Curriculum
2021

B. Tech.
Mechanical Engineering
(Duration of Study : 4 years)

GMRIT
Training Tomorrow's Engineers Today

Department of Mechanical Engineering
GMR Institute of Technology
Rajam, Andhra Pradesh
(An Autonomous Institute Affiliated to JNTU Kakinada, AP)
NBA Accredited and NAAC Accredited

Vision of GMRIT

- To be among the most preferred institutions for engineering and technological education in the country
- An institution that will bring out the best from its students, faculty and staff – to learn, to achieve, to compete and to grow – among the very best
- An institution where ethics, excellence and excitement will be the work religion, while research, innovation and impact, the work culture

The Mission of GMRIT

- To turnout disciplined and competent engineers with sound work and life ethics
- To implement outcome based education in an IT-enabled environment
- To encourage all-round rigor and instill a spirit of enquiry and critical thinking among students, faculty and staff
- To develop teaching, research and consulting environment in collaboration with industry and other institutions

Department Vision

To be a preferred department of learning for students and teachers alike, with dual commitment to Academics & Research, serving students in an atmosphere of innovation and critical thinking

Department Mission

- To provide an adoptable education for the graduates in preparing them for a rewarding career to develop academics and research in collaboration with industry and other institutions in the field of Mechanical Engineering.
- To prepare the students as thinking professionals and good citizens who will be able to apply their knowledge critically and innovatively in solving contemporary professional and social problems.

Programme Educational Objectives (PEOs)

Graduates in Mechanical Engineering, a few years after graduation would

I. Graduates with ability to solve core engineering problems through continuous self-paced learning in tune with changing technologies

II. Reinforce engineering skills, critical thinking and problem-solving skills in professional engineering practices and deal with socio-economical, technical and business challenges

III. Nurture professionalism with soft skills, managerial & leadership skills and ethical values.

Programme Outcomes (POs):

Engineering graduate will be able to

PO 1 Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems (Engineering knowledge)

PO 2 Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences (Problem analysis)

PO 3 Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations (Design/development of solutions)

PO 4 Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (Conduct investigations of complex problems)

PO 5 Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations (Modern tool usage)

PO 6 Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (The engineer and society)

PO 7 Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development (Environment and sustainability)

PO 8 Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice (Ethics)

PO 9 Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (Individual and teamwork)

PO 10 Communicate effectively on complex 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 (Communication)

PO 11 Demonstrate knowledge and understanding of the 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 (Project management and finance)

PO 12 Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (Life-long learning)

Programme Specific Outcomes (PSOs):

PSO 1 Demonstrate the knowledge and application of Geometric modelling, Design, Analysis and Simulation of Mechanical Engineering Systems (Program Specific)

PSO 2 Ability to apply the advanced concepts of thermal and manufacturing engineering in solving industry problems (Program Specific)

Mapping:

Mapping of PEOs with the expected Program outcomes

The Mechanical Engineering Program Outcomes leading to achievement of Programme Educational Objectives are summarized in the following Table.

Programme Educational Objectives (PEOs)	Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)													
	Pos												PSOs	
	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO1 2	PSO1	PSO2
I	3	2	1	1	2	1	3	2	1	1	2	3	1	1
II	2	3	3	3	2	3	2	2	1	1	2	2	3	3
III	1	1	2	1	2	3	3	3	3	3	3	2	3	2

3 = Strong, 2 = Moderate & 1 = Weak

Department of Mechanical Engineering

Minimum Credits to be Earned: 160 (for Regular Students)
127 (for Lateral Entry Students)

No.	Course Code	Course	POs	Contact Hours			
				L	T	P	C
First Semester							
1	21HSX01	Communicative English	10, 12	2	-	-	2
2	21MAX01	Engineering Mathematics I	1	3	-	-	3
3	21PYX01/ 21CYX01	Engineering Physics / Engineering Chemistry	1 / 1	3/3	-	-	3/3
4	21BEX01/ 21BEX06	Basics of Engineering /IT Workshop	1,12/1,12	3/ -	-	-/ 3	3/1.5
5	21BEX02	Problem Solving and Programming Skills	1, 12	3	-	-	3
6	21BEX03	Problem Solving and Programming Skills Lab	4	-	-	3	1.5
7	21BEX04/ 21BEX05	Engineering Drawing / Engineering Workshop	1,5,10/1,9,10	-	-	3/3	1.5/1.5
8	21PYX02/ 21CYX02	Engineering Physics Lab / Engineering Chemistry Lab	4/4	-	-	3/3	1.5/1.5
9	21HSX02	Communicative English Lab	10,12	-	-	3/-	1.5/-
			Total	**14/11**	**-**	**12/12**	**20/17**
Second Semester							
1		Language Elective	10,12	2	-	-	2
2	21MAX02	Engineering Mathematics II	1	3	-	-	3
3	21CYX01/ 21PYX01	Engineering Chemistry / Engineering Physics	1/1	3/3	-	-	3/3
4	21BEX01/ 21BEX06	Basics of Engineering / IT Workshop	1,12/1,12	-/3	-	3/-	1.5/3
5	21BEX07	Python Programming	1,12	3	-	-	3
6	21BEX08	Python Programming Lab	4	-	-	3	1.5
7	21BEX05/ 21BEX04	Engineering Workshop / Engineering Drawing	1,9,10/ 1,5,10	-	-	3/3	1.5/1.5
8	21CYX02/ 21PYX02	Engineering Chemistry Lab / Engineering Physics Lab	4/4	-	-	3/3	1.5/1.5
9	21HSX02	Communicative English Lab	10,12	-	-	-/3	-/1.5
			Total	**11/14**	**-**	**12/12**	**17/20**
Third Semester							
1	21ME301	Engineering Materials and Manufacturing Technology	1,2,3,4	3	-	2	4
2	21ME302	Computer Aided Machine Drawing	1,5,10,PSO_1	3	-	2	4
3	21ME303	Engineering Mechanics	1,2,3	3	-	-	3
4	21ME304	Fluid Mechanics and Hydraulic Machines	1,2,3,PSO_1	3	-	-	3
5	21ME305	Kinematics of Machinery	1,2,3	3	-	-	3
6	21ME306	Thermodynamics	1,2,3,PSO_1	3	-	-	3
7	21ME307	Fluid Mechanics and Hydraulic Machines Lab	1,2,10	-	-	3	1.5
8	21MA305	Computational Mathematics Lab	1,4,10	-	-	3	1.5
9	21ESX01	Employability Skills I	1,2,5,8,10,12	-	-	2	-
10	21HSX11	CC & EC Activities I	6,7,9,10	-	-	1	-
			Total	**18**	**-**	**13**	**23**
Fourth Semester							
1	21IT306	Object Oriented Programming through Java	1,2,3,4,5	3	-	2	4
2	21ME401	Applied Thermodynamics	1,2,3,7,PSO_2	3	-	-	3
3	21ME402	Dynamics of Machinery	1,2,3	3	-	-	3
4	21ME403	Metal Cutting and Machine Tools	1,2,3	3	-	-	3
5	21ME404	Mechanics of Solids	1,2,3,10	3	-	-	3
6	21ME405	Thermal Engineering Lab	1,2,3,10,12,PSO_2	-	-	3	1.5
7	21ME406	Mechanics of Solids Lab	1,2,3,10	-	-	3	1.5
8	21ESX01	Employability Skills I	1,2,5,8,10,12	-	-	2	2
9	21HSX11	CC & EC Activities I	6,7,9,10	-	-	1	1
			Total	**15**	**-**	**11**	**22**

Fifth Semester							
1	21ME501	Computer Aided Design and Manufacturing	1,2,5,9,10,PSO_1	3	-	2	4
2	21ME502	Design of Machine Members I	1,2,3, PSO_1	3	-	-	3
3	21ME503	Steam and Gas Turbines	1,2,3,6,7,PSO_2	3	-	-	3
4	21ME504	Mechanical Measurements and Metrology	1,2,3,4,10	3	-	2	4
5		Elective I (Professional Elective)		3	-	-	3
6		Elective II (Open Elective I)		3	-	-	3
7	21ME507	Metal Cutting and Machine Tools Lab	1,2,3,4,PSO_1,PSO_2	-	-	3	1.5
8	21TPX01	Term Paper	1,4,10,12	-	-	3	1.5
9	21ESX02	Employability Skills II	1,2,5,8,10,12	-	-	2	-
10	21HSX12	CC & EC Activities II	6,7,9,10	-	-	1	-
11	21SIX01	Summer Internship #I	1,2,8,10,12	-	-	-	1
			Total	**18**	**-**	**13**	**24**
Sixth Semester							
1	21ME601	Design of Machine Members II	1,2,3,PSO_1	3	-	-	3
2	21ME602	Finite Element Methods	1,2,3,PSO_1	3	-	-	3
3	21ME603	Heat Transfer	1,2,3,7, PSO_1, PSO_2	3	-	-	3
4		Elective III (Professional Elective)		3	-	2	4
5		Elective IV (Open Elective II)		3	-	-	3
6	21ME606	Heat Transfer Lab	1,2,3,4,7,10	-	-	3	1.5
7	21MPX01	Mini Project	All POs	-	-	3	1.5
8	21ESX02	Employability Skills II	1,2,5,8,10,12	-	-	2	2
9	21HSX12	CC & EC Activities II	6,7,9,10	-	-	1	1
10	21ATX01	Environmental Studies	1,6,7,12	-	-	-	-
11	21ATX02	Professional Ethics and Human Values	**--**	-	-	-	-
12	21ATX--	Audit Course	**--**	-	-	-	-
			Total	**15**	**-**	**11**	**22**
Seventh Semester							
1	21PWX01	Project Work	All POs	-	-	16	8
2		Elective V (Professional Elective)		3	-	-	3
3		Elective VI (Professional Elective)		3	-	-	3
4		Elective VII (Open Elective III)		3	-	-	3
5	21SIX02	Summer Internship #II	1,2,5,6,10,12	-	-	-	1
			Total	**9**	**-**	**16**	**18**
Eighth Semester							
1	21FIX01	Full Semester Internship (FSI)	1,2,5,8,9,10, PSO_1,PSO_2	-	-	-	8
2		Elective VIII (Professional Elective)		-	-	-	3
3		Elective IX (Open Elective IV)		-	-	-	3
			Total	**-**	**-**	**-**	**14**
			Total Credits	**100**	**-**	**88**	**160**

List of Electives

No.	Course Code	Course	POs	Contact Hours			
				L	T	P	C
Language Electives							
1	21HSX03	Advanced Communicative English	10,12	2	-	-	2
2	21HSX04	Communicative German		2	-	-	2
3	21HSX05	Communicative French		2	-	-	2
4	21HSX06	Communicative Japanese		2	-	-	2
5	21HSX07	Communicative Spanish		2	-	-	2
6	21HSX08	Communicative Korean		2	-	-	2
7	21HSX09	Communicative Hindi		2	-	-	2
Elective I : Career Path I, II, III and Other Core Electives							
1	21MEC11	Automotive Informatics**(Automotive Electronics Career Path)**	1,5,6	3	-	-	3
2	21MEC21	Fundamentals of Digital Manufacturing Science**(Digital Manufacturing Career Path)**	1,5,PSO_2	3	-	-	3
3	21MEC31	Data Analytics & Operations Management**(Smart Management Analytics Career Path)**	1,2,11	3	-	-	3
4	21ME005	Alternate Fuels and Emission Control in Automotives	1,6,7	3	-	-	3
5	21ME006	Industrial Robotics and Applications	1,2,3, PSO_1	3	-	-	3
6	21ME007	Nontraditional Machining and Forming Processes	1,2,PSO_2	3	-	-	3
7		MOOCs		3	-	-	3
Elective II: Open Elective I							
1	21CE001	Disaster Management	2,7	3	-	-	3
2	21EE001	Electrical Installation, Safety and Auditing	2,3,6,8	3	-	-	3
3	21ME001	Fundamentals of Optimization Techniques	1,2	3	-	-	3
4	21EC001	Sensors for Engineering Applications	1	3	-	-	3
5	21CS001	Fundamentals of Artificial Intelligence	1,2,3	3	-	-	3
6	21CH001	Energy Conversion and Storage Devices	1,3,6,7	3	-	-	3
7	21IT001	Fundamentals of Multimedia	1,5,7	3	-	-	3
8	21BS001	Nano Materials and Technology	1,12	3	-	-	3
Elective III : Career Path I, II, III and Other Core Electives							
1	21MEC12	Sensors & Actuators for Automotive Electronics **(Automotive Electronics Career Path)**	1,4,10,PSO_2	3	-	2	4
2	21MEC22	Artificial Intelligence & Robotics **(DigitalManufacturing Career Path)**	2,5,12	3	-	2	4
3	21MEC32	Smart Supply Chain Analytics **(Smart Management Analytics Career Path)**	1,2,3,5	3	-	2	4
4	21ME008	Additive Manufacturing	1,2,3,PSO_2	4	-	-	4
5	21ME009	Mechatronics	1,2,3,4,9,PSO_1	4	-	-	4
6	21ME010	Computational Fluid Dynamics	1,2,3,4,5	4	-	-	4
7		MOOCs		3	-	-	3
Elective IV : Open Elective II							
1	21CE002	Air Pollution and Environmental Impact Assessment	6,7,12	3	-	-	3
2	21EE002	Renewable Energy sources	2,7	3	-	-	3
3	21ME002	Principles of Entrepreneurship	1,11	3	-	-	3
4	21EC002	Electronics for Agriculture	1,2	3	-	-	3
5	21CS002	Fundamentals of Machine Learning	2,3	3	-	-	3
6	21CH002	Industrial Safety and Hazard Management	1,2,3,6,8	3	-	-	3
7	21IT002	Fundamentals of Cloud Computing	1,7	3	-	-	3
8	21BS002	Advanced Numerical Techniques	1,2	3	-	-	3
9	21BS003	Functional Materials and Applications	1,7	3	-	-	3
Elective V : Career Path I, II, III and Other Core Electives							
1	21MEC13	Automotive Instrumentation and Diagnostics **(Automotive Electronics Career Path)**	1,2,5	3	-	-	3
2	21MEC23	3D Printing **(Digital Manufacturing Career Path)**	1,5,PSO_2	3	-	-	3
3	21MEC33	Quality Assurance & Reliability Engineering for Sustainability **(Smart Management Analytics Career Path)**	1,3,5	3	-	-	3
4	21ME011	Automobile Engineering	1,6,7	3	-	-	3
5	21ME012	Design for Manufacturing	1,2,7,12,PSO_2	3	-	-	3

6	21ME013	Operations Research	1,2,3,5	3	-	-	3
7		MOOCs		3	-	-	3
Elective VI							
1	21ME014	Refrigeration and Air Conditioning	1,2,3,7	3	-	-	3
2	21ME015	Industrial IOT for Manufacturing	1,2, PSO_1,PSO_2	3	-	-	3
3	21ME016	Quality Engineering	1,10,11,12	3	-	-	3
4		MOOCs		3	-	-	3
Elective VII: Open Elective III							
1	21CE003	Solid Waste Management	3,7,12	3	-	-	3
2	21EE003	Fundamentals of Electrical Vechicle Technology	2,3,12	3	-	-	3
3	21ME003	Industrial Engineering and Management	1,11	3	-	-	3
4	21EC003	Interfacing & Programming with Arduino	1,2	3	-	-	3
5	21CS003	Data Science for Engineering Applications	2,3,4	3	-	-	3
6	21CH003	Industrial Ecology for Sustainability Development	2,6,7	3	-	-	3
7	21IT003	Fundamentals of Mobile Computing	1,7	3	-	-	3
8	21BS004	Advanced Materials of Renewable Energy	1,7	3	-	-	3
9	21BS005	Applied Linear Algebra for Engineers	1,12	3	-	-	3
Elective VIII							
1	21ME017	Power Plant Engineering	1,2,3,6,7	-	-	-	3
2	21ME018	Supply Chain Management	1,2,5,10,11,12	-	-	-	3
3	21ME019	Industrial Tribology	1,2,3,12	-	-	-	3
4		MOOCs		-	-	-	3
Elective IX: Open Elective IV							
1	21CE019	Green Buildings	1,7,12	-	-	-	3
2	21EE017	Sustainable Energy	1,2,12	-	-	-	3
3	21ME004	Total Quality Management	1,11	-	-	-	3
4	21EC011	Communication Technologies	1,2	-	-	-	3
5	21CS020	Applications of Artificial Intelligence	2,3,6,7	-	-	-	3
6	21CH016	Green Technologies	1,6,7	-	-	-	3
7	21IT015	Human Computer Interaction	1,7	-	-	-	3
8	21BS006	Handling of Industrial Waste and Waste water	1,7	-	-	-	3
Audit Course							
1	21AT001	Communication Etiquette in Workplaces					
2	21AT002	Contemporary India: Economy, Policy and Society					
3	21AT003	Design The Thinking					
4	21AT004	Ethics and Integrity					
5	21AT005	Indian Heritage and Culture					
6	21AT006	Intellectual Property Rights and Patents					
7	21AT007	Introduction to Journalism					
8	21AT008	Mass Media Communication					
9	21AT009	Science, Technology and Development					
10	21AT010	Social Responsibility					
11	21AT011	The Art of Photography and Film Making					
12	21AT012	Gender Equality for Sustainability					
13	21AT013	Women in Leadership					
14	21AT014	Introduction to Research Methodology					
15	21AT015	Climate Change and Circular Economy					

