive Manufacturing Technologies, Nomenclature of AM Machines, Prototyping, Tooling and Manufacturing, Comparison of AM with conventional manufacturing processes, Classification of Additive Manufacturing Processes

Unit 2: Generalized Additive Manufacturing ProcessChain Software, Design and Quality Aspects of Additive Manufacturing

Introduction, Eight Steps in Additive Manufacturing, Variation from one AM Machine to Another, Maintenance of Equipment, Material Handling Issue, Conclusion Preparation of CAD model, stl files, exchange formats, related issues, concept of DFAM

Unit 3: Materials, Applications, Trends and Advancements in Additive Manufacturing

Additive manufacturing materials, Issues, Hybrid materials; Applications, Trends and Advancements in Additive Manufacturing, Friction additive Manufacturing, AM with conventional manufacturing, AM with Casting, 4 dimensional AM, Allied Processes

Part-B

Unit 4: Additive Manufacturing Processes utilizing Material Jetting and Binder Jetting

Additive Manufacturing Processes utilizing Material Jetting: Materials, Material Processing Fundamentals, Material Jetting Machines, Common processes; Additive Manufacturing Processes utilizing Binder Jetting: Materials, Process Variations, BJ Machines, Common processes

Unit 5: Additive Manufacturing Processes utilizing Sheet Lamination Processes and Directed Energy Deposition Processes

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Additive Manufacturing Processes utilizing Sheet Lamination Processes: Materials, Common processes; Additive Manufacturing Processes utilizing Directed Energy Deposition Processes: General DED Process Description, Material Delivery, DED systems, Process Parameters, Processing-Structure-Properties Relationships, Common Processes

Unit 6: Additive Manufacturing Processes utilizing Vat Photopolymerization, Powder Bed Fusion Processes and Extrusion Based System

Additive Manufacturing Processes utilizing Vat Photopolymerization: Materials, Reaction Rates, Photopolymerization Process Modelling, Scan Patterns, Common processes; Additive Manufacturing Processes utilizing Powder Bed Fusion Processes: Material, Powder Fusion Mechanism, Process Parameters and Modelling, Powder Handling, Common processes; Additive Manufacturing Processes utilizing Extrusion Based System: Basic principles, plotting and Path Control, Bio extrusion, Other Systems, Common processes

Text Books:

1. Additive Manufacturing: Fundamentals and Advancements, M. Srivastava, S. Rathee, S. Maheshwari, T.K. Kundra, CRC Press
2. Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing; B. Stucker, D.W. Rosen, I. Gibson
3. Additive Manufacturing Handbook: Product Development for the Defense Industry; A. B. Badiru, V. V. Valencia, D. Liu; CRC Press

Reference Books:

1. Friction Based Additive Manufacturing Technologies: Principles for Building in Solid State, Benefits, Limitations, and Applications; Srivastava, S. Rathee, S. Maheshwari, T.K. Kundra, CRC Press
2. Rapid Manufacturing; D. Pham, S.S. Dimov; Springer

Weblinks:
https://nptel.ac.in/courses/video/112104204

Instructions for setting of Paper Seven questions are to set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each part A and part B (one from each unit). Student needs to attempt two questions out of three questions from each part. Each question will be of 20 marks.

Assessment Tools:

In general parameters for Internal /Continuous Assessment (Theory Courses):

Parameter	Weightage
Two Sessional (Mid-Term)Tests	60%
Assignments	20%
Class Performance	10%
Class Attendance	10%

Theory Course: Total Marks 200
Internal/Continuous Assessment: 100

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- Two Sessional Tests: 30 Marks Each (Total weighted marks for Sessional Tests: 60)
- Assignments: 20 Marks
- Class Work/ Performance: 10 Marks
- Attendance: 10 Marks

End Semester Exams: 100 Marks

Course Articulation Matrix

CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS01	PSO2	PSO3
BME-DS-726.1	3	-	-	3	-	-	-	-	-	2	-	2	3	3	3
BME-DS-726.2	3	2	2	2	2	2	-	-	-	2	-	2	3	3	1
BME-DS-726.3	-	-	-	3		2	3	-	-	2	1	3	3	3	3
BME-DS-726.4	2	3	-	3	2	2	2	-	-	2	2	2	3	3	2

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INTERDISCIPLINARY SUBJECTS OFFERED BY MECHANICAL DEPARTMENT TO OTHER DEPARTMENTS

Course Code	Title of Course
BME-OE-001	Basics of Mechanical Engineering
BME-OE -002	Energy Audit
BME-OE -003	Quality Control
BME-OE -004	Production Management
BME-OE -005	Rapid prototyping
BME-OE-006	Six Sigma Techniques
BME-OE-007	Robotic Mechanism
BME-OE-008	Fundamentals of MATLAB
BME-OE-009	Operations Research
BME-OE-010	Maintenance Management

(Note: The courses will be designed before being offered and approved by BOS for final approval by Academic Council)

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Appendix A

S.No.	Course Code	Title of Course	Regional	National	Global
1	BPH-106	Physics for Engineers	√	√	
2	BCH-106	Chemistry for Engineers	√	√	
3	BMA-102	Mathematics-1	√	√	
4	BEE-101	Basic Electrical Engineering	√	√	
5	BCS-101	Programming for Problem Solving	√	√	
6	BCS-100	AI for Engineers	√	√	√
7	BME-101A	Engg Graphics & Design	√	√	
8	BPH-151A	Physics lab	√	√	
9	BEE-151A	Basic Electrical Engg lab	√	√	
10	BHM-201	English	√	√	
11	BHM-MC-001	Constitution of India	√	√	
12	BMA-202	Mathematics-2	√	√	
13	BME-102	Workshop/Manufacturing Practices	√	√	
14	BBT-100	Biology for Engineers	√	√	
15	BCH-151A	Chemistry lab	√	√	
16	BCS-151	Programming for Problem Solving lab	√	√	
17	BEE-151A	Basic Electrical Engg lab	√	√	
18	BHM-151	English lab	√	√	
19	BHM-MC-002	EVS	√	√	
20	BME-DS-301A	Engineering Mechanics	√	√	
21	BME-DS-302	Thermodynamics	√	√	
22	BME-DS-303	Fluid Mechanics & Machines	√	√	
23	BME-DS-304	Manufacturing Processes	√	√	
24	BME-DS-351	Engineering Mechanics Lab	√	√	
25	BME-DS-352/	Fluid Mechanics & Machines Lab	√	√	
26	BME-DS-353	CAD Lab	√	√	
27	BHM-320	Universal Human Values	√	√	√
28	DTI-300	Design Thinking and Innovation-I			√

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29	BHM-MC-004	Quantitative Aptitude	√	√	
30	Proj-ME-300A	Summer Internship –I			√
31	BEC-DS-302	Digital Electronics	√	√	
32	BEC-DS-352	Digital Electronics Lab	√	√	
33	BME-DS-311	Basics of Automobile Engineering	√	√	
34	BME-DS-312	Basics of Automobile Engineering Lab	√	√	
35	BME-DS-401	Applied Thermodynamics	√	√	
36	BME-DS-405	Thermal Engineering	√	√	
37	BME-DS-402A	Strength of Materials	√	√	
38	BME-DS-403A	Manufacturing Technology	√	√	
39	BME-DS-404	Material Science Code	√	√	
40	BME-DS-451	Thermal Engineering Lab	√	√	
41	BME-DS-452	Strength of Material Lab	√	√	
42	BME-DS-453	Workshop Technology Lab	√	√	
43	DTI-400	Design Thinking and Innovation-II			√
44	BHM-MC-006	Quantitative Aptitude and Personality Development-I	√	√	
45	BHM-MC-002	Sports & Yoga			√
46	BEC-DS-403	Microcontrollers	√	√	
47	BEC-DS-453	Microcontrollers Lab	√	√	
48	BEE-DS-421	Fundamentals of Electric and Hybrid Vehicles	√	√	
49	BME-DS-412	Electric Vehicle Safety and standard	√	√	
50	BME-DS-501A	Theory of Machines	√	√	
51	BME-DS-551	Theory of Machines Lab	√	√	
52	DTI-500	Design Thinking and Innovation-III			√
53	BHM-MC-008	Quantitaive Aptitude & Personality Development-II	√	√	
54	PROJ-ME-500	Summer Internship-II/ Seminar	√	√	
55	BME-DS-522A	Mechatronics System Controls	√	√	
56	BHM-520	Enterpreneurship and Startup	√	√	
57	HM-506	French-I			√
58	HM-507	German-I			√