B.Tech. (Honors)							
Domain I-Automobile Technology and Systems							
1	21MEH11	Alternative Energy Sources for Automobiles	1,7	4	-	-	4
2	21MEH12	Automobile body and Chassis Systems	1,6,7	4	-	-	4
3	21MEH13	Automotive Transmission Systems	1,2,3	4	-	-	4
4	21MEH14	Vehicle Aero Dynamics	1,3,7	4	-	-	4
Domain II- Application of Vibro-dynamics and lubrication in Modern Engineering							
1	21MEH21	Dynamics of Systems	1,2	4	-	-	4
2	21MEH22	Mechanical Vibrations	1,2,PSO_1	4	-	-	4
3	21MEH23	Modern Concepts of Engineering Design	1,2,4,5,PSO_1	4	-	-	4
4	21MEH24	Theory of Lubrication	1,2	4	-	-	4
Domain III-Manufacturing Automation and Inspection							
1	21MEH31	Welding Technology	1,5,PSO_1	4	-	-	4
2	21MEH32	Precision Engineering	1,2,8	4	-	-	4
3	21MEH33	Automation in Manufacturing	1,2,PSO_2	4	-	-	4
4	21MEH34	Non-Destructive Testing Methods	1,PSO_2	4	-	-	4
Domain IV-Production & Operations Strategy							
1	21MEH41	Maintenance Engineering	1,5,12	4	-	-	4
2	21MEH42	Production Operations and Management	1,5,11	4	-	-	4
3	21MEH43	Advanced Assessment systems of Industrial Processes	1,2,3,4,11	4	-	-	4
4	21MEH44	Enterprise Resource Planning	1,6,9,11	4	-	-	4

B.Tech. (Minors)							
Energy Science & Technology							
1	21CHM11	Foundation of Energy Science and Technology	1,2,3,5,7,12	4	-	-	4
2	21CHM12	Energy Generation from Waste	1,2,3,4,5	4	-	-	4
3	21CHM13	Energy Storage Systems	1,2,3,6,7	4	-	-	4
4	21CHM14	Hydrogen Energy and Fuel Cells	1,2,3,7	4	-	-	4
Nano Science & Technology							
1	21CHM21	Introduction and Characterization of Nano Materials	1,2,3,7	4	-	-	4
2	21CHM22	Carbon NanoStructures and Applications	1,3,4,5	4	-	-	4
3	21CHM23	Energy, Environment & Biomedical Nanotechnology	1,2,3,7	4	-	-	4
4	21CHM24	Industrial Applications of Nano Technology	2,3,5,7	4	-	-	4
Environment Engineering							
1	21CEM11	Watershed Engineering	6,7	4	-	-	4
2	21CEM12	Industrial Pollution Control and Engineering	3,6,7,12	4	-	-	4
3	21CEM13	Solid and Hazardous Waste Management	1,3,6,7	4	-	-	4
4	21CEM14	Ecology and Environmental Assessment	1,3,6,7	4	-	-	4
Artificial Intelligence & Machine Leaning							
1	21CSM11	Fundamentals of AI & Machine Learning	1,12	4	-	-	4
2	21CSM12	Feature Engineering for Machine Learning	1,2,3	4	-	-	4
3	21CSM13	Exploratory Data Analytics	1,4	4	-	-	4
4	21CSM14	Deep Learning	1,2,4	4	-	-	4
Cyber Security							
1	21CSM21	Fundamentals of Security	1,2	4	-	-	4
2	21CSM22	Management of Information Security	3,6,7	4	-	-	4
3	21CSM23	Cyber Security	1,3,4	4	-	-	4
4	21CSM24	Cloud Security	2,3	4	-	-	4
Data Science & Analytics							
1	21CSM31	Data Cleaning	2,3,4	4	-	-	4
2	21CSM32	Data Engineering	1,2,3,4	4	-	-	4
3	21CSM33	Text Analytics	1,2,4	4	-	-	4
4	21CSM34	Social Network and Semantic Analysis	2,4	4	-	-	4
Computer Systems Programming							
1	21CSM41	Programming Fundamentals	1,2,3	4	-	-	4
2	21CSM41	Data Structures & Algorithms	1,2,3,4	4	-	-	4
3	21CSM41	Fundamentals of Databases	1,4	4	-	-	4
4	21CSM41	Fundamentals of Computer Networks & Operating Systems	1,2,3	4	-	-	4

Digital IC Design							
1	21ECM11	Fundamentals of VLSI Design	1,2,3	4	-	-	4
2	21ECM12	Digital Design using HDL	1,2,3	4	-	-	4
3	21ECM13	FPGA Technology	1,2	4	-	-	4
4	21ECM14	Analog and Mixed Signal Design	1,2	4	-	-	4
Industrial Automation							
1	21ECM21	Microcontrollers and Interfacing	1,2,3	4	-	-	4
2	21ECM22	Sensors and Data Acquisition System	1,2	4	-	-	4
3	21ECM23	Fundamentals of Labview	1,2	4	-	-	4
4	21ECM24	Medical Robotics	1,2,3	4	-	-	4
Communications and Networking							
1	21ECM31	Principles of communications	1,2	4	-	-	4
2	21ECM32	Coding Theory and Practice	1,2	4	-	-	4
3	21ECM33	Ad-hoc and wireless sensor Networks	1,2,3	4	-	-	4
4	21ECM34	Fundamentals of Multimedia Networking	1,2,3	4	-	-	4
Avionics							
1	21ECM41	Principles of Aerodynamics	1,2	4	-	-	4
2	21ECM42	Aircraft Electrical Systems	1,2	4	-	-	4
3	21ECM43	Aircraft Instrument Systems	1,2	4	-	-	4
4	21ECM44	Aircraft Communication and Navigational systems	1,2	4	-	-	4
Geographic Information System							
1	21ECM51	Sensors and Sensing Technology	1,2	4	-	-	4
2	21ECM52	Geographic Information Systems	1,2	4	-	-	4
3	21ECM53	Digital Image Processing	1,2	4	-	-	4
4	21ECM54	Lidar Systems	1,2	4	-	-	4
Electric Vehicles Technology							
1	21EEM11	Introduction to Electric Vehicles Technologies	2,3	4	-	-	4
2	21EEM12	Electrical Drives and Controllers for Electric Vehicles	2,3	4	-	-	4
3	21EEM13	Charging Technology in Electric Vehicles	2,3	4	-	-	4
4	21EEM14	Computer Vision in Electric Vehicles	2,3	4	-	-	4
Smart City Management							
1	21EEM21	Fundamentals of Smart City	2,3	4	-	-	4
2	21EEM22	Smart City Infrastructure	2,3,5,6,7,11	4	-	-	4
3	21EEM23	Computational Methods for Smart City Management	3,5	4	-	-	4
4	21EEM24	Communication Technologies and Mobility for smart city	2,3	4	-	-	4
Industrial Applications and Control							
1	21EEM31	Modelling and Simulations of Industrial Applications	2,3	4	-	-	4
2	21EEM32	Industrial Sensors and Actuators	2,3	4	-	-	4
3	21EEM33	Programmable Logic Controllers	2,3	4	-	-	4
4	21EEM34	Control Design for Industrial Applications	2,3	4	-	-	4
Cloud Application Development							
1	21ITM11	Introduction to Cloud Computing	6,7,12	4	-	-	4
2	21ITM12	Introduction to Web Development with HTML, CSS, JavaScript	1,2,3,9,12	4	-	-	4
3	21ITM13	Developing Cloud Native Applications	5,8,10	4	-	-	4
4	21ITM14	Developing Cloud Apps with Node.js and React	5,8,10	4	-	-	4

21HSX01 Communicative English

(Common to all B Tech Programmes) **2 0 0 2**

Course Outcomes

1. Develop effective listening skills for better comprehension of English spoken in different social and workplace contexts.
2. Compose speech clearly on a specific topic using appropriate language in informal discussions
3. Explain the implicit and explicit meanings of a text while reading
4. Summarize the texts of reading and listening based on comprehension
5. Construct sentences using proper grammatical sentence structures
6. Choose and use the appropriate vocabulary, phrases in different contexts

COs – POs Mapping

Cos	PO10	PO12
1	3	1
2	3	1
3	3	1
4	3	1
5	3	1
6	3	1

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Listening: Identifying the topic, the context and specific pieces of information by listening to short audio texts and answering a series of questions about main idea and supporting ideas.
Speaking: Asking and answering general questions on familiar topics such as home, family, work, studiesand interests; introducing oneself and others.
Reading: Skimming to get the main idea of a text; scanning to look for specific pieces of information.
Writing: Beginnings and endings of paragraphs - introducing the topic, summarizing the main idea and/orproviding a transition to the next paragraph.
Grammar and Vocabulary: Content words and function words; word forms: verbs, nouns, adjectives and adverbs; nouns: countables and uncountables; singular and plural; basic sentence structures; simple question - wh-questions; word order in sentences.

Poem: Once upon a time by Gabriel Okara

15 Hours

Unit II

Listening: Listening for global comprehension and summarizing what is listened to.
Speaking: Discussing specific topics in pairs or small groups and reporting what is discussed
Reading: Identifying sequence of ideas; recognizing verbal techniques that help to link the ideas in a paragraph together
Writing: Paragraph writing (specific topics) using suitable cohesive devices; mechanics of writing - punctuation, capital letters.
Grammar and Vocabulary: Cohesive devices - linkers, sign posts and transition signals; use of articles and zero article; prepositions.

Short-story: Next Sunday by R.K. Narayan

15 Hours

Unit III

Listening: Making predictions while listening to conversations/ transactional dialogues without video; listeningwith video.
Speaking: Role plays for practice of conversational English in academic contexts (formal and informal) - askingfor and giving information/directions.
Reading: Reading a text in detail by making basic inferences - recognizing and interpreting specific contextclues; strategies to use text clues for reading comprehension
Writing: Summarizing - identifying main idea/s and rephrasing what is read; avoiding redundancies andrepetitions; introducing the structure of essay writing.
Grammar and Vocabulary: Verbs - tenses; subject-verb agreement; direct and indirect speech, reporting verbsfor academic purposes

Speech: The fringe benefits of failure (Harvard inaugural address) by J. K. Rowlings

15 Hours

Unit IV

Listening: Identifying key terms, understanding concepts and answering a series of relevant questions that testcomprehension.

Speaking: Formal oral presentations on topics from academic contexts -without the use of PPT slides.

Reading: Studying the use of graphic elements in texts to convey information, revealtrends/patterns/relationships, communicate processes or display complicated data.

Writing: Information transfer; describe, compare, contrast, identify significance/trends based on informationprovided in figures/charts/graphs/tables.

Grammar and Vocabulary: Quantifying expressions - adjectives and adverbs; comparing and contrasting; degrees of comparison; use of antonyms; Editing short texts identifying and correcting common errors in grammar and usage.

Essay: How to read a book? by Virginia Woolf

15 Hours

Total: 60 Hours

Textbook (s)

1. *English All Round: Communication Skills for Undergraduate learners*, Vol.1,Published by Orient BlackSwan, 2019

Reference (s)

1. Chase, Becky Tarver. *Pathways:Listening, Speaking and Critical Thinking.*Heinley ELT; 2ndEdition, 2018.
2. Skillful Level 2 Reading & Writing Student's Book Pack (B1) MacmillanEducational.
3. Hewings, Martin.*Cambridge Academic English (B2)*. CUP, 2012. (Student Book, Teacher ResourceBook, CD & DVD)
4. Bailey, Stephen. *Academicwriting: A handbook for international students*.Routledge, 2014
5. Dhanavel.S.P. *English and Communication Skills for Students of Science and Engineering.* OrientBlackswan, 2009.

Web resource(s)

Grammar/Listening/Writing

1. 1-language.com
2. www.5minuteenglish.com
3. www.englishpractice.com

Grammar/Vocabulary

4. English Language Learning online
5. www.bbc.co.uk/learningenglish
6. www.better-english.com
7. www.nonstopenglish.com
8. www.vocabulary.com

Reading

9. www.usingenglish.com
10. www.englishclub.com
11. www.english-online.at

Listening

12. learningenglish.voanews.com
13. www.englishmedialab.com

Speaking

14. www.talkenglish.com
15. BBC Learning English – Pronunciation tips
16. Merriam-Webster – Perfect pronunciation Exercises

All Skills

17. www.englishclub.com
18. www.world-english.org
19. learnenglish.britishcouncil.org

Online Dictionaries

20. Cambridge dictionary online
21. MacMillan dictionary
22. Oxford learner's dictionaries

21MAX01 Engineering Mathematics I

(Common to all B. Tech. Programmes)

3 0 0 3

Course Outcomes

1. Find the solution of system of linear equations, eigen values and eigen vectors
2. Identify the nature of the quadratic form using matrix theory
3. Classify and solve first and higher order ordinary differential equations with constant coefficients
4. Apply the knowledge of Mean value theorems, Maxima and Minima of functions of several variables
5. Analyze the characteristics to trace the curve
6. Adapt methods for measuring lengths, volumes, surface area of an object and also the procedure to transformchange of variables and order of integration

COs – POs Mappings

COs	PO1
1	3
2	3
3	3
4	3
5	3
6	3

3- Strongly linked | 2-Moderately linked | 1-Weakly linked

Unit I
Matrices

Rank-Echelon form, Normal form, Solution of Linear System of equations –Gauss Elimination Method and Gauss Jordan Method
Eigen values and Eigen vectors – Properties (without proofs), Cayley-Hamilton Theorem (without proof) - Inverseand powers of a matrix
Quadratic forms- Reduction of quadratic form to canonical form using orthogonal transformation – Rank, indexand signature, Nature of Quadratic form

LU-Decomposition Method

15 Hours

Unit II
Differential Equations

Differential equations of first order and first degree–exact and reducible to exact, Newton's Law of cooling, Lawof natural growth and decay, orthogonal trajectories
Linear differential equations of higher order with constant coefficients with RHS term of the type e^{ax}, sin ax, cos ax polynomials in x, (x), $x^m V(x)$

Problems related to LCR circuits

15 Hours

Unit III
Curve tracing and Functions of Several Variables

Curve tracing-Cartesian, Polar and Parametric curves
Functions of several variables-Partial differentiation, Taylor's theorem (generalized Mean Value theorem-without proof), Jacobian, Functional dependence, Maxima and Minima of functions of two variables with and without constraints

Applications of Mean value theorems

15 Hours

Unit IV
Applications of Integration

Lengths, Volumes and Surface areas of revolution in Cartesian and Polar Coordinates
Multiple integrals-Double integrals, Change of order of Integration, change of variables (Cartesian and Polar coordinates) and evaluation of triple integrals

Problems related to Centroid and Mass

15 Hours
Total: 60 Hours

Textbook (s)

1. B. S. Grewal, Higher Engineering Mathematics, 42nd Ed., Khanna Publishers, New Delhi, 2012
2. E. Kreyszig, Advanced Engineering Mathematics, 9th Ed., Wiley, 2012
3. R. K. Jain, S. R. K.Iyengar, Advanced Engineering Mathematics, 4th Ed., Narosa Publishing House,New Delhi, 2014

Reference (s)

1. B. V. Ramana, Engineering Mathematics, 4th Ed., Tata McGraw Hill, New Delhi, 2009
2. D. S. Chandrashekharaiah, Engineering Mathematics, Volume 1, Prism Publishers, 2010
3. T. K. V. Iyengar, B. Krishna Ghandhi, S. Ranganathan and M.V. S.S.N. Prasad, Engineering Mathematics, Volume-I, 12th Ed., S. Chand Publishers, 2014
4. U. M. Swamy, P. VijayaLaxmi, K. L. Sai Prasad and M. Phani Krishna Kishore, A Text Book of Engineering Mathematics–I, Excel Books, New Delhi, 2010

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Int. Test 3[1] (%)
Remember	10	10	-
Understand	30	30	-
Apply	60	60	70
Analyze	-	-	10
Evaluate	-	-	20
Create	-	-	-
Total (%)	100	100	100

Sample question (s)

Remember

1. State Cayley-Hamilton theorem.
2. What is Bernoulli's equation?

Understand

1. Represent $x^2y + 3y - z$ in powers of $(x - 1)$ using Taylor's theorem.
2. Show that $3y^4z^2\hat{\imath} + 4x^3z^2\hat{\jmath} + 3x^2y^2\hat{k}$ is solenoidal.

Apply

1. Make use of the properties, to compute the sum and the product of the Eigen values of $A = \begin{pmatrix} 1 & 2 & 3 \\ 0 & 5 & 1 \\ 0 & 0 & 2 \end{pmatrix}$.
2. Solve $(D^3 - 3D^2 + 4) = e^{2x} + 6 + 80\cos 2x$

Evaluate

1. Determine the Eigen values and corresponding Eigen vectors of $\begin{bmatrix} -2 & 2 & -3 \\ 2 & 1 & -6 \\ -1 & -2 & 0 \end{bmatrix}$
2. Evaluate $\iiint_v \nabla.\vec{F}\,dV$, where $\vec{F} = 4x\hat{\imath} - 2y^2\hat{\jmath} + z^2\hat{k}$ and V is bounded by $x^2 + y^2 = 4, z = 0$ and $z = 3$.

[1]Open book Examination

Analyze

1. Examine the given differential equation for a circuit in which self-inductance and capacitance neutralize each other is $L\frac{d^2i}{dt^2} + \frac{1}{C} = 0$ and find the current i as a function of t of given that I is the maximum current, and $i = 0$ when $t = 0$.
2. Analyze the graph of $y^2(x - a) = x^2(x + a)$ by using the properties of curve tracing

21PYX01 Engineering Physics

(Common to all B.Tech. Programmes)

3 0 0 3

Course Outcomes

1. Interpret the concepts of mechanics to understand the conservative principles
2. Outline the principles of electrostatics, magnetostatics and able to explain electromagnetism
3. Illustrate the concepts of Interference, Diffraction, Polarization and their applications
4. Summarize the fundamental concepts of quantum theory and identify the applications of quantum theoryin various contexts
5. Classify solids into conductors, insulators and semiconductors and understand conductivity in intrinsicand extrinsic semiconductors
6. Demonstrate the emission of laser light and their applications in various engineering fields. Interpret andclassify optical fibers and their applications in modern communication systems.

COs – POs Mapping

COs	PO1
1	3
2	3
3	3
4	3
5	3
6	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I
Mechanics, Electrostatics and Magnetostatics

Scalar and Vector fields, – Gradient, divergence and curl – Gravitational potential energy – Work Energy theorem – Central forces – Conservative forces– Angular momentum - Kepler's laws of planetary motion (qualitative) Electric flux - Gauss's law (electrostatics) – Applications of Gauss law: Coulomb's law from Gauss law,Spherically distributed charge (Non conducting sphere) - Ampere's law, application of Ampere's law - Biot-Savart's law, Applications of Biot-Savart's law: B due to current carrying straight conductor and a circular loop
– Faraday's law – Lenz's law - Maxwell's equations.

Electric field due to infinite sheet of charge and infinite line of charge

17 Hours

Unit II Wave
Optics

Principle of Superposition-Interference of light - Conditions for sustained Interference –Young's double slit interference-Interference in thin films (reflected light) - Newton's Rings, Determination of Wavelength, applications of Interference
Diffraction - Fraunhofer Diffraction at Single slit - Diffraction Grating – Grating Spectrum - Determination of Wavelength - applications of Diffraction.
Polarization - Types of polarization - Polarization by double refraction - Nicol's Prism - Half wave and Quarter wave plates - applications of Polarization.

Wedge shaped film - Polariods - Rayleigh criterion in resolution

14 Hours

Unit III
Quantum theory and semiconductors

Dual nature of matter - de-Broglie Hypothesis - Properties of matter waves – Uncertainty Principle - Physical significance of wave function - Schrödinger's wave equation – Particle in infinite potential well (one dimensionalbox) - Free electron theory of metals, electrical conductivity - Fermi Dirac Distribution function (qualitative) - Kronig - Penney model (qualitative) - Classification of materials into conductors, semiconductors and insulators. Intrinsic semiconductors - Density of charge carriers (qualitative) - Fermi energy level – Electrical conductivity
- Extrinsic semiconductors (P-type & N-type) - Density of charge carriers (qualitative) - Dependence of Fermi energy on carrier concentration and temperature - Hall effect - Applications of Hall effect - Drift and Diffusion currents

Tunneling effect

17 Hours

Unit IV
Lasers and Optical Fiber

Characteristics of laser – Stimulated absorption – Spontaneous emission - Stimulated emission – Population inversion – Pumping mechanism – Active medium –Laser systems: Ruby laser, He-Ne laser, Semiconductor laser – Applications of Lasers
Introduction to Optical Fibers-Total Internal Reflection and Critical angle of propagation - Acceptance angle - Numerical Aperture-Classification of fibers based on Refractive index profile and modes – Applications of optical fibers - Block Diagram of Fiber optic Communication system

Fiber optic sensors - Holography.

12 Hours

Total: 60 Hours

Textbook (s)

1. Halliday, Resnick and Krane, Physics Part-II, Wiley India Pvt. Ltd, 2014
2. D Kleppner and Robert Kolenkow, An Introduction to Mechanics –II, Cambridge University Press, 2015.
3. David J Griffiths, Introduction to Electrodynamics, Printice Hall of India, 2012.
4. R.K. Gour and S.L. Gupta, Engineering Physics, Dhanpath rai Publications, New Delhi, 2014
5. S. O. Pillai, Solid State Physics, 6th Ed., Newage International Publishers, 2015
6. A. S. Vasudeva, Modern Engineering Physics, S. Chand and Company, New Delhi, 2006

Reference (s)

1. V. Rajendran, Engineering Physics, McGraw Hill Education (India) Private LTD, 2010
2. M. Armugam, Engineering Physics, Anuradha Agencies, 2007
3. P.K. Palanisamy, Engineering Physics – I, II, Scitech Publications (India) Pvt. Ltd, 2011.
4. M.R. Srinivasan, Engineering Physics, New age International Publishers, 2nd Edition, 2014.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Int. Test 3 (%)
Remember	40	40	-
Understand	40	40	-
Apply	20	20	80
Analyze	-	-	20
Evaluate	-	-	-
Create	-	-	-
Total (%)	100	100	100

Sample question (s)

Remember

1. Define Principle of Superposition.
2. State Faraday's law of electromagnetic induction and Lenz's law.
3. Recall vector and scalar fields.

Understand

1. Explain the construction and working principle of Nicole's prism.
2. Illustrate Ruby laser and explain its working principle with energy level diagram.
3. Outline fermi dirac distribution function.

Apply

1. Demonstrate any four applications of lasers with reference to their characteristics.
2. Apply Biot-Savart's law, and calculate the Magnetic field induction along the infinite length of a straightconductor at points close to the conductor.
3. Calculate electric field intensity due to infinite line of charge by applying Gauss law.

Analyze

1. Compare insulator, semiconductor and conductors based on energy bands
2. Differentiate the types of optical fiber based on refractive index profiles.
3. Justify the formation of newton rings based on interference of light.

21CYX01 Engineering Chemistry

(Common to all B.Tech. Programmes)

3 0 0 3

Course Outcomes

1. Illustrate the different types of polymers and their applications
2. Interpret the Nernst equation for electrode potential and construct various types of energy storage devices
3. Describe corrosion factors and implement prevention measures
4. Estimate the calorific value of a fuel and select a suitable fuel as an energy resource
5. Describe the important renewable energy sources and their usage
6. Explain bonding, colour and magnetic properties of molecules

COs – POs Mapping

COs	PO1
1	3
2	3
3	3
4	3
5	3
6	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I
Polymer Chemistry

Introduction to polymers, functionality of monomers, chain growth and step growth polymerization, coordinationpolymerization, copolymerization (stereospecific polymerization) with specific examples of polymer formation. Plastics - Thermoplastics and Thermosettings; Compounding of plastics; Preparation, properties and engineering applications of – Teflon, Bakelite, polycarbonate; Fibre reinforced plastics (FRP), Elastomers: Processing of natural rubber, Vulcanization of rubber–Engineering applications of rubber

Conducting polymers: mechanism of conduction in polyacetylene and applications of conducting polymers, Bio-degradable polymers: Poly hydrohy alkanoates (PHA), Poly caprolactum (PCL)

Molecular imprinting polymers (MIP)

15 Hours

Unit II
Electrochemistry and Corrosion

Concept of Electrode potential, electrochemical cell, Nernst equation, cell potential calculationsPrimary cells – Fuel cells, hydrogen-oxygen fuel cells, working of the cells

Secondary cells – lead acid and lithium ion batteries- working of the batteries including cell reactions Corrosion: Introduction to corrosion, electrochemical theory of corrosion, differential aeration cell corrosion,galvanic corrosion, metal oxide formation by dry electrochemical corrosion, Pilling Bedworth ratios and uses, environmental factors (pH, temperature, DO) affecting corrosion rate, protection methods – corrosion inhibitorswith specific examples, cathodic and anodic protection.

Organic coatings

15 Hours

Unit III
Fuel Chemistry

Fuels **–** Types of fuels, calorific value - HCV, LCV, numerical problems based on calorific value; Working and calorific value determination using Bomb calorimeter & Junkers Calorimeter, Characteristics of a good fuel, Analysis of coal - Proximate analysis & Ultimate analysis, refining of petroleum, liquid fuels, knocking and anti- knock agents, Octane and Cetane values, cracking of oils-Catalytic cracking, Synthetic petrol-polymerization, Fischer Tropsch & Bergius Process

Renewable Energy Resources: Energy scenario in India, Solar energy- Harnessing of solar energy in the form ofPhoto-voltaic cells, Bio-energy: Biodiesel

Rocket Fuels

15 Hours

Unit IV
Structure and Bonding Models

Molecular orbital theory – bonding in homo- and heteronuclear diatomic molecules – energy level diagrams ofO_2, N_2, NO and CO, etc. π-molecular orbitals of butadiene and benzene, calculation of bond order
Crystal field theory – salient features – energy level diagrams for transition metal ions – splitting in octahedraland tetrahedral environments, Magnetic properties and colour of complexes
Band theory of solids – band diagrams for conductors, semiconductors and insulators, role of doping on band structures.

Planck's quantum theory, Schrodinger equation (qualitative treatment only)

15 Hours
Total: 60 Hours

Textbook (s)

1. P. C. Jain and Monica Jain, Engineering Chemistry, 16th Ed., Dhanpat Rai Publishing Company,New Delhi, 2015
2. Peter Atkins, Julio de Paula and James Keeler, Atkins' Physical Chemistry, 10/e, Oxford UniversityPress, 2010.

Reference (s)

1. S. Chawla, A Textbook of Engineering Chemistry, 3rd Ed., Dhanpat Rai& Co (Pvt) Ltd, New Delhi,2012
2. P. Murthy, C. V. Agarwal, A. Naidu, Textbook of Engineering Chemistry, B. S. Publications,Hyderabad, 2006
3. S. S. Dara, A Textbook of Engineering Chemistry, S. Chand and Company Limited, New Delhi, 1994

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Int. Test 3[1] (%)
Remember	20	20	-
Understand	60	60	-
Apply	20	20	60
Analyze	-	-	40
Evaluate	--	-	-
Create	--	-	-
Total (%)	100	100	100

Sample question (s)

Remember

1. Define polymer. Which are the different types of polymerization?
2. Differentiate between polymer and plastic? List out the differences between thermoplastics andthermosetting plastics?
3. Define calorific value, HCV and LCV

Understand

1. What is meant by vulcanization of rubber? Explain the advantages of vulcanization.
2. What is compounding of plastics? Explain the role of Fillers and Stabilizers withexamples in compounding of plastics.
3. How a photo-voltaic cell is constructed and what is the working mechanism of it?

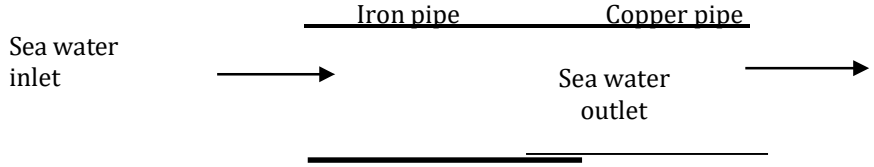
[1]Open book Examination

Apply

1. By which methods, the underground pipelines are protected from corrosion? Explain the involvedmechanisms.
2. Illustrate the Molecular orbital diagram of NO molecule by applying the MOT.

Analyze

1. When a metal X (of reduction potential = 0.337V at 25^0C) is connected to another metal Y (of reduction potential = -0.140V at 25^0C) and this structure is exposed continuously to sea water, whichtype of corrosion would take place? Explain with suitable mechanism.
2. Which type of corrosion is involved in the following jointed pipeline and why? Explain the involvedmechanism in detail



21BEX01 Basics of Engineering

(Common to all B.Tech. Programmes)

3 0 0 3

Course Outcomes

1. Understand the principles of surveying and building materials and components
2. Understand the working principle of steam, Gas, Diesel, Hydro-electric, Nuclear Power plants and IC Engines
3. Understand the working principle of vapour compression & vapour absorption refrigeration systems, Window and Split type AC systems
4. Illustrate the behavior of basic electric circuit elements for both DC and AC excitation
5. Outline the construction and working principle of DC machines with appropriate safety measures
6. Understand the operation of sensors for engineering applications.

COs – POs Mapping

COs	PO1	PO12
1	3	1
2	3	1
3	3	1
4	3	1
5	3	1
6	3	1

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Surveying, building materials and components

Surveying principles, measurements of distances and areas. Building Materials: Bricks, stones, sand, cement, steel and concrete. Substructure: safe bearing capacity, foundations and types. Superstructure: stone and brick masonry, beams, columns, lintels, roofs, floors, plastering.

Layout of building (Plan and Elevation)

15 Hours

Unit II

Power Plant, IC Engines, Refrigeration and Air Conditioning System

Power plant – Classification, Working principle - steam, Gas, Diesel, Hydro-electric and Nuclear Power plants. IC Engines - Working principle of Petrol and Diesel Engines, Four stroke and two stroke cycles, Comparison. Refrigeration and Air Conditioning System – Simple and practical vapour absorption system, Window and Splittype room Air conditioner.

Layout of typical domestic refrigerator

15 Hours

Unit III

Fundamentals of Electrical Engineering

Voltage, Current, Ohm‘s law, Kirchhoff’s laws, Faraday‘s Laws, Basic circuit elements–R, L and C-series and parallel circuits, mesh and nodal analysis, Generation of alternating current, basic definitions, RMS and average values of periodic waveforms-form factor and peak factor, Principle of operation and construction-DC machines,Electric shock and its prevention, Methods of earthing.

Indian electricity safety rules.

15 Hours

Unit IV

Sensors & Consumer Electronics

Sensors and Applications: Resistive Sensors, Inductive Sensors, Capacitive Sensors, Optical Sensors, Electro Magnetic Sensors, Thermal Sensors. Electronic Appliances: Photo Copier, Digital Camera, Mobile Phone, Television, Washing Machine.

Ultrasonic sensors and applications

15 Hours

Total: 60 Hours

Textbook(s):

1. G. Shanmugam and M.S. Palanichamy, Basic Civil and Mechanical Engineering, 3rd Ed., Tata. McGraw. Hill Publishing Co., New Delhi, 2000.
2. Ramamrutham S., Basic Civil Engineering, 3rd Ed., Dhanpat Rai Publishing Co. (P) Ltd. 2013.
3. Ganeshan.V, IC Engines, Tata McGraw-Hill Education Pvt. Ltd, 3rd Ed., 2013.
4. C.P.Arora, Refrigeration and Air Conditioning, Tata McGraw-Hill Publishing Company Limited, 3rdEd., 2009.
5. P.K.Nag, Power Plant Engineering,Tata McGraw Hill Publishing Company, India, 4th Ed., 2014.
6. R.K.Rajput, Power Plant Engineering, 5th Ed., Lakshmi Publications, 2016.
7. D. P. Kothari and I. J. Nagrath, Theory and Problems of Basic Electrical Engineering, 4th Ed., PHILearning Private limited, 2013.
8. Ramana Pilla, M. Surya Kalavathi and G.T.Chandra Sekhar, Basics of Electrical Engineering, 1st Ed., S. Chand & Company Ltd., 2018
9. D. Patranabhis, Sensors and transducers, 2nd Ed., PHI publication, 2013.
10. Principles of Electrical Engineering by V. K. Mehta and Rohit Mehta, S Chand and company Ltd, 5thEdition, 2012
11. 11. Basic Electrical Engineering Theory and Problems by D.P. Kothari and I.J. Nagrath, Prentice Hall,India, 4 th Edition, 2013.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Int. Test 3[1] (%)
Remember	20	40	-
Understand	55	60	25
Apply	25	-	75
Analyze	-	-	-
Evaluate	-	-	-
Create	-	-	-
Total (%)	100	100	100

Sample question (s)

Remember

1. Define Surveying.
2. Define Plane surveying.
3. Define Geodetic Surveying.
4. Define Bearing capacity, Ultimate bearing capacity, Gross safe bearing capacity and Net bearingcapacity?
5. What are the different types of foundations and explain with neat sketches.
6. What is the standard Size of brick?
7. Why is gypsum needed in cement?
8. Define a cantilever beam.
9. What is D.P.C?
10. What is plastering?
11. Classify the power plant
12. Label the components of IC engine
13. State Faradays laws of Electro-magnetic Induction.
14. Define Kirchhoff's laws
15. List out five Indian electricity safety rules
16. Define RMS and average values, form factor and peak factor, of a periodic waveform
17. Define resolution of a sensor.
18. List any two applications of an electromagnetic sensor.
19. State the purpose of a sensor?
20. List any two applications of a capacitive sensor.
21. Define Slew rate of sensor.

[1]Open book Examination

Apply

1. The following perpendicular offsets were taken at 10 meters intervals from a survey line to an irregularboundary line: 3.25, 5.60, 4.20, 6.65, 8.75, 6.20, 3.25, 4.20, 5.65
2. Calculate the area enclosed between the survey line, the irregular boundary line, and first and last offsets,by the application of a) average ordinate rule b) trapezoidal rule and C) Simpsons rule.
3. Demonstrate the working of engine adopted byAPSRTC bus.
4. Power can be produced from the steam. Justify the statement.

21BEX06 IT Workshop

(Common to all B.Tech. Programmes)

0 0 3 1.5

Course Outcomes

At the end of the course, students will be able to

1. Apply knowledge for computer assembling and Operating System installation
2. Understand trouble shooting of various problems of Hardware
3. Construct residential wiring and various types of wiring schemes
4. Demonstrate the working and troubleshooting of various electrical gadgets
5. Understand the applications of various sensors and transducers
6. Demonstrate the working principle of top loaded washing machine

CO-PO Mapping

CO	PO1	PO12
1	3	2
2	3	2
3	3	2
4	3	2
5	3	2
6	3	2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

List of Experiments

1. Identify the peripherals of a computer, components in a CPU and its functions. Draw the block diagram of the CPU along with the configuration of each peripheral.
2. Disassemble and assemble the PC back to working condition.
3. Installation of MS Windows (2010 or Latest Version) on the personal computer .Word Orientation: Introduction to MS Word, Accessing, overview of toolbars, saving files, Using help and resources, rulers, Font, Colors, format painter, creating custom tabs.
4. Creating a Scheduler: Introduction to MS Excel, Gridlines, Format Cells, Summation, auto fill, FormattingText, is creating custom tabs.
5. Creating Power Point Slides: Basic power point utilities and tools, PPT Orientation, Slide Layouts, InsertingText, Word Art, Formatting Text, Bullets and Numbering, Auto Shapes, Lines and Arrows, Master Layouts,Types of views.
6. Interactive Presentations: Hyperlinks, Inserting –Images, Clip Art, Audio, Video, Objects, Tables and Charts, Rehearsals.
   Two lamps control using two 2-way switches: Design of electrical circuit to control two lamps connected in series and parallel using two two-way switches.
7. Wiring of living room: Development of socket connections consisting one-way and two-way switches forliving room.
8. Tube-light wiring: To do the installation and connection of tub-light wiring.
9. Electrical wiring circuit incorporated with fuse cut-out, energy meter and main switch.
10. Godown wiring: Preparing a godown wiring circuit with PVC conduit system.
11. Resistance, Current and Voltage Measurements using Digital Multimeter.
12. Temperature measurement using thermocouple sensors and understand the working principle of relay.
13. Detection of smoke using smoke sensor and measuring the speed of DC motor using Speed sensor.
14. Distance measurement using Linear Voltage Differential Transducer.
15. Identification of Fault detection in top loaded / front loaded washing machine

Reference Books

1. Faithe Wempen & Rosemary Hattersley & Richard Millett & Kate Shoup , Computing fundamentals:digital literacy edition, Wiley, 2014.
2. Clements & Alan, Principles of
   Computer Hardware, Oxford press,
   fourth edition,2006.