MEITS

59	HM-508	Spanish-I			√
60	BEC-DS-510	Digital Signal Processing and its applications	√	√	
61	BEC-DS-551	Digital Signal Processing Lab	√	√	
62	BEE-DS-535	Design Architecture and Control of Electric Vehicle	√	√	
63	BEE-DS-554	Electric Vehicle Simulation lab	√	√	
64	BME-DS-604	Machine Design	√	√	
65	BME-DS-602	Heat Transfer	√	√	
66	BME-DS-652	Heat Transfer Lab	√	√	
67	PROJ-ME-600	Project Phase - I	√	√	
68	BHM-MC-009	Quantitaive Aptitude & Personality Development-III	√	√	
69	HM-606	French-II			√
70	HM-607	German-II			√
71	HM-608	Spanish-II			√
72	BME-DS-603	Robotic Analysis	√	√	
73	BEC-DS-717	Robitics Lab	√	√	
74	BEE-DS-635	Energy Storage and Battery Management System	√	√	
75	BME-DS-612	Electric Vehicle Testing & Validation Lab	√	√	
76	PROJ-ME-700	Project Phase - II/Industrial Project	√	√	
77	BME-DS-703	Industrial Engineering & Operation Research	√	√	
78	BME-DS-702	Industry Automation	√	√	√
79	BEE-DS-751	Industry Automation Lab	√	√	
80	BME-DS-711	Electric Vehicle Charging and Infrastructure	√	√	
81	BME-DS-712	Electric Vehicle Charging Station Lab	√	√	
82	BME-DS-527	Design Thinking	√	√	
83	BME-DS-528	Plastic Technology	√	√	
84	BME-DS-529	Tool Engineering & Design	√	√	
85	BME-DS-626	Fundamental of Robot	√	√	

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86	BME-DS-531	Cooling Towers & Chillers	√	√	
87	BME-DS-532	Refrigeration Systems & Basics of Air-conditioning	√	√	
88	BME-DS-533	Refrigeration Systems & Basics of Air-conditioning Lab	√	√	
89	BME-DS-625	Renewable Energy & Resource Utilization	√	√	
90	BME-DS-627	CNC Technology & Programming	√	√	
91	BME-DS-628	Metrology & Quality Assurance	√	√	
92	BME-DS-629	Digital Manufacturing	√	√	
93	BME-DS-603	Robotic Analysis	√	√	
94	BME-DS-631	Heat Exchangers	√	√	
95	BME-DS-632	Green Building Technologies	√	√	
96	BME-DS-633	Heating Ventilation Air Conditioning (HVAC) system	√	√	
97	BME-DS- 727	Mould and Press Tool Design	√	√	
98	BME-DS-728	Product Design & Development	√	√	
99	BME-DS-729	Computer Aided Design	√	√	
100	BME-DS-702	Industrial Automation	√	√	
101	BME-DS-731	Building Safety, Insulation & Accoustic	√	√	
102	BME-DS-732	Computational Fluid Dynamics	√	√	
103	BME-DS-733	Building Management Systems (BMS) for HVAC	√	√	
104	BME_DS-521	I C Engine	√	√	
105	BME-DS-523	Welding & Forging Technology	√	√	
106	BME-DS-525	Power Plant Engineering	√	√	
107	BME-DS-526	Production Engineering	√	√	
108	BME-DS-622	CAD/CAM	√	√	
109	BME-DS-623	Advanced Strength of Material	√	√	
110	BME-DS-624	Process Planning and Cost Estimation	√	√	
111	BME-DS-626	Fundamental of Robot	√	√	
112	BME-DS-722	Modern Machining Methods	√	√	
113	BME-DS-723	Gas Dynamics & Jet	√	√	

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		Propulsion			
114	BME-DS-724	Mechanical Vibrations	√	√	
115	BME-DS-725	Design of Machine Tools	√	√	
116	BME-DS-726	Additive Manufacturing	√	√	
117	BME-OE-001	Six Sigma Techniques	√	√	
118	BME-OE-002	Maintenance Management	√	√	
119	BME-OE-003	Quality Control	√	√	
120	BME-OE-004	Production Management	√	√	
121	BME-OE-005	Robotic Mechanism Rapid Prototyping	√	√	
122	BME-OE-006	Basics of Mechanical Engineering	√	√	
123	BME-OE-007	Energy Audit	√	√	
124	BME-OE-008	Fundamentals of MATLAB	√	√	√
125	BME-OE-009	Operations Research	√	√	
126	BME-OE-010	Rapid Prototyping	√	√	