21BEX02 Problem Solving and Programming Skills

(Common to all B.Tech. Programmes)

3 0 0 3

Course Outcomes

1. Explain and illustrate aspects of the problem solving using algorithm, flowchart
2. Demonstrate conditional and iterative statements to write programs
3. Understand and apply the concepts of arrays and user defined functions
4. Describe and apply the concepts of pointers and structures
5. Understand and apply the file manipulation functions to handle data files
6. Solve problems of varying complexity by developing programs in C

COs – POs Mapping

COs	PO1	PO12
1	3	2
2	3	2
3	3	2
4	3	3
5	2	3
6	2	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Introduction to Problem Solving and Fundamentals of C

Problem solving basics: Introduction to computers, the problem-solving Aspect, Top-down Design, Algorithms,Flowcharts/Pseudo codes, Implementation of algorithms, Types of Programming Languages, Program development steps, The compilation process, Syntax and Semantic errors.

Fundamentals of C: C Fundamentals: C Character set, Token, Data types, variables, Declarations, Operators andExpressions: Different types of operators, expressions, Type Conversions, Precedence and Order of Evaluation, Data input and output statements.

Control Flow Statements: Branching: if, if-else, nested if, else-if ladder, Looping: while, do-while, for, Break, Continue, goto, Switch statement

Comma and size of operators, bitwise operators, escape sequences

19 Hours

Unit II

Arrays and Functions

Arrays: definition, declaration, accessing elements, storing elements, 2-D arrays, Multidimensional arrays Stringsand string manipulations

Functions: Built-in functions, User-defined Functions: Function prototyping, Function Definition, Passing arguments to function, call by value, Recursion, Passing arrays to function, Storage classes, Scope and life time of variables.

Preprocessor commands, *enumerations*

15 Hours

Unit III

Pointers and Structures

Pointers: Fundamentals, declarations, passing pointers as argument to function (Call by reference), arrays andpointers, Operations on pointers, dynamic memory management functions

Structures: Definition, declaration, Structures and Functions, Arrays of Structures, Pointers to Structures, Self-referential Structures, typedef, Unions

Dangling pointers, variable length arguments

14 Hours

Unit IV
Data Files and Introduction to Data Structures

File manipulation: Creation of Files, Opening and Closing a File, Processing a File, Unformatted Files Introduction to Data Structures: Definitions, Classification of data structures: Linear, Non-Linear, Operations onLinked lists, Stack, Queue.

Command line arguments, Macros, error handling functions.

12 Hours
Total: 60 Hours

Textbook (s)

1. Byron Gottfried, Programming with C, 3rd Ed., Tata McGraw Hill, 2017.
2. R. G. Dromey, How to solve it by Computer, Pearson Education India, 2008

Reference (s)

1. Y. Kanetkar, Let us C, 8th Ed., BPB Publication, 2004
2. ISRD Group, "Programming and Problem Solving Using C", Tata McGraw Hill, 2008.
3. F. E. V. Prasad, C Programming: A Problem-Solving Approach, Giliberg, Cengage, 2010
4. A. S. Tenenbaum, Y. Langsam and M. J. Augenstein,Data Structures using C, Pearson Education, 2009
5. Ellis Horowitz, Anderson-Freed, S Sahni, Fundamentals of Data Structures in C, 2nd Ed., Universities Press,2008

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Assignment Test [5] (%)
Remember	25	20	-
Understand	35	40	30
Apply	40	40	40
Analyze	-	-	30
Evaluate	-	-	-
Create	-	-	-
Total (%)	100	100	100

Sample question (s)

Remember

1. Define Algorithm
2. List any four types of operators of C - Language
3. What is dangling pointer?

Understand

1. What is Structured programming?
2. Differentiate linear and nonlinear data structures
3. List any four string handling functions

Apply

1. Write a program for matrix multiplication using arrays
2. Solve Towers of Hanoi problem using recursion
3. Identify the suitable file mode for adding new data in to the existing file

Analyze

1. Compare structure and union
2. Differentiate logical and relational operators
3. Distinguish between Recursive and non-recursive functions

21BEX03 Problem Solving and Programming Skills Lab

(Common to all B.Tech. Programmes)

0 0 3 1.5

Course Outcomes

1. Implement, execute the programs in C language for solving a problem
2. Exercise conditional and iterative statements to Write C programs
3. Implement programs to develop applications using functions
4. Apply Arrays and structures to solve real world problems
5. Make use of pointers to design applications with efficient use of memory
6. Solve problems using files concept

COs – POs Mapping

COs	PO4
1	3
2	3
3	3
4	3
5	3
6	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

List of Experiments

1. Draw the Flow charts using Raptor tool (Minimum 2)

2. Mr. John takes a loan to buy a truck at the rate of some interest. Help John to calculate thesimple interest to be paid for the loan amount for a time.

   For example:
   Given P=15000 amount at the rate of 5% interest annually (T=12 months).find SI?

   Functional Description:
   Complete the task using C editor and the output of the program is to display a float value.

   Constraints:
   - P>10,000
   - T>0
   - 2<=R<=5

   Sample Test case:
   15000
   11
   3
   4950.00
   The first integer indicates Principal
   amountSecond integer indicates Time
   Third integer indicates Rate of interest
   Forth value indicates the interest to be paid by John.

3. A person brought a new house and want to paint his house. He is having following details: Length, Height, Breadth and cost for square feet to paint a single wall. Help him out to calculatethe cost for painting work.
   For example:
   Given L=5, B=3, H=10, C=1000 and find total cost of house for painting

   Functional Description:
   Complete the task using C editor and the output of the program is to display a value.

   Constraints:
   - 0<L<100

- 0<B<100
- 1<=H<=10
- C>100

Sample Test case:
5
3
10
1000
150000
The first integer indicates
LengthSecond integer indicates
BreadthThird integer indicates
Height Fourth integer indicates
Cost Fifth value indicates total
cost.

4. Government wants implement new pension scheme to people of the country based on the following criteria

Age	Amount to be paidmonthly	Pension after 60Years
Below 18	---	Not Eligible
18-22	210	5000
23-27	310	5000
28-35	410	5000
35-45	510	5000

Help the citizens to know how much amount need to be paid based on age criteria

Functional Description:
Complete the task using C editor and the output of the program is to display a value.

Sample Test case:
20
210
5000
The first integer indicates Age
Second integer indicates amount to be
paidThird integer indicates pension
amount

5. There are n students attempted a competitive exam. The college wants to allocate the section toa student based on their rank. Use an appropriate logic to order the students according to their rank.

Functional Description:
Complete the task using C editor by reading set of integer values into 1-D array and displaythem in sorted order.

Constraints:
- n>4
- All values should be in integer

Sample Test case:
5
3
2
1
4
10
1 2 3 4 10

6. Consider a country with n states. Read capital income from n states and find the highest , lowestcapital income

Functional Description:

Complete the task using C editor by reading set of integer values into 1-D array and displayhighest and lowest values.

Constraints:

- n>=2
- All values should be in integer

Sample Test case:

5
3
2
1
4
10
1 10

7. 2 colleges with 3 teams each participating in a technical quiz. Each team should consists of students from IT, ECE, CSE. Find the total number of students participated from each branch in both colleges.

Functional Description:
Complete the task using C editor by reading set of integer values into 2-D array and display theoutput.

Constraints:

- All values should be in integer

Sample Test case:

College1 College2

2	3	4	1	2	5
3	4	5	5	6	3
4	2	1	6	2	4

21 19 22

8. Divya is teaching her student Amit about palindromes. A palindrome is a word, phrase, number,or other sequence of characters which reads the same backward or forward.

For example
The string "MALAYALAM" is a palindrome. Help Divya to check whether Amit identified palindromes correctly or not.

Functional Description:
Complete the task using C editor and the output of the program is to display a value.

9. A box contains 'n' distinct color balls. A person has to take 'r' balls at a time. Find thearrangements and selections of balls.

Functional Description:
Complete the task using C editor and the output of the program is to display the output.

Constraints:

- n>0
- r>=0

Sample Test case:

5
3
10
60
The first integer indicates
nSecond integer indicates
r
Third integer indicates number of
arrangementsForth value indicates number
of arrangements

10. a. Bob wants to store some information regarding his research work later he wants to seeWhenever necessary. Suggest him how efficiently he can do this work.
    b. An Organization has several branches which maintain information regarding company oneOf Sub branches wants some information from main branch. Help them in effective way

    Functional Description:
    Complete the task using C editor and the output of the program is to display its content.

11. Determine all positive integer values that evenly divide into a number, its factors. Return thepth element of your list, sorted ascending. If there is no pth element, return 0. For example, given the number n = 20, its factors are {1,2,4,5,10,20}. Using 1-based indexingif p = 3, return 4. If p > 6, return 0.
    Function Description
    Complete the function pthFactor in the editor below. The function should return a long integervalue of the pth integer factor of n.
    pth Factor has the following parameter(s):
    n: an integer
    p: an
    integer
    Constraints
    • 1 ≤ n ≤ 1015
    • 1 ≤ p ≤ 109
    Input Format for Custom Testing
    Input from stdin will be processed as follows and passed to the function.The first line contains an integer n, the number to factor.
    The second line contains an integer p, the 1-based index of the factor to return.Sample Case 0
    Sample Input 0
    10
    3
    Sample Output 0
    5
    Explanation 0
    Factoring n = 10 we get {1, 2, 5, 10}. We then return the p = 3rd factor as our answer.Sample Case 1
    Sample Input 1
    10
    5
    Sample Output 1
    0
    Explanation 1
    Factoring n = 10 we get {1, 2, 5, 10}. There are only 4 factors and p = 5.We return 0 as our answer.
    Sample Case 2
    Sample Input 2
    1
    1
    Sample Output 2
    1
    Explanation 2
    Factoring n = 1 we get {1}. We then return the p = 1st factor as our answer.

12. Alex wants to paint a picture. In one stroke, Alex can only paint the same colored cells which are joined via some edge.Given the painting, determine the minimum number of strokes tocompletely paint the picture.Take for example, the canvas with height given by h = 3 and widthgiven by w = 5 is to be painted with picture picture=["aabba", "aabba", "aaaca"], the diagrambelow shows the 4 strokes needed to paint the canvas.

    Strokes
    Canvas 1 2 3 4
    aabba aa bb a
    aabba aa bb a
    aaaca aaa c a
    Function Description

Complete the function strokesRequired in the editor below. The function must return an integer,the minimum number of strokes required to paint the canvas.

strokesRequired has the following parameter(s):
picture[picture[0],...picture[h-1]]: an array of strings where each string represents one row ofthe picture to be painted

Constraints
- $1 \le h \le 105$
- $1 \le w \le 105$
- $1 \le h*w \le 105$
- len(picture[i]) = w (where $0 \le i < h$)
- picture[i][j] ∈ {'a', 'b', 'c'} (where $0 \le i < h$ and $0 \le j < w$)

Input Format For Custom Testing
The first line contains an integer, h, that denotes the height of the picture and the number ofelements in picture.
Each line i of the h subsequent lines (where $0 \le i < h$) contains a string that describes picture[i].Sample Case 0
Sample Input For Custom
Testing3
aaab
a
abab
a
aaaca
Sample
Output5
Explanation
The 'a's can be painted in 2 strokes, 'b's in 2 strokes and 'c' in 1 stroke, for a total of 5.Strokes
Canvas 1 2 3 4 5
aaaba aaa b a
ababa a a b b a
aaaca aaa c a
Sample Case 1
Sample Input For Custom
Testing4
bbb
a
abb
a
acaa
aaac
Sample
Output4
Explanation
The 'a's can be painted in 1 stroke, the 'b's in 1 stroke and each 'c' requires 1 stroke.

Strokes
Canvas 1 2 3 4
bbba bbb a
abba bb a a
acaa a aa c
aaac aaa c

13. We define the following:
A binary string is a string consisting only of 0's and/or 1's. For example, 01011, 1111, and 00are all binary strings.
The prefix of a string is any substring of the string that includes the beginning of the string. For example, the prefixes of 11010 are 1, 11, 110, 1101, and 11010.

We consider a non-empty binary string to be magical if the following two conditions are true: The number of 0's is equal to the number of 1's.
For every prefix of the binary string, the number of 1's should not be less than the number of0's.

For example, 11010 is not magical because it doesn't have an equal number of 0's and 1's, but 110100 is magical because it satisfies both of the above conditions.

A magical string can contain multiple magical substrings. If two consecutive substrings are magical, then we can swap the substrings as long as the resulting string is still a magical string.Given a magical binary string, binString, perform zero or more swap operations on its consecutive magical substrings such that the resulting string is as lexicographically large as possible. Two substrings are considered to be consecutive if the last character of the first substring occurs exactly one index before the first character of the second substring.

For example, if we look at the magical binary string binString = 1010111000, we see two magical binary substrings, 1010 and 111000 among others. If we swap these two substrings we get a larger value: 1110001010. This is the largest possible magical substring that can be formed.

Function Description
Complete the function largestMagical in the editor below. The function must return a string denoting the lexicographically largest possible magical string that can be formed by performingzero or more swap operations on consecutive magical substrings of binString.

largestMagical has the following parameter(s):
binString: a string

Constraints
Each character of binString ∈
{01}.1 ≤ |binString| ≤ 50
binString is a magical string.

Input Format For Custom Testing
The only line of input contains the string
binString.Sample Case 0
Sample Input 0
11011000
Sample Output 0
11100100
Explanation 0
Given the magical string binString = 11011000, we can choose two consecutive magical substrings, 10 and 1100, to swap such that the resultant string, str = 11100100, is the lexicographically largest magical string possible.
Sample Case 1
Sample Input 1
1100
Sample Output 1
1100
Explanation 1
The only magical substring of binString is 1100. So none of the operations can be applied onthe string.
Sample Case 2
Sample Input For Custom
Testing1101001100
Sample
Output
1101001100
Explanation
The only consecutive magical substrings of binString are 110100 and 1100. Note that 100 is not a magical substring because it contains more zeroes than ones. If we were to swap them, itwould result in a lexicographically smaller string. Thus, binString is already the lexicographically largest magical string that can be formed.

List of Augmented Experiments[1]

1. Employee's Management System

[1]Students shall opt any one of the Augmented Experiments in addition to the regular experiments

2. Library management system
3. Automation of department store
4. Personal Dairy Management
5. Telecom Billing Management
6. Bank Management System
7. Contacts Management

Reading Material (s)

1. C Programming Lab manual–Department of CSE-GMRIT Rajam, 2019

21BEX04 Engineering Drawing

(Common to all B.Tech. Programmes)

0 0 3 1.5

Course Outcomes

1. Understand Principles of engineering drawing
2. Construct Conic sections using general methods and other methods
3. Construct Orthographic projections of Points, Lines and Planes
4. Construct Orthographic projections of Solids using basic drafting software
5. Construct Isometric projections using basic drafting software
6. Construct Orthographic projections from given isometric projections of an object and vice versa

COs – POs Mapping

COs	PO_1	PO_5	PO10
1	3	-	2
2	3	-	2
3	3	-	2
4	3	3	2
5	3	3	2
6	3	3	2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

List of Experiments

Unit I

Conic Sections-Introduction to Orthographic Projections

Construction of conics using general method and other special methods
Orthographic Projections of Points, Straight Lines parallel to both planes, parallel to one plane and inclined toother plane

9 Hours

Unit II

Orthographic Projections of Straight Lines and Planes

Projections of Straight Lines inclined to both planes; Projections of Planes; Regular Planes Perpendicular Parallel to one Reference Plane and inclined to other Reference Plane; inclined to both the Reference Planes

Practice the following topics by using any one 2D drafting software

9 Hours

Unit III

Projections of Solids &Isometric Projections

Projections of Prisms, Cylinders, Pyramids and Cones with the axis inclined to one Principal Plane and Parallelto the other, Projections of Prisms, Cylinders, Pyramids and Cones inclined to both the Principal Planes Introduction to Isometric Projections, Isometric axes, angles, Isometric views, Construction of Isometric viewsof Simple planes and Solids in various positions

15 Hours

Unit IV

Conversion of Engineering Views

Conversion of Orthographic Views of Simple Solid objects into Isometric View, Conversion of Isometric Viewof Simple Solid objects into Orthographic Views

9 Hours

Total: 42 Hours

List of Drawing Sheets

1. Conics by General Method
2. Conics by using Special Methods
3. Projections of Points and Straight lines in Simple Positions
4. Projections of Lines inclined to both planes
5. Projections of Planes in Simple positions
6. Projections of Planes inclined to both planes

7. Projections of Solids
8. Projections of Solids inclined to both planes
9. Isometric Projections
10. Conversion of Orthographic views into Isometric views
11. Conversion of Isometric views into Orthographic views

List of Augmented Experiments[3]