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Appendix B

S.No.	Course Code	Title of Course	Employability	Enterpreneurship	Skill Development
1	BPH-106	Physics for Engineers			√
2	BCH-106	Chemistry for Engineers			√
3	BMA-102	Mathematics-1			√
4	BEE-101	Basic Electrical Engineering			√
5	BCS-101	Programming for Problem Solving			√
6	BCS-100	AI for Engineers			√
7	BME-101A	Engg Graphics & Design			√
8	BPH-151A	Physics lab			√
9	BEE-151A	Basic Electrical Engg lab			√
10	BHM-201	English			√
11	BHM-MC-001	Constitution of India			√
12	BMA-202	Mathematics-2			√
13	BME-102	Workshop/Manufacturing Practices			√
14	BBT-100	Biology for Engineers			√
15	BCH-151A	Chemistry lab			√
16	BCS-151	Programming for Problem Solving lab			√
17	BEE-151A	Basic Electrical Engg lab			√
18	BHM-151	English lab			√
19	BHM-MC-002	EVS			√
20	BME-DS-301A	Engineering Mechanics	√		√
21	BME-DS-302	Thermodynamics	√		√
22	BME-DS-303	Fluid Mechanics & Machines	√		√
23	BME-DS-304	Manufacturing Processes	√		√

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24	BME-DS-351	Engineering Mechanics Lab	√		√
25	BME-DS-352/	Fluid Mechanics & Machines Lab	√		√
26	BME-DS-353	CAD Lab	√		√
27	BHM-320	Universal Human Values	√		√
28	DTI-300	Design Thinking and Innovation-I	√		√
29	BHM-MC-004	Quantitative Aptitude	√		√
30	Proj-ME-300A	Summer Internship –I	√		√
31	BEC-DS-302	Digital Electronics	√		√
32	BEC-DS-352	Digital Electronics Lab	√		√
33	BME-DS-311	Basics of Automobile Engineering	√		√
34	BME-DS-312	Basics of Automobile Engineering Lab	√		√
35	BME-DS-401	Applied Thermodynamics	√		√
36	BME-DS-405	Thermal Engineering	√		√
37	BME-DS-402A	Strength of Materials	√		√
38	BME-DS-403A	Manufacturing Technology	√		√
39	BME-DS-404	Material Science Code	√		√
40	BME-DS-451	Thermal Engineering Lab	√		√
41	BME-DS-452	Strength of Material Lab	√		√
42	BME-DS-453	Workshop Technology Lab	√		√
43	DTI-400	Design Thinking and Innovation-II	√		√
44	BHM-MC-006	Quantitative Aptitude and Personality Development-I	√		√
45	BHM-MC-002	Sports & Yoga	√		√
46	BEC-DS-403	Microcontrollers	√		√
47	BEC-DS-453	Microcontrollers Lab	√		√

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48	BEE-DS-421	Fundamentals of Electric and Hybrid Vehicles	√		√
49	BME-DS-412	Electric Vehicle Safety and standard	√		√
50	BME-DS-501A	Theory of Machines	√		√
51	BME-DS-551	Theory of Machines Lab	√		√
52	DTI-500	Design Thinking and Innovation-III	√		√
53	BHM-MC-008	Quantitaive Aptitude & Personality Development-II	√		√
54	PROJ-ME-500	Summer Internship-II/ Seminar	√		√
55	BME-DS-522A	Mechatronics System Controls	√		√
56	BHM-520	Enterpreneurship and Startup		√	
57	HM-506	French-I	√		√
58	HM-507	German-I	√		√
59	HM-508	Spanish-I	√		√
60	BEC-DS-510	Digital Signal Processing and its applications	√		√
61	BEC-DS-551	Digital Signal Processing Lab	√		√
62	BEE-DS-535	Design Architecture and Control of Electric Vehicle	√		√
63	BEE-DS-554	Electric Vehicle Simulation lab	√		√
64	BME-DS-604	Machine Design	√		√
65	BME-DS-602	Heat Transfer	√		√
66	BME-DS-652	Heat Transfer Lab	√		√
67	PROJ-ME-600	Project Phase - I	√		√
68	BHM-MC-009	Quantitaive Aptitude & Personality Development-III	√		√
69	HM-606	French-II	√		√
70	HM-607	German-II	√		√