1. Draw the Knuckle Pin and fork end of the knuckle joint
2. Draw the Socket and spigot cotter joint
3. Draw the Tommy bar and body of the Screw jack
4. Draw the Cup and Big and Small screws of screw jack
5. Draw the Connecting rod of IC Engine using CAD
6. Draw the Pipe spool with flanges and a valve
7. Draw a sample pipe line construction design in oil and gas industries using CAD
8. Draw the Pipe truss design using AutoCAD
9. Draw a 3-D bolt and nut with Threads using CAD
10. Draw a 3-D Cross head pattern using CAD
11. Draw the sample Bridge using CAD
12. Draw the pipe vice using CAD
13. Draw the Ni-Cd Battery zapper circuit diagram using CAD
14. Draw the circuit diagram of battery charger with automatic cutoff using CAD
15. Draw the satellite dish and Antenna using CAD

Reading Material (s)

Textbook (s)

1. N.D. Bhatt, V. M. Panchal, Pramod R. Ingle, Engineering drawing, Charotar Publications, 54th Edition, 2014
2. D. M. Kulkarni, A.P. Rastogi, Ashoke K. Sarkar, Engineering Graphics with Auto CAD, PrenticeHall of India, 2nd Edition, 2010

Reference (s)

1. K. C. John, Engineering Graphics for Degree, PHI Publications, 2nd Edition, 2009
2. M. B. Shah and B. C. Rana, Engineering Drawing, Pearson Publishers, 2nd Edition, 2009
3. D. A. Jolhe, Engineering Drawing, Tata McGraw-Hill Education, 1st Edition, 2008

[3]Students shall opt any one of the Augmented Experiments in addition to the regular experiments

21BEX05 Engineering Workshop

(Common to all B.Tech. Programmes)

0 0 3 1.5

Course Outcomes

1. Make use of basic hand tools of carpentry, fitting, tin smithy and house wiring
2. Develop simple wooden components cross lap, T-Lap, Dovetail and Mortise and Tennon joints
3. Develop simple house hold items Square Box without lid ,Taper Tray, Open Scoop and Funnel
4. Develop Square, V, Half Round and Dovetail Fits using mild steel
5. Understand simple house wiring circuits
6. Create a model using the basic principles of all workshop trades

COs - POs Mapping

COs	PO1	PO9	PO10
1	3	2	2
2	3	3	2
3	3	3	2
4	3	3	2
5	3	3	2
6	3	3	2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

List of experiments

Trades

Carpentry :
1. Cross Lap joint
2. T-Lap joint
3. Dovetail Joint
4. Mortise and Tennon Joint

Fitting :
1. Square Fit
2. V- Fit
3. Half Round Fit
4. Dovetail Fit

Tin Smithy :
1. Square Box without lid
2. Taper Tray
3. Open Scoop
4. Funnel

House wiring :
1. Parallel/Series connection of three bulbs
2. Florescent Lamp Wiring
3. Stair Case Wiring
4. Godown Wiring

Total: 45 Hours

List of Augmented Experiments[4]

1. Prepare Tee–bridle joint
2. Prepare Corner dovetail joint
3. Make Corner bridge joint
4. Make Dovetail lap joint
5. Prepare 90^0 round elbow pipe
6. Prepare Ellipse using GI sheet
7. Make cylindrical pipe
8. Make Round T-pipe
9. Prepare hexagonal fitting
10. Prepare diagonal dovetail fitting
11. Prepare universal fitting

[4]Students shall opt any one of the Augmented Experiments in addition to the regular experiments

12. Make square fitting
13. Set the general house wring
14. Set the dim & bright lighting
15. Set the test lamping

Reading Material (s)

1. Engineering workshop Lab manual, Department of Mechanical Engineering, GMRIT Rajam.

21PYX02 Engineering Physics Lab

(Common to all B.Tech. Programs)

0 0 3 1.5

Course Outcomes

1. Infer the knowledge from the scientific methods and learn the process of measuring different physicalparameters
2. Develop the laboratory skills in handling of electrical and Optical instruments
3. Demonstrate the interference and diffraction phenomena of light
4. Inspect and experience physical principles of Magnetic fields and optical fiber communications
5. Apply the principles of physics and measure the solid state properties of materials
6. Design and analyze experiment based on physics concepts

COs – POs Mapping

COs	PO4
1	3
2	3
3	3
4	3
5	3
6	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

List of Experiments

1. Variation of magnetic field along the axis of current-carrying circular coil-Stewart and Gee's Method
2. Determination of wavelengths of spectral line of mercury spectrum using diffraction grating
3. Determination of radius of curvature of convex lens by forming Newton's rings
4. LCR circuit- Study of parallel and series Resonance
5. Measurement of thickness of a thin paper using wedge method
6. Fiber optics-Numerical aperture of a given fiber and study of bendig losses
7. Meldie's Experiment–Transverse and longitudinal modes
8. Determination of wave length of Laser by diffraction grating
9. Determination of Hall Coefficient and charge carrier density of semi-conductor
10. Determination of Band gap of a semiconductor

List of Augmented Experiments[5]

1. To study the magnetization (M) of a ferromagnetic material in the presence of a magnetic field B and to plot the hysteresis curve (M vs. B)
2. Study the Thermo emf of the thermocouple
3. LCR Series and Parallel–Design of circuit for various resonance frequencies
4. Determination of characteristics of Laser beam
5. Determination of Horizontal component of earth's magnetic field
6. Study of double refraction in calcite crystals
7. Dispersive power of various liquids using spectrometer
8. Photo cell–Characteristics and determination of Planks constant
9. Michelson's interferometer.

Reading Material (s)

1. Physics Lab manual–Department of Physics, BS & H, GMRIT, Rajam, 2019
2. S. Balasubramanian , M.N. Srinivasan " A Text book of Practical Physics"- S Chand Publishers, 2017
3. Y. Aparna and K. Venkateswararao, Engineering Physics–I and II, VGS Techno series, 2010
4. S. Panigrahi and B. Mallick, Engineering Practical Physics, Cengage leaning, Delhi, 2015
5. http://www.amrita.vlab.co.in Virtual Labs, Amrita University.
6. http:/www./iitk.vlab.co.in

[5]Students shall opt any one of the Augmented Experiments in addition to the regular experiments

21CYX02 Engineering Chemistry Lab

(Common to all B.Tech. Programmes)

0 0 3 1.5

Course Outcomes

1. Utilize different Analytical tools and execute experiments involving estimation of raw materials, finishedproducts and environmental samples etc.
2. Utilize modern instruments like ion analyzer, UV Vis spectrophotometer for characterization of materialsused in industry & environment
3. Determine the amount of fluoride present in water for its quality in drinking purpose
4. Estimate the acid number of oil and assess its suitability as a lubricant.
5. Prepare a cross-linked & thermosetting polymer - Bakelite
6. Identify the adulteration of food items such as milk, honey, tea, coffee

COs – POs Mapping

COs	PO4
1	3
2	3
3	3
4	3
5	3
6	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

List of Experiments

1. Introduction to Quantitative Analysis - Demonstration
2. Determination of Acid number of a lubricating oil [titration of weak acid vs. strong base]
3. Estimation of Strength of an acid in Pb-Acid battery by pH metry
4. Conductometry - Determination of cell constant and conductance of solutions
5. Potentiometry - Determination of redox potentials and emfs using Weston cell
6. Preparation of a polymer - Bakelite
7. Determination of molecular weight of a polymer using viscometer
8. Verify Lambert-Beer's law - □ calculation or conc. estimation
9. Assessment of quality of water – Fluoride content
10. Detection of adulteration of food in Honey/Milk/Tea
11. Making and using a blue printing paper
12. Measurement of 10Dq by spectrophotometric method
13. Determination of corrosion of metal in the presence/absence of inhibitor

List of Augmented Experiments[6]

1. Assessment of ground water quality of your village/Mandal (by taking min. 6 locations and determiningmin. 4 parameters – Fluoride, Chloride, Hardness, TDS etc.
2. Preparation of desired quality of Viscosity Index lubricating oil
3. Studies on the effect of various factors on corrosion
4. Making a battery of required potential
5. Energy scenario in India- Various sources, % consumption, solutions to meet future demand etc.

Reading Material (s)

1. K. Gouru Naidu, Engineering Chemistry Lab Manual, 1st Ed., 2014
2. G. Svehla, Vogel's Qualitative Inorganic Analysis, 7th Ed., Pearson Education, New Delhi, 2003

[6]Students shall opt any one of the Augmented Experiments in addition to the regular experiments

21HSX02 Communicative English Lab

(Common to all B Tech Programmes)

0 0 3 1.5

Course Outcomes

1. Make use of the acquired knowledge of English sound system
2. Improve articulation of sounds using the patterns of accent, rhythm and intonation
3. Develop the skills of communication in formal and informal situations
4. Choose and play different roles and practice interpersonal communication
5. Organize ideas in a structured manner in public speaking activities
6. Demonstrate the necessary verbal and non-verbal communication in technical presentations

COs – POs Mapping

Cos	PO10	PO12
1	3	1
2	3	1
3	3	1
4	3	1
5	3	1
6	3	1

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

List of Experiments

Module-1: Letters and Sounds of English **(2) sessions**
Letters and sounds, Speech Organs
Module -2: Interaction-1: **(1) session**
Greeting and taking leave, introducing oneself to others.
Module -3: The Sounds of English: **(1) session**
Consonants, consonant clusters and Vowels
Module -4: Pronouncing Words:
Silent letters, Plural markers and past tense markers **(1) session**
Module -5: Interaction-2: **(1) session**
Making request and response to them ask for and give/refuse permission,Ask for and give directions, thank and respond
Module -6: Stress and Intonation **(1) session**
Module -7: Interaction-3: **(1) session**
Invite, accept, and declining invitations, Make complaints and respond to them, Express sympathy
Module -8: Presentation Skills: **(2) sessions**
Oral and PPT Presentations
Module -9: Interaction-4: **(1) session**
Apologize and respond, advice and suggest, Telephone Skills
Module -10: Group Discussions **(1) Session**

List of Augmented Experiments[2]

1. Common Errors in English
2. Listening Skills
3. Writing Skills
4. Reading Skills
5. Public Speaking
6. Interview Skills
7. Business Communication
8. Functional English
9. Preparation for GRE/TOEFL
10. Preparation for IELTS/CAT/GMAT

[2]Students shall opt any one of the Augmented Experiments in addition to the regular experiments

Reading Material (s)

1. K. Nirupa Rani, Jayashree Mohanraj and B. Indira, Strengthen Your Steps-Maruthi publications, 2012
2. K. Nirupa Rani, Jayashree Mohan Raj, B. Indira, (Ed) Speak Well (C.D) Orient Black Swan Pvt Ltd,Hyderabad, 2012
3. D. Jones, English Pronouncing Dictionary (Software)*CUP, Ver.1.0, 2003*
4. *J. Sethi, S. Kamlesh, D. V. Jindal. A Practical Course in English Pronunciation, Prentice-hall of India, New Delhi, 2007*
5. T. Balasubramanian, A Textbook of English Phonetics for Indian students, McMillan, 1981
6. K. Mohan and M. Raman, Effective English Communication, 1st Ed., Tata McGraHills, 2000
7. R. K. Bansal and J. B. Harrison, Spoken English, 3rd Ed., Orient Black Swan, Hyderabad, 1983

21HSX03 Advanced Communicative English
(Language Elective for all B Tech Programmes)

2 0 0 2

Course Outcomes

1. Summarize the information while listening to English spoken in different social and workplace contexts
2. Play different roles in Group Discussions and make formal structured presentations on academic topics using PPTslides
3. Organize information from reading texts after selecting relevant and useful points
4. Paraphrase academic texts, prepare CV and make presentations and project reports
5. Apply the knowledge of grammar in both spoken and written communication with accuracy
6. Develop vocabulary to enhance communicative ability

COs – POs Mapping

Cos	PO10	PO12
1	3	1
2	3	1
3	3	1
4	3	1
5	3	1
6	3	1

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Listening: Listening for presentation strategies and answering questions on the speaker, audience, and key points.
Speaking: Formal presentations using PPT slides without graphic elements and with graphic elements.
Reading: Reading for presenting – strategies to select, compile and synthesize information for presentation;reading to recognize academic style.
Writing: Paraphrasing; using quotations in writing; using academic style - avoiding colloquial words and phrases. Writing structured persuasive/argumentative essays on topics of general interest using suitable claims, examples and evidences for presenting views, opinions and position.
Grammarand Vocabulary: Formal/academic words and phrases; Phrasalprepositions; phrasal verbs

Novel: *Time Machine* by H G wells

15 Hours

Unit II

Listening: Following an argument/ logical flow of thought; answering questions on key concepts after listeningto extended passages of spoken academic discourse.
Speaking: Group discussion on general topics; agreeing and disagreeing, using claims
Reading: Understand formal and informal styles; recognize the difference between facts and opinions.
Writing: Formal letter writing and e-mail writing (enquiry, complaints, seeking permission, seeking internship);structure, conventions and etiquette.
Grammar and Vocabulary: Language for different functions such as stating a point, expressing opinion, agreeing/disagreeing, adding information to what someone has stated, and asking for clarification.

Drama: Hayavadana by Girlish karnad

15 Hours

Unit III

Listening: Identifying views and opinions expressed by different speakers while listening to discussions.
Speaking: Group discussion; reaching consensus in group work (academic context).
Reading: Identifying claims, evidences, views, opinions and stance/ position.
Writing: Applying for internship/ job **-** Writing one's CV/Resumeand cover letter.
Grammarand **Vocabulary:** Active and passive voice – use of passive verbs in academic writing.*Autobiography: Wings of Fire* by Abdul Kalam

15 Hours

Unit IV

Listening: Understanding inferences; processing of information using specific context clues and processing ofexplicit and implicit information inferable from the text or from previous /back ground knowledge.
Speaking: Formal team presentations on academic/ general topics using PPT slides.
Reading: Reading for inferential comprehension.
Writing: Structure and contents of a Project Report; identifying sections in project reports; understanding thepurpose of each section; significance of references.
Grammarand Vocabulary: Reinforcing learning; editing short texts; correcting common errors in grammarand usage.

Travelogue: Butter Chicken in Ludhiyana by Pankaj Mishra

15 Hours
Total: 60 Hours

Textbook (s)

1. *English All Round: Communication Skills for Undergraduate Learners*, vol.2, Published by Orient BlackSwan, 2019.

Reference (s)

1. Chase, Becky Tarver. *Pathways:Listening, Speaking and Critical Thinking.*Heinley ELT; 2nd Edition,2018.
2. Skillful Level 2 Reading & Writing Student's Book Pack (B1) MacmillanEducational.
3. Hewings, Martin.*Cambridge Academic English (B2)*. CUP, 2012. (Student Book, Teacher ResourceBook, CD & DVD)
4. Bailey, Stephen. *Academicwriting: A handbook for international students*.Routledge, 2014
5. Dhanavel,S.P. *English And Communication Skills For Students Of Science And Engineering.* OrientBlackswan, 2009.

Web resource(s)

Grammar/Listening/Writing
1. 1-language.com
2. www.5minuteenglish.com
3. www.englishpractice.com

Grammar/Vocabulary
4. English Language Learning online
5. www.bbc.co.uk/learningenglish
6. www.better-english.com
7. www.nonstopenglish.com
8. www.vocabulary.com

Reading
9. www.usingenglish.com
10. www.englishclub.com
11. www.english-online.at

Listening
12. learningenglish.voanews.com
13. www.englishmedialab.com

Speaking
14. www.talkenglish.com
15. BBC Learning English – Pronunciation tips
16. Merriam-Webster – Perfect pronunciation Exercises

All Skills
17. www.englishclub.com
18. www.world-english.org
19. learnenglish.britishcouncil.org

Online Dictionaries
20. Cambridge dictionary online
21. MacMillan dictionary
22. Oxford learner's dictionaries

21MAX02 Engineering Mathematics II

(Common to all B. Tech. Programmes)

3 0 0 3

Course Outcomes

1. Solve problems related to engineering applications using integral transform techniques
2. Make use of Laplace transforms in solving the differential equations with the initial and boundaryconditions
3. Utilize basic knowledge of conservative field, potential function and work done and also identify therelationships between line, surface and volume integrals in engineering problems
4. Find the Fourier series of periodic functions and expand a function in sine and cosine series
5. Solve problems related to basic linear and non-linear partial differential equations
6. Formulate and solve some of the physical problems of engineering using partial differential equations

COs – POs Mappings

COs	PO1
1	3
2	3
3	3
4	3
5	3
6	3

3- Strongly linked | 2-Moderately linked | 1-Weakly linked

Unit I
Laplace Transforms

Laplace transforms of standard functions, Shifting Theorems, Transforms of derivatives and integrals (Properties- without proofs), Unit step function, Dirac delta function, evaluation of definite integrals Inverse Laplace transforms, Convolution theorem (without proof), Application of Laplace transforms toordinarydifferential equations with constant coefficients

Laplace transforms of Periodic functions

15 Hours

Unit II
Vector Calculus

Vector Differentiation-Gradient, Divergence, Curl and Vector Identities (without proofs)
Vector Integration - Line integral, work done, Scalar Potential function, surface and volume integrals, Vector integral theorems- Green's, Stokes and Gauss Divergence Theorems (Theorems without proof) and related problems

Proofs of Vector Identities

15 Hours

Unit III
Fourier Series and Transformations

Fourier series– even and odd functions, Half-range sine and cosine series, Fourier integral theorem (without proof) Fourier transforms – sine and cosine transforms, properties (without proofs), inverse Fourier transforms.