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71	HM-608	Spanish-II	√		√
72	BME-DS-603	Robotic Analysis	√		√
73	BEC-DS-717	Robitics Lab	√		√
74	BEE-DS-635	Energy Storage and Battery Management System	√		√
75	BME-DS-612	Electric Vehicle Testing & Validation Lab	√		√
76	PROJ-ME-700	Project Phase - II/Industrial Project	√		√
77	BME-DS-703	Industrial Engineering & Operation Research	√		√
78	BME-DS-702	Industry Automation	√		√
79	BEE-DS-751	Industry Automation Lab	√		√
80	BME-DS-711	Electric Vehicle Charging and Infrastructure	√		√
81	BME-DS-712	Electric Vehicle Charging Station Lab	√		√
82	BME-DS-527	Design Thinking	√		√
83	BME-DS-528	Plastic Technology	√		√
84	BME-DS-529	Tool Engineering & Design	√		√
85	BME-DS-626	Fundamental of Robot	√		√
86	BME-DS-531	Cooling Towers & Chillers	√		√
87	BME-DS-532	Refrigeration Systems & Basics of Air-conditioning	√		√
88	BME-DS-533	Refrigeration Systems & Basics of Air-conditioning Lab	√		√
89	BME-DS-625	Renewable Energy & Resource Utilization	√		√
90	BME-DS-627	CNC Technology & Programming	√		√
91	BME-DS-628	Metrology & Quality Assurance	√		√
92	BME-DS-629	Digital Manufacturing	√		√
93	BME-DS-603	Robotic Analysis	√		√
94	BME-DS-	Heat Exchangers	√		√

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	631				
95	BME-DS-632	Green Building Technologies	√		√
96	BME-DS-633	Heating Ventilation Air Conditioning (HVAC) system	√		√
97	BME-DS-727	Mould and Press Tool Design	√		√
98	BME-DS-728	Product Design & Development	√		√
99	BME-DS-729	Computer Aided Design	√		√
100	BME-DS-702	Industrial Automation	√		√
101	BME-DS-731	Building Safety, Insulation & Accoustic	√		√
102	BME-DS-732	Computational Fluid Dynamics	√		√
103	BME-DS-733	Building Management Systems (BMS) for HVAC	√		√
104	BME_DS-521	I C Engine	√		√
105	BME-DS-523	Welding & Forging Technology	√		√
106	BME-DS-525	Power Plant Engineering	√		√
107	BME-DS-526	Production Engineering	√		√
108	BME-DS-622	CAD/CAM	√		√
109	BME-DS-623	Advanced Strength of Material	√		√
110	BME-DS-624	Process Planning and Cost Estimation	√		√
111	BME-DS-626	Fundamental of Robot	√		√
112	BME-DS-722	Modern Machining Methods	√		√
113	BME-DS-723	Gas Dynamics & Jet Propulsion	√		√
114	BME-DS-724	Mechanical Vibrations	√		√
115	BME-DS-725	Design of Machine Tools	√		√
116	BME-DS-726	Additive Manufacturing	√		√
117	BME-OE-001	Basics of Mechanical Engineering	√		√
118	BME-OE-	Energy Audit	√		√

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	002				
119	BME-OE-003	Quality Control	√		√
120	BME-OE-004	Production Management	√		√
121	BME-OE-005	Rapid Prototyping	√		√
122	BME-OE-006	Six Sigma Techniques	√		√
123	BME-OE-007	Robotic Mechanism	√		√
124	BME-OE-008	Fundamentals of MATLAB	√		√
125	BME-OE-009	Operations Research	√		√
126	BME-OE-010	Maintenance Management	√		√

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Appendix C

S.No.	Course Code	Title of Course	Environment Sustainability	Gender Equality	Professional Ethics	Human Values
1	BHM-MC-002	EVS	√			
2	BHM-320	Universal Human Values		√	√	√
3	BEE-DS-421	Fundamentals of Electric and Hybrid Vehicles	√			
4	BME-DS-412	Electric Vehicle Safety and standard	√			
5	BEE-DS-535	Design Architecture and Control of Electric Vehicle	√			
6	BEE-DS-554	Electric Vehicle Simulation lab	√			
7	BEE-DS-635	Energy Storage and Battery Management System	√			
8	BME-DS-612	Electric Vehicle Testing & Validation Lab	√			
9	BME-DS-711	Electric Vehicle Charging and Infrastructure	√			
10	BME-DS-712	Electric Vehicle Charging Station Lab	√			
11	BME-DS-625	Renewable Energy Resource & Utilization	√			
12	BME-OE-002	Energy Audit	√			
13	BHM- MC-002	Sports & Yoga		√		

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