FourierTransformofconvolutionproducts

15 Hours

Unit IV
Partial Differential Equations and Applications

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions, solutionsof first order linear (Lagrange) equations and non-linear equations (four standard types) Method of Separation of Variables, Applications to wave equation, one dimensional heat conduction equationand two-dimensional Laplace equation (Cartesian form)

Charpit's method

15 Hours
Total:60 Hours

Textbook (s)

1. Dr. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 42nd Edition, New Delhi, 2012
2. S. R. K. Iyengar, R. K. Jain,Advanced Engineering Mathematics, Narosa Publishing House, 4th Edition,New Delhi, 2014
3. B. V. Ramana , Engineering Mathematics, Tata McGraw Hill, New Delhi, 4th Edition,2009

Reference book (s)

1. T. K. V. Iyengar*et.al,* Engineering Mathematics, 12th Edition,Volume -II, S. Chand Publishers, 2014
2. U. M. Swamy*et.al,*A Text Book of Engineering Mathematics – I, Excel Books, New Delhi, 2010
3. D.S.Chandrashekharaiah, Engineering Mathematics, Vol- 1, Prism Publishers, 2010
4. Erwin Kreyszig Advanced Engineering Mathematics, Wiley Student Edition,9th Edition, 2012

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Int. Test 3[1] (%)
Remember	10	10	-
Understand	30	30	-
Apply	60	60	70
Analyze	-	-	10
Evaluate	-	-	20
Create	-	-	-
Total (%)	100	100	100

Sample question (s)

Remember

1. Define unit step function.
2. Solve the PDE. $\sqrt{p} + \sqrt{q} = 2x$.

Understand

1. Interpret Laplace transform technique $y^{11} - 3y^1 + 2y = e^{3t}$ given $(0) = 1\ and\ y^1(0) = 0$.
2. Show that the vector $(x^2 - yz) - (y^2 - zx)\ J - (z^2 - xy)\ K$ is Irrotational.

Apply

1. Verify Gauss divergence theorem $F = (x^3 - yz) - 2x^2y\ J - z\ K$taken over the surface of the cubeformed by the planes $x = y = z = a$ and coordinate planes.
2. A tightly stretched string with fixed end points $x = 0\ and\ x = l$is initially in a position given by $y = y_0 \sin^3 \frac{\pi x}{l}$.If it is released from rest from this position, find the displacement $y(x, t)$.

Evaluate

1. Using Laplace transform to evaluate $\int_0^\infty \frac{\cos at - \cos bt}{t}\ dt$
2. Evaluate $(x) = x^2$as a fourier series in $-\pi < x < \pi$.

Analyze

1. Examine whether $F = (y^2 cosx + z^3) + (2ysinx - 4) + (3xz^2 + 2)$ is a conservative vector field ? If so find the scalar potential?
2. Distinguish Gradient, Divergence and Curl by using their physical interpretation.

[1]Open book Examination

21BEX06 PYTHON PROGRAMMING

3 0 0 3

Course Outcomes

At the end of the course, students will be able to

1. Understand the fundamentals of Python with syntax and semantics.
2. Apply the concepts of conditional and control flow statements.
3. Apply the concepts of strings, dictionaries, sets, list and tuples.
4. Demonstrate and apply the concepts of Functions and Modules.
5. Understand and apply the concepts files and demonstrate searching and sorting mechanisms.
6. Understand exception handling in Python and standard libraries using classes and objects.

CO – PO Mapping

CO	PO_1	PO_{12}
1	3	1
2	3	1
3	3	1
4	3	1
5	3	1
6	2	2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I **16 Hours**

Introduction: Brief history and need for python programming, Running Python Scripts, Identifiers., Statements, Variables, Keywords, Input-Output statements, Indentation, command line arguments.
Types - Integers, Strings, Booleans **Operators**-Arithmetic, Comparison/Relational, Assignment, Logical, Bitwise, Membership, Identity **Expressions and order of evaluations-** Precedence and Associativity.
Conditional Statements: Simple If, If-Else, Elif statement types, pass statements and iteration statements-While, For, Break, Continue **Lists-** List Traversals, Slicing, List Methods, List Comprehension and Multi-Dimensional List

Applications of Python, REPL (Read, Evaluation, Print, Loop)

Unit II **14 Hours**

Introduction to Strings: String initialization and declaration, String Values, String Formatting and Multi Line Strings, String slicing. **Introduction to Tuple, Dictionary and Sets:** Dictionary, dictionary operations and dictionary methods, Sets, set operations, Tuple, Tuple operations and methods
Methods Available in Python: eval syntax and its use cases, filter, reduce, map

Grouping with Dictionaries, Keyword Arguments

Unit III **15 Hours**

Functions- Defining Functions, Calling Functions, Types of Arguments, Anonymous Functions, Scope of the Variables in a Function - Global and Local Variables. **Modules and Packages-** Creating modules, import statement, from. Import statement. Math and itertools modules.
Files-Creating files, operations on files - Open, Close, Read and Write. **Searching and Sorting:** Searching techniques-Linear search and Binary search. Sorting techniques-Bubble sort.

Lambda function, Decorators.

Unit IV **15 Hours**

Classes and Objects in Python: Class-Creating a Class in Python, Object-Creating an Object in Python, The Constructor Method, Classes with Multiple Objects, File Objects. **Exception Handling-** Exception, try except block, Raising Exceptions, User Defined Exception.
Numpy and Pandas: Introduction to Numpy and Pandas packages of python, Basic operations on numpy and pandas.

Regular Expressions, Methods for Boolean Array.

Total: 60 Hours

Textbook (s)

1. Richard L. Halterman, "Fundamentals of Python Programming" , 3rd Edition, Southern Adventist University, 2019.
2. Willaim Mckenny, "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython" 2nd Edition, O'Reily 2017.

Reference(s)

1. Wesley J Chun, "Core Python Applications Programming", 3rd Edition, Pearson Education India, 2015.
2. Kenneth A. Lambert. "Fundamentals of Python: First Programs", 2nd Edition, Publisher: Cengage Learning 2018
3. Python Programming: A Modern Approach, VamsiKurama, Pearson 2017 Learning Python, Mark Lutz, Orielly, 5th Edition.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	30	30	--
Understand	50	40	--
Apply	20	30	50
Analyze	--	--	50
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Remember

1. What are the benefits of Python?
2. What is an Interpreted language?
3. List any four string handling functions

Understand

1. Explain lists and tuples?
2. Differentiate between the two?
3. What are Dict and List comprehensions?

Apply

1. Explain user defined exception
2. Justify multiple inheritance is supported in python?
3. Design a simple GUI page using Tkinter

Open Book Exam Questions

1. Write a program which accepts a sequence of comma-separated numbers from console and generate a list and a tuple which contains every number.Suppose the following input is supplied to the program: 34, 67, 55,33,12,98.
   Then, the output should be:
   ['34', '67', '55', '33', '12', '98']
   ('34', '67', '55', '33', '12', '98')

2. A website requires the users to input username and password to register. Write a program to check the validity of password input by users.Following are the criteria for checking the password:
   At least 1 letter between [a-z]
   At least 1 number between [0-9]
   At least 1 letter between [A-Z]
   At least 1 character from [$#@]
   Minimum length of transaction password: 6
   Maximum length of transaction password: 12
   Your program should accept a sequence of comma separated passwords and will check them according to the above criteria. Passwords that match the criteria are to be printed, each separated by a comma.
   Example: If the following passwords are given as input to the program:
   ABd1234@1,a F1#,2w3E*,2We3345
   Then, the output of the program should be:
   ABd1234@1

21BEX07 PYTHON PROGRAMMING LABORATORY

0 0 3 1.5

Course Outcomes

1. Understand the available programming platforms for problem solving using python.
2. Apply mathematical and logical methods which improve critical thinking.
3. Understand and apply python programs with constraints and iterative statements.
4. Develop python programs step-wise by defining functions and calling them.
5. Apply python lists, tuples and dictionaries for representing compound data.
6. Analyze various searching and sorting techniques using python and apply exception handling.

Co-Po Mapping

CO	PO4
1	3
2	3
3	3
4	3
5	3
6	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

WEEK-1

1. A) Installation of Python and setting up environmental variables.
   B) Write a Python program to perform the following operations on two integers a and b
      - Arithmetic operations
      - Logical operations

   C) Write a python Program to find the ASCII value of a Character and vice versa (use ord and chr methods).

   D) Write a python Program to convert a given decimal number into binary, octal and hexadecimal (use bin, oct and hex methods).

WEEK-2

2. A) Write a Python program to check the given year is a leap year or not using if statement.
   B) Write a Python program to check the given number is Armstrong or not using iteration statements.
   C) Write a Python Program to perform following operations on List
      - Create a Empty list
      - Append the elements into list
      - Find the length, minimum, maximum.

WEEK-3

A) Write a Python program to use python generators to print all the prime numbers upto the given value n.

B) Write a Python program for a given list of numbers print all the numbers one by one using iterators in python.

WEEK-4

A) Write a Python program to flatten a nested list.

B) Write a Python program to find the transpose of the matrix using list.

C) Write a Python program to split a list into evenly sized chunks.

WEEK-5

A) Write a Python program in a given list of numbers create another list of even numbers using list comprehension.

B) Write a Python program in a given a list of numbers n form a tuple of two numbers such that highest maximum and lowest minimum are in 1 tuple, second max and second min in other tuple and so on

Eg: Given list of numbers 1, 4, 6, 2, 3, 5

Output: ((6,1),(5,2), (4,3))

WEEK-6

A) Write a Python Program to remove punctuations from a String.

B) Write a Python program to count the frequency of characters in the string and store them in a dictionary data structure.

WEEK-7

A) Write a Python program to find the cube of a given number using lambda()/anonymous function.

B) Write a Python program to filter only even numbers from a given list using filter method.

WEEK-8

A) Write a Python program to find the squares of the list of numbers using map function.

B) Write a Python program to print all the combinations for the given list of numbers using itertools.

C) Write a Python program to print all the permutations for the given list of numbers using itertools.

WEEK-9

A) Define a class and write a method which accepts multiple parameters/arguments and find the sum of given parameters.

B) Write a Python program to find the sum of the elements in the array using reduce function of the python.

WEEK-10

A) Write a Python program to search a key element in the list using linear search approach.

B) Write a Python program to sort the given list using bubble-sort technique.

WEEK-11

A) Write a python program to Convert the given list to numpy array.

B) Write a Python program to Remove rows in numpy array that contains non-numeric values.

C) Write a Python program to Find the number of occurences of sequence in numpy array.

WEEK-12

A) Write a python program to Combine one and two – dimensional numpy array.

B) Write a Python program to Perform matrix multiplication on numpy arrays.

C) Write a Python program Create a pandas data frame with two dimensional list.

WEEK-13

A) Write a Python program to Create a data frame from dict of numpy array.

B) Write a Python program to Clean the string data in the given pandas data frame.

C) Write a Python program on Conditional operations on pandas data frame.

List of Augmented Experiments

1. Read n strings as input and print the frequency of characters in all the string but keep the below cases in mind
    - If string contains any digit raise user defined exception “string has digit in it”
    - If string contains any space raise user defined exception “string has space in it”
    - If string contains any special characters raise a user defined exception “string contains special characters”
2. Implementation of Selection Sort using Python.
3. Implementation of Insertion Sort using Python.
4. Develop a gaming application Tic Tac Toe.
5. Develop a gaming application Chess.
6. Develop an editor in Python.
7. Develop a program to test the typing speed using Python.
8. Develop a program for Number Guessing.
9. Develop Website using Python.
10. Develop a Game Spin a Yan.
11. Develop a Phone Book using Python.
12. Develop Python Story /Paragraph Generator using Keywords entered(min 10 keywords to be entered)

21HSX04 Communicative German

(Language Elective for all B Tech Programmes)

2 0 0 2

Course Outcomes

1. Demonstrate an awareness of the relevance of foreign languages and understanding of the foreign culture
2. Show a basic level of proficiency necessary in an environment where German is used professions and careersexclusively
3. Make use of German language in description, narration, asking/answering questions and short statements forthe variety of topics and situations
4. Build familiar vocabulary, everyday expressions and very simple sentences, which relate to the satisfying ofconcrete needs
5. Comprehend the foreign language with sufficient ability to grasp the main idea and some supporting detailsin short conversations
6. Write sentences and short paragraphs in German language

COs – POs Mapping

COs	PO10	PO12
1	3	1
2	3	1
3	3	1
4	3	1
5	3	1
6	3	1

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit-1

Grammar:

1) Nouns 2) Indefinite articles 3) Definite articles 4) Prepositions 5) Negation 6) Interrogatives 7) Conjugationof verbs in present perfect 8) Conjugation of verbs in present tense

15 Hours

Unit-2

Vocabulary:

1) Alphabet 2) Transport 3) Hobby4) Birthday 5) Colors 6) Numbers 0 to 100 (Ordinal, cardinal) 7) Parts of theface and body 8) Clothes 9) Fruits and vegetables 10) Time, Days, Months, Seasons

15 Hours

Unit-3

Communicative skills:

1) How to greet 2) Locating objects and places 3) How to ask and answer questions 1) How to introduce oneself4)How to talk about the weather5) How to talk over the telephone

Grammar:

1) Personal Pronoun 2) Imperative mood 3) Nominative and Accusative cases 4) Dative case 5) Adjectives 6)Separable and Inseparable verbs 7) Modal verbs 8) Conjunctions 9) Plurals

15 hours

Unit-4

Civilization:

1)Greetings2) Etiquettes3) Facts about Germany4) German customs and traditions5) Food culture in Germany

Vocabulary:

1) Food and Drinking 2) Family and Friends 3) Names of Country, its Citizens & Language 4) Vacation 5) Home 6) Furniture 7) Office 8) Directions 9) Shopping 10) Contacts 11) Daily routine 12) Games/Sports 13) MedicalEquipment

15 hours

Total: 60 hours

Recommended study material:

1. Netzwerk A1 Kursbuch by Stefanie Dengler, Paul Rusch, Helen Schmitz, Tanja Sieber
2. Netzwerk A1 Arbeitsbuch by Stefanie Dengler , T Mayr-Sieber, Paul Rusch

21HSX05 Communicative French
(Language Elective for all B Tech Programmes)

2 0 0 2

Course Outcomes

1. Demonstrate an awareness of the relevance of foreign languages and understanding of the foreign culture
2. Show a basic level of proficiency necessary in an environment where French is used professions and careersexclusively
3. Make use of French language in description, narration, asking/answering questions and short statements forthe variety of topics and situations
4. Build familiar, everyday expressions and very simple sentences, which relate to the satisfying of concreteneeds
5. Comprehend the foreign language with sufficient ability to grasp the main idea and some supporting detailsin short conversations
6. Write sentences and short paragraphs in French language

COs – POs Mapping

Cos	PO10	PO12
1	3	1
2	3	1
3	3	1
4	3	1
5	3	1
6	3	1

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit-1

Grammar: 1) Nouns2)Indefinite articles3) Definite articles4) Prepositions5) Negation6) Interrogatives7) Irregular verbs (Present tense) : être8) Regular verbs (Present tense): -er 9) Expressions : c'est, cesont, il y a. 10)Imperative mood

15 Hours

Unit-2

Vocabulary: 1) Alphabet 2) Geography of France 3) Days4) Months5) Colours 6) Numbers 0 to 100 (Ordinal,cardinal) 7) Parts of the face and body

15 Hours

Unit-3

Communicative skills: 1) How to greet2) Locating objects and places3) How to ask and answer questions4)How to introduce oneself 5) How to talk about the weather6) How to talk over the telephone
Grammar: 1) Contracted Articles 2) Irregular verbs (present tense): avoir, aller, faire, venir, écrire, lire, recevoir. 3) Adjectives 4) Verbs: -ir (present tense) 5) Tense: futurproche 6) Impersonal verbs: pleuvoir ; neiger.
7) Possessive adjectives

15 hours

Unit-4

Civilization: 1)Greetings 2) Etiquettes3) Facts about France4) French customs and traditions5) Food culture
Vocabulary: 1) Clothes 2) Fruits and vegetables 3) Festivals

15 hours
Total: 60 hours

Recommended study material

1. **Sans frontieres 1**by Michèle Verdelhan-Bourgad

21HSX09 Communicative Hindi

(Language Elective for all B Tech Programmes)

2 0 0 2

Course Outcomes

1. Build confidence to speak Hindi language and demonstrate an awareness and relevance of Hindi language
2. Show a basic level of proficiency in speaking in meaningful conversations in careers
3. Make use of good vocabulary in description, narration, asking/answering questions and short statements for the variety of topics and situations
4. Practice familiar, everyday expressions and sentence structures, which relate to the satisfying of concreteneeds
5. Comprehend the language and grasp the main idea and some supporting details in short conversations.
6. Write simple sentences and short paragraphs in Hindi language

COs – POs Mapping

Cos	PO10	PO12
1	3	1
2	3	1
3	3	1
4	3	1
5	3	1
6	3	1

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Writing: Introduction to Alphabet (phonology) –classification; Mathra
Vocabulary: Useful words- home, animals, birds, vegetables, flowers, fruits, relationships, days, months
Grammar Noun, Pronoun, verb, adjective, adverb, post position, conjunction, interjection.

15hours

Unit II

Vocabulary: Antonyms, synonyms, gender, vachan, suffix, prefix
Speaking:. Simple sentences, comparative sentences, Sentence structures, use of want, not, don't, must, so-that, aa-ee-ye
Grammar: Tense, Usage of lag-sak-chuck-Degrees of comparison

15hours

Unit III

Writing: Official, Formal and informal letters
Speaking: Self- introduction, Conversations (at bank, post office, etc.)
Grammar and Vocabulary: Translations - words; sentences, paragraphs. **15 hours**

Unit IV

Writing: Short notes/stories, Essay writing
Speaking: Short talk and Conversations in travel, market etc
Vocabulary: Names of numerals, business vocabulary, time and scales of measurement etc.

15 hours
Total: 60 hours

Recommended Study material:

1. MeenuKaturia. *Saral Hindi Vyakaran tatha Rachana. Kumar publications Delhi.*
2. N.RajeshRakhade & G.kanaka Durga*. Hindi Speaking course,* Mudra Books. 2014

21ME301 Engineering Materials and Manufacturing Technology

3 0 2 4

Course Outcomes

1. Understand the properties and applications of Ferrous and Non-Ferrous alloys
2. Interpret proper moulds and gating system design
3. Choose proper melting furnace
4. Identify and distinguish the process details of metal joining processes
5. Explain the characteristics of cold and hot working processes
6. Understand the principle of press working of metals

COs – POs Mapping

COs	PO_1	PO_2	PO_3	PO_4
1	2	2	-	3
2	2	2	1	3
3	2	2	1	3
4	3	2	-	3
5	3	3	-	3
6	3	2	-	3

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit- I

Introduction to Engineering materials

Classification of steels, structure and properties of plain carbon steels, low alloy steels, stainless steels, structure and properties of white cast iron, malleable cast iron, grey cast iron and spheroidal grey cast iron. Structure, properties and applications of copper and its alloys, aluminium and its alloys. Introduction to Composite Materials.

Practical Components

1. Preparation and study of microstructure of Cast Iron
2. Preparation and study of microstructure of Copper
3. Preparation and study of microstructure of Aluminium
4. Preparation and study of the microstructure of low carbon, medium carbon and high carbon steels

11+6 Hours

Unit- II

Casting Process: Basic casting process, Patterns, pattern allowances and their application, Principles of Gating and risering systems, Special casting processes: CO_2, Shell moulding, Centrifugal, Die and Investment casting. Solidification of casting, Solidification of pure metal and alloys, short & long freezing range alloys.

Methods of Melting: Types of furnaces, Crucible melting, Cupola operation.

Practical Components

1. Design and preparation of a rectangular pattern for the preparation of a mould cavity
2. Preparation of a mould cavity for a straight pipe
3. Testing of Flowability of Moulding sand
4. Testing of hardness of Moulding sand

12+8 Hours

Unit- III

Welding Process-Special welding and Other Joining processes

Welding process – Introduction; Classification of welding processes - ARC welding, Gas welding and Cutting, Thermit welding, Plasma welding processes and their characteristics; Types of welded joints and its characteristics; Heat affected zones in welding, Welding defects - reasons and remedies

Special welding processes - Friction and Explosive welding

Other Joining processes - Soldering & Brazing

Practical Components

1. Preparation of a Lap joint using Arc Welding setup
2. Preparation of a T-joint in using Arc welding setup
3. Preparation of a weld joint using Spot welding setup
4. Strength test of a weld joint on a Universal testing machine

12+8 Hours

Unit- IV

Bulk metals Processing

Hot and cold working - Characteristics; Rolling - Fundamentals, Forging - Types, hammers, defects; Die Materials. Basic extrusion process and its characteristics; Analysis and Power requirement estimation in rolling, forging and extrusion processes

Press working of metals - Operations and their characteristics, Drawing processes and its force analysis, Hot and cold spinning, Types of presses

Practical Components

1. Preparation a washer of given dimensions using blanking and piercing operations with progressive dies
2. Preparation of an elbow pipe using Injection Moulding equipment
3. Study of Blow Moulding machine

12+8 Hours

Total: 45+30 Hours

Textbook(s)

1. V. Raghavan, Elements of Materials Science, PHI Learning, 5th Edition, 2004
2. S Kalpakjian, S R. Schmid, Manufacturing - Engineering and Technology, Pearson publications, 4th Edition, 2016
3. P.N.Rao, Manufacturing Technology –Foundry, Forming and Welding, McGrawHill Companies, Volume 1, 3rd Edition, 2016

Reference(s)

1. R.K. Rajput, Engineering Materials & Metallurgy", S. Chand Publications, 2nd Edition, 2006
2. O.P. Khanna, Welding Technology, Dhanpat Rai Publications, 22nd Edition, 2015
3. Amitabha Ghosh, and Ashok Kumar Mallik, Manufacturing Science, East West Press Private Ltd., 2nd Edition, 2016
4. H S Bava, Manufacturing Processes – II, Tata McGraw-Hill Publishing Company Limited, First Reprint, 2016

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Lab Examination (%)
Remember	35	30	-
Understand	35	25	-
Apply	20	25	40
Analyze	10	20	40
Evaluate	-	-	20
Create	-	-	-
Total (%)	100	100	100

Sample Question(s)

Remember

1. List any three essentials of Metal Casting.
2. List any four properties of moulding sand.
3. Define arc welding.
4. List any three types of patterns.
5. Recall the classification of welding processes.
6. Name any two types of mechanical working of metals.
7. List any four press working operations.

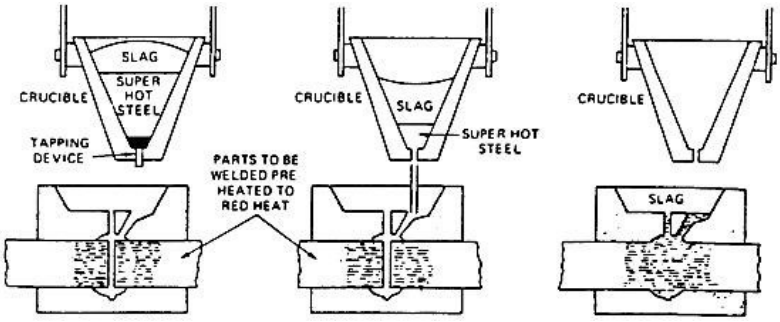
Understand

1. Compare the properties of grey cast iron with white cast iron.
2. Classify the Tool Steels.
3. Explain the method of determining the moisture content in molding sand?
4. Compare Gas welding and Gas Cutting processes in atleast three points.
5. Compare drop forging and press forging processes in atleast four points.
6. Compare blow & injection moulding processes.
7. Explain sand mould making procedure with support of neat diagram.
8. Illustrate recrystallization and grain growth analysis.
9. Outline the Arc welding process with neat diagram.

Apply

1. A rectangular mold with dimensions 100 mm×200 mm×400 mm is filled with copper with no superheat. Determine the final dimensions of the part as it cools to room temperature. Repeat the analysis for gray cast iron.
2. Determine the maximum force required for extruding a cylindrical aluminium billet of 50 mm diameter and 75mm length to a final diameter of 10mm. The average tensile yield stress for aluminium is 170 N/mm^2.
3. Build a schematic figure depicting all the basic casting process and special casting process.
4. Develop a schematic diagram that shows the basic extrusion process.
5. Choose a processing technique from a) Blow moulding, b) Injection moulding, c) Arc welding, d) Gas welding to manufacture the object depicted below:

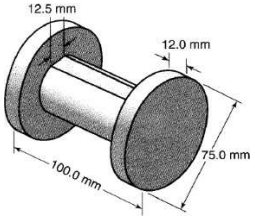
6. Identify the welding process presented in below picture:



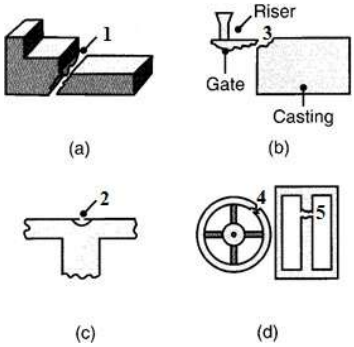
7. A sprue is 300 mm long and has a diameter of 125 mm at the top. The molten metal level in the pouring basing (which is much larger than the top of the sprue) is taken to be 75 mm from the top of the sprue for design purposes. If a flow rate of 650 mm^3/s is to be achieved, what should be the diameter at the bottom of the sprue? Will the sprue aspirate? Explain.
8. A jeweler wishes to produce 24 gold rings in one investment-casting operation. The wax parts are attached to a wax central sprue 12 mm in diameter. The rings are located in four rows, each 12 mm from the other on the sprue. The rings require a 3-mm diameter,12-mm long runner to the sprue. Estimate the weight of gold needed to completely fill the rings, runners, and sprues.
9. Select the best suitable materials among the alloy steels available for manufacturing of railway tracks.

Analyze

1. How a hot chamber die-casting differs from cold chamber die-casting?
2. How a runner extension is helpful for good casting quality?
3. Enunciate the factors based on which the type of fabrication method is chosen for a given application.
4. The blank for the spool shown in figure below is to be sand cast out of A-319, an aluminum casting alloy. Make a sketch of the wooden pattern for this part, and include all necessary allowances for shrinkage and machining.



5. Figure below indicates various defects and discontinuities in cast products marked as **1,2,3,4&5**.
   a. Identify each defect
   b. Offer solutions to avoid it.



6. Differentiate between MMC‟s and C-C Composites
7. Compare the physical, chemical and mechanical properties of ceramics with those of metals.

21ME302 Computer Aided Machine Drawing

3 0 2 4

Course Outcome(s)

1. Apply the principles of engineering drawing in machine drawing using a 2D CAD software
2. Understand and construct the sectional views of the given isometric view of an object or machine element using a 2D CAD software
3. Construct computer aided fasteners namely screwed fasteners and key joints drawings using a 2D CAD software
4. Construct computer aided fasteners namely shaft couplings and riveted joints using a 2D CAD software
5. Develop assembly drawings from the given part drawing using a 2D CAD software
6. Produce part drawing from given assembly drawing using 2D CAD software

COs-POs Mapping

COs	PO_1	PO_5	PO_{10}	PSO_1
1	3	3	3	3
2	-	2	3	2
3	3	3	2	3
4	3	3	3	3
5	3	3	3	3
6	3	3	3	3

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Through drafting using any one drafting software (for Unit I and Unit II):

Unit- I

Principles of Drawings

Sections

Hatching of sections, cutting planes, Revolved or removed section, half section, Local section

Conventional representation

Common features, Springs, Gears, Materials Interrupted views and Braking of Shaft, Pipe, Bar Surface finishing & Machining Symbols

Dimensioning

General principles, Method of execution, Methods of indicating dimensions, arrangement of dimensions, Special indications and Standard abbreviations. Sectional views: Full section, half section and Auxiliary Sections

Practical Components

1. Principles of drawing: Exercise covering hatching of sections, cutting planes, dimensioning etc.,
2. Conventional representation: Conventional representation of common machine components, Dimensioning and standard abbreviations
3. Sectional views: Draw the sectional views from the front, the view from above and the sectional view from the left/ right from the given isometric view of an object or machine element

18 Hours

Unit- II

Fasteners

Screwed Fasteners

Screw thread nomenclature, Forms of threads, Types of thread profiles, Representation of threads, Bolted joints, Locking arrangements, Foundation bolts

Key Joints

Types of Key Joints, Type of Cotter Joints, Types of Pin Joints and knuckle Joints

Shaft couplings

Introduction, Applications of couplings, Types of Couplings, Working Principles

Riveted Joints: Introduction, Rivet and Riveting, Classification of rivets, Terminology of riveted joint, Types of riveted joints

Practical Components

1. Screwed fasteners – 1
   a. Construction of different types of thread profiles, Methods of drawing hexagonal and square nuts
   b. Forms of nuts, Construction of locking arrangements for nuts (Lock nut, locking by split pin, Wile's lock nut, Grooved nut, locking by plate and locking by spring washer)
2. Screwed fasteners – 2

   a. Eye foundation bolt
   b. Bent foundation bolt
   c. Rag foundation bolt
3. Key joints: Flat Saddle keyed joint, hollow saddle keyed joint, round keyed joint, Cotter joint with sleeve, Cotter joint with socket and spigot ends, Knuckle joint
4. Shaft couplings – 1: Rigid couplings
   Construction of Butt-muff coupling, Half-lap muff coupling, flanged coupling, Protected flanged coupling
5. Shaft couplings – 2: Flexible couplings
   Construction of universal coupling and Oldham coupling
6. Riveted joints:
   Construction of different types of riveted heads namely snap head, cone head and flush counter-sunk head
   a. Riveted Lap joint: Single riveted lap joint, Double riveted chain lap joint, Double riveted zig-zag lap joint
   b. Riveted Butt joint: Single riveted single strap butt joint, single riveted double strap butt joint

27 Hours

Through Solid modeling using any one solid modeling software (for Unit III and Unit IV):

Unit- III

Assembly Drawings

Introduction, Importance of BOM, Assembly procedures, Construction of assembly drawings from the given part or detailed views, using conventions and easy drawing proportions, Assembly drawings of Stuffing box, Single tool post, Plummer block, Screw Jack, flanged coupling, protected flanged coupling, knuckle joint

Practical Components

1. Construction of assembly drawing of Stuffing box
2. Construction of assembly drawing of Plummer block
3. Construction of assembly drawing of Screw jack

21 Hours

Unit- IV

Part drawings

Introduction, Importance of BOM, Part drawing procedure, construction of part drawings from the given assembly drawings using conventions and easy drawing proportions. Part drawings of Stuffing box, Single tool post, Plummer block, Screw Jack, Protected flanged coupling, Oldham coupling

Representation of size, tolerances, geometric dimensioning and machining symbols required for the production of machine parts in shop floor

Practical Components

1. Construction of part drawings of Oldham coupling
2. Construction of part drawings of single tool post
3. Construction of detailed production drawings of screw jack
4. Construction of detailed production drawings of Plummer block

24 Hours

Total: 90 Hours

(**Note:** Sheets under Unit-I and II need to be practiced with any one basic 2D drafting software, Sheets under Unit III and IV need to be practiced with any one solid modelling software and Sheets on production drawing may be practiced either with Drafting software or solid modelling software)

Textbook(s)

1. Machine Drawing – K. L. Narayana, P. Kannaiah & K. Venkata Reddy, New Age Publishers, 4th Edition, 2014
2. Production Drawing – K. L. Narayana, P. Kannaiah, K. Venkata Reddy, New Age International, 3rd Edition, 2014

Reference(s)

1. Machine Drawing includes AutoCAD – Ajeet Singh, McGraw Hill, 2nd Edition, 2012
2. Machine Drawing with AutoCAD- Goutam Pohit, Goutam Ghosh, Pearson Education, 1st Edition, 2007

Sample Question(s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)
Remember	25	--
Understand	35	--
Apply	40	50
Analyze	--	--
Evaluate	--	40
Create	--	10
Total (%)	100	100

Remember

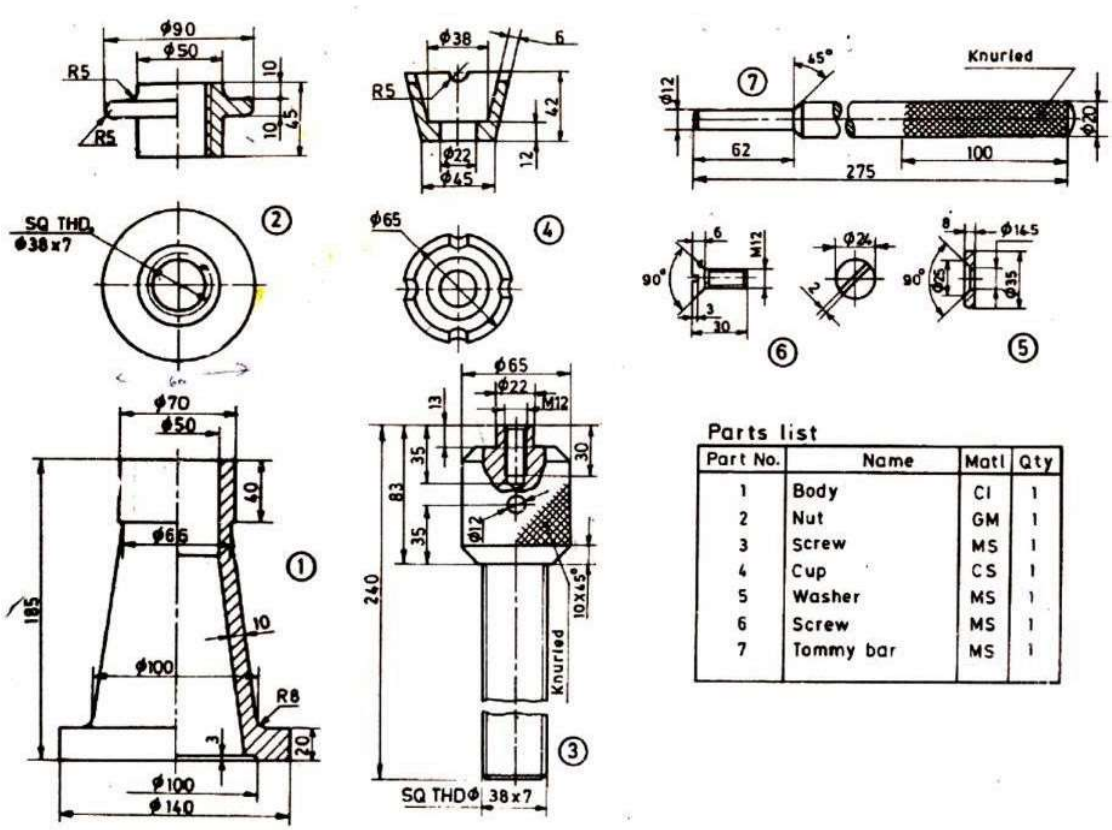
1. Show the conventional representation of concrete, aluminum, wood and glass
2. Show the conventional representation of leaf spring, spur gear, ball bearing and splined shaft
3. Sketch the method of dimensioning chamfers and countersunk
4. Recall the positions of various orthographic views in first and third angle projections

Understand

1. Explain the differences between engineering drawing and machine drawing
2. Identify the points to be considered while laying out the different views of an object
3. Interpret the usage of auxiliary section and its necessity
4. Classify the different types of screw thread forms

Apply

1. Sketch the two views of Locking by split pin with proportions marked
2. Demonstrate the various methods of fitting a Flat saddle key in position
3. Draw the sectional view from the front, view from the side of a cotter joint with sleeve used to connect two rods of 50 mm diameter each
4. Assemble all the given parts of screw jack and draw half sectional front view, top view and right-side view. Use a 3D geometric modeling software package for this purpose



Analyze

1. Differentiate between butt muff coupling and half lap muff coupling
2. Compare flanged coupling and protected flanged coupling

3. Name three types of rigid shaft couplings. Justify why they are called rigid
4. Justify where and why universal coupling is used in preference to Oldham coupling

Evaluate

1. Compare between single riveted lap joint and single riveted single strap butt joint
2. Defend the statement "production drawings are more useful than machine drawings"
3. Evaluate the importance of BOM
4. Interpret the differences between tolerance and allowance

Create

1. Generate the different views of Plummer block using a 3D software package
2. Generate the isometric views from the given orthographic views of a machine component
3. Generate the internal threads of a hexagonal headed nut in the AutoCAD software
4. Generate the parts of single tool post with appropriate production drawing symbols using a 3D software package

21ME303 Engineering Mechanics

3 0 0 3

Course Outcome(s)

1. Compute the resultant of forces and moments using free body diagrams and able to apply the concepts of friction
2. Identify the centroid of composite figures and bodies
3. Determine the area and mass moment of inertia of composite figures and bodies
4. Analyze plane truss (frame) by method of joints and method of sections
5. Apply the fundamental concepts of Kinematics and kinetics of particles to the analysis of simple, practical problems
6. Understand the fundamental concepts of kinematics and kinetics of rigid body and able to apply the work-energy and impulse - momentum principle to analyze the simple, practical problems

COs – POs Mapping

COs	PO_1	PO_2	PO_3
1	3	2	2
2	3	2	2
3	3	2	2
4	3	2	2
5	3	3	2
6	3	3	2

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit- I

System of forces-Equilibrium of system of forces

Types of Force Systems-Coplanar Concurrent Forces–Resultant–Moment of a Force and its application– Couples and Resultant of a Force System, Free body diagrams, equations of equilibrium of coplanar concurrent and non-concurrent force systems, Lami's theorem, resolution of a force into a force and a couple, Theorem of Varignon

Friction

Theory of friction–Angle of friction–Laws of friction-static friction–Kinetic friction

Polygon law of forces for resultant

14 Hours

Unit- II

Centroid-Centre of Gravity-Area Moments of Inertia-Mass Moment of Inertia

Centroids of simple figures (from basic principles)-Centroids of Composite Figures, Centre of gravity of simple body (from basic principles), center of gravity of composite bodies, Definition–Moment of Inertia of simple bodies

Analysis of perfect frames (Analytical Method)

Types of Frames-Assumptions for forces in members of a perfect frame, Method of joints, Method of sections, Force table, Cantilever Trusses, Structures with one end hinged and the other freely supported on rollers carrying horizontal or inclined loads

Radius of gyration of an area

15 Hours

Unit- III

Rectilinear motion of a particle-Kinematics-Kinetics

Introduction to Dynamics, Rectilinear motion: displacement, velocity and acceleration, Graphical representation, Motion with uniform acceleration and variable acceleration, Equations of rectilinear motion, equations of dynamic equilibrium

Curvilinear Motion of a particle-Kinematics-Kinetics

Introduction, Position vector, velocity and acceleration, Components of Motion; Equations of Motion, Equations of Dynamic Equilibrium

Motion of Projectile – Expression for time of flight, height, range and angle of projection

16 Hours

Unit- IV

Plane Motion of rigid bodies-Kinematics and Kinetics of Rigid body

Introduction to plane motion, Rotation, Relationship between linear and angular motion variables, general plane motion, absolute and relative velocity in plane motion, Instantaneous center of rotation in plane motion

Alternate approaches Motion of rigid bodies-Kinetics of Rigid Body-Work and Energy - Impulse and Momentum

Work - Energy Method: Principle of Work and Energy for a Rigid Body-Principle of Impulse and Momentum, Conservation of Momentum, Angular Momentum

Conservation of angular momentum

15 Hours

Total: 60 Hours

Textbook(s)

1. K. Vijay Kumar Reddy, J. Suresh Kumar, Singer's Engineering Mechanics Statics and Dynamics, BS Publications, 3rd Edition, 2011
2. A. K. Tayal, Engineering Mechanics Statics and Dynamics, Umesh Publications, 14th Edition, 2011
3. S. S. Bhavikatti, Engineering Mechanics, New Age International, 2008
4. S. Timoshenko & D. H. Young, and JV Rao, Engineering Mechanics, 4th Edition, TMH Education, 2006

Reference(s)

1. Irving H. Shames and G. Krishna Mohana Rao, Engineering Mechanics, 4th Edition, Pearson, 2006
2. R. K. Bansal, Engineering Mechanics, Laxmi Publications, 3rd Edition, 2004

Sample Questions(s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examinations (%)
Remember	15	15	-
Understand	20	20	-
Apply	65	65	70
Analyze	-	-	30
Evaluate	-	-	-
Create	-	-	-
Total (%)	100	100	100

Remember

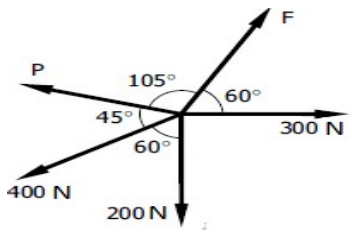
1. Name the different types of system of forces
2. Define centroid
3. Define area moment of inertia
4. State the laws of friction
5. List the assumptions of perfect frame
6. Define Rectilinear and Curvilinear motions

Understand

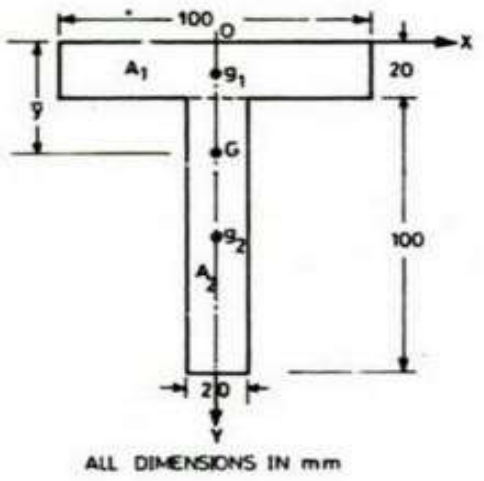
1. Explain Lami's theorem
2. Compare center of mass and center of gravity
3. Compare mass moment of inertia and area moment of inertia
4. How will you distinguish between static friction and dynamic friction?
5. Explain the difference between frame and truss
6. Explain the D Alembert's principle

Apply

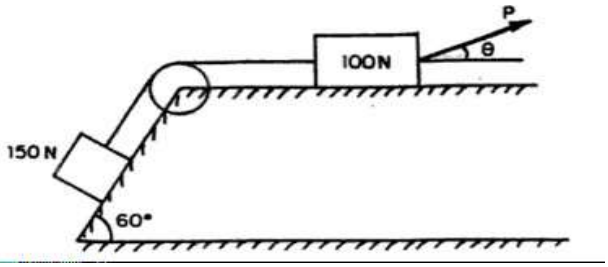
1. Figure represents the concurrent force system acting at a joint of a bridge truss. Determine the value of P and E to maintain equilibrium of the forces



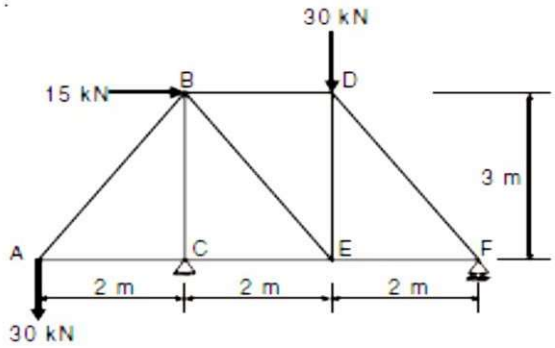
2. Identify the centroid of T-section shown in below Fig.



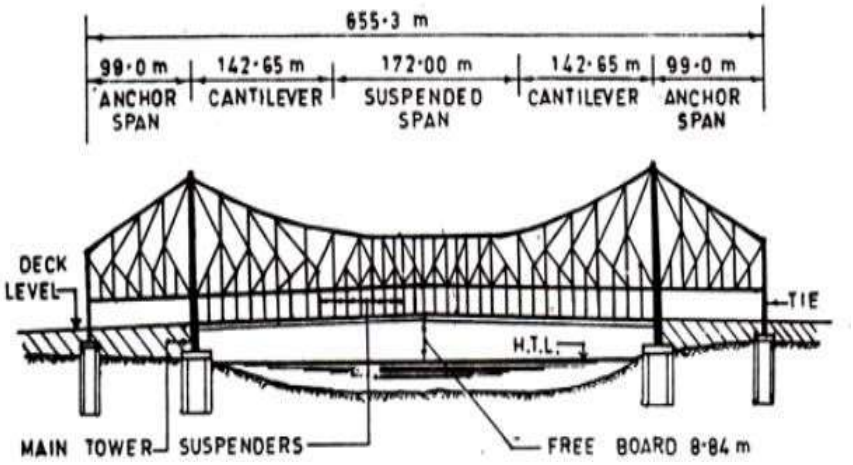
3. Determine the moment of inertia of the areas of Triangle bout its base by first principle
4. Determine the least value of force P to cause motion to impend rightwards. Assume the co-efficient of friction under the blocks to be 0.2 and pulley to be frictionless.



5. Determine the forces in all the members of the truss shown in Fig.



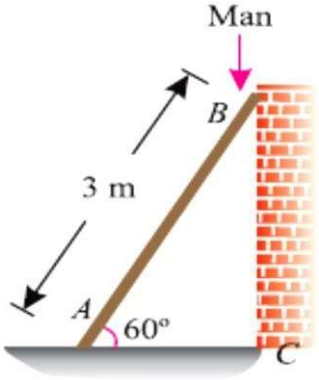
6. A stone is dropped into a well and the splash is heard two seconds later. If sound travels 335m/s, what is the depth of the well?
7. Determine the axial forces on each member temporary/semi-permanent steel bridges such as Bailey or Callender-Hamilton have been illustrated in Fig. **(For Open Book Examination and not for semester end examination)**



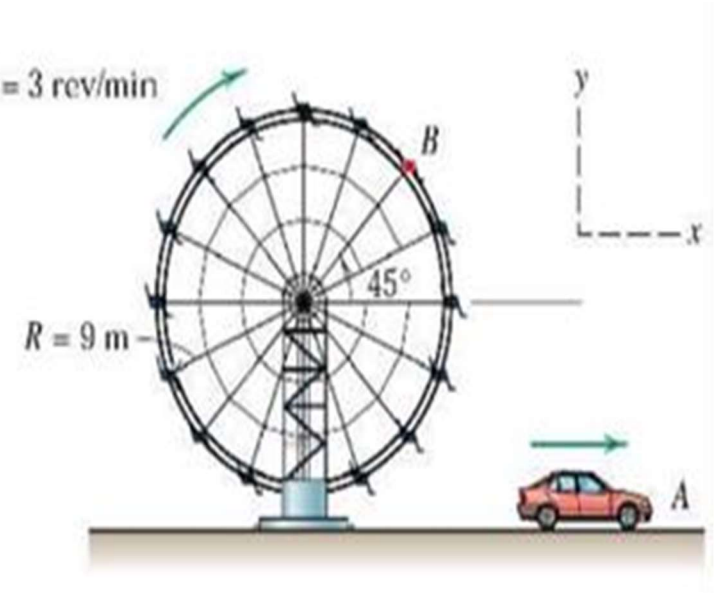
8. An 1800 kg Toyota Innova travels down the 10° inclined road at a speed of 6 m/s. If the driver jams on the brakes, causing his wheels to lock, solve how far the tires skid on the road using: a. Equation of the motion b. Principles of work-Energy The coefficient of kinetic friction between the wheels and the road is 0.5 **(For Open Book Examination and not for semester end examination)**

Analyze

1. A uniform ladder 3 m long weighs 200 N. It is placed against a wall making an angle of 60° with the floor as shown in Fig. The coefficient of friction between the wall and the ladder is 0.25 and that between the floor and ladder is 0.35. The ladder, in addition to its own weight, has to support a man of 1000 N at its top at B. Calculate: i) The horizontal force P to be applied to ladder at the floor level to prevent slipping. ii) If the force P is not applied, what should be the minimum inclination of the ladder with the horizontal, so that there is no slipping of it with the man at its top?

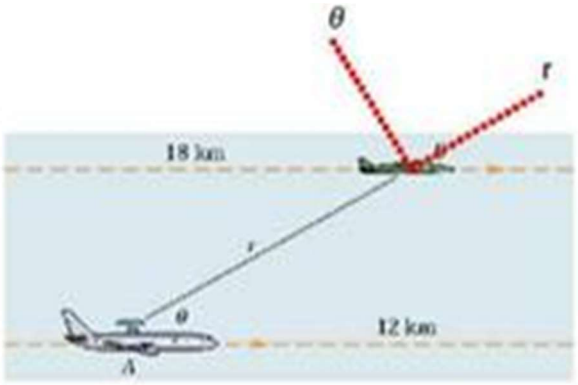


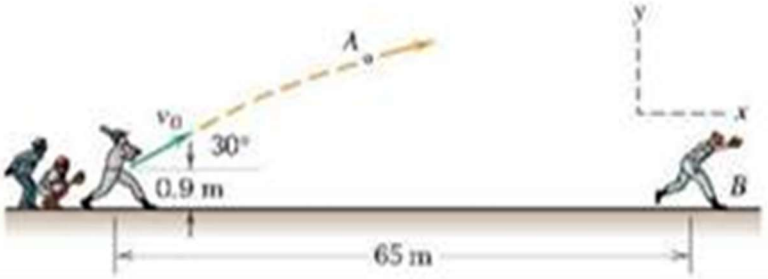
2. Compare the location of the centroids of an arc of circle and a sector of a circle subtending the same angle at the centre of the circle
3. A car A is travelling on a straight level road with a uniform speed of 60 km/hr. it is followed by another car B moving at a speed of 70 km/hr. when the distance between them is 2.5 km, the car B is decelerated at 20 km/ hr^2 . will the car be catch up with A? if not, why not? If yes, at what distance and time?
4. Analyze the ability of a hook (used by a crane) to raise prefabricated walls upright. The hook was approximately J-shaped, with a lip. The hook would grip one end of the wall and lift, while the other end of the wall remained in contact with the ground **(For Open Book Examination and not for semester end examination)**
6. The car A has a forward speed of 18 km/h and is accelerating at 3 m/s^2 Determine the velocity and acceleration of the car relative to observer B, who rides in a nonrotating chair on the Ferris wheel. The angular rate ω = 3 rev/min of the Ferris wheel is constant **(For Open Book Examination and not for semester end examination)**



7. A batter hits the baseball A with an initial velocity of v_o = 30 m/s directly toward fielder B at an angle of 30^0 to the horizontal; the initial position of the ball is 0.9 m above the ground level. Fielder B requires 14 sec to judge where the ball should be caught and begins moving to that position with constant speed. Because of

great experience, fielder B choose his running speed so that he arrives at the "catch position" simultaneously with the baseball. The catch position is the field location at which the ball altitude is 2.1 m. Determine the velocity of the ball relative to the fielder at the instant the catch is made **(For Open Book Examination and not for semester end examination)**





21ME304 Fluid Mechanics & Hydraulic Machines

3 0 0 3

Course Outcome(s)

1. Define fluid properties and explain the measurement of pressure
2. Apply conservation of mass principle to fluid flow problems
3. Apply Bernoulli's equation to fluid flows and momentum equation to find force on pipe bend
4. Explain major and minor losses of flow through pipes
5. Analyze the performance of hydraulic turbines
6. Explain the working principles of centrifugal and reciprocating pumps and find their performance

COs – POs Mapping

COs	PO_1	PO_2	PO_3	PSO_1
1	3	3	2	1
2	3	3	3	2
3	3	2	3	2
4	2	3	3	3
5	2	3	3	2
6	3	2	3	3

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit- I

Fluid statics

Physical properties of fluids- specific gravity, viscosity, surface tension- vapor pressure and their influence on fluid motion- atmospheric gauge and vacuum pressure –measurement of pressure- Piezometer, U-tube and differential manometers. Total pressure, center of pressure, hydrostatic forces on vertical, inclined and curved surfaces, Buoyancy, center of buoyancy, metacenter

Stability of floating bodies and applications

14 Hours

Unit- II

Fluid Kinematics and Dynamics

Classification of flows, Stream line, path line and streak lines and stream tube, differential equation of continuity, Acceleration, Potential and stream function. Surface and body forces–Euler's and Bernoulli's equations for flow along a stream line, momentum equation and its application on force on pipe bend

Applications of Navier-stokes equations

15 Hours

Unit- III

Internal & External flow through Pipes

Viscous flow through pipe, Reynold's experiment-Darcy Weisbach equation-Minor losses in pipes-pipes in series and pipes in parallel- total energy line-hydraulic gradient ine. Measurement of flow: pitot tube, venturi meter, and orifice meter.

Laminar and Turbulent boundary layer theory

14 Hours

Unit- IV

Basics of Hydraulic Machines-Turbines and pumps

Classification of turbines, Pelton wheel, Francis turbine and Kaplan turbine, Blade angle, velocity triangles, efficiencies, specific speed. Centrifugal & Reciprocating pumps: Principle and Classification, Blade angle, velocity triangle, efficiencies, specific speed, characteristic curves, cavitations in pumps, NPSH, slip, Indicator diagram

Flow over radial vanes

17 Hours

Total: 60 Hours

Textbook(s)

1. Dr.P.N.Modi and Dr.S.M.Seth ,Fluid Mechanics and Hydraulic Machines , 22nd Edition, Raj sons publications Pvt. Ltd, 2018
2. Dr. R.K. Bansal, Fluid mechanics and hydraulic machines, 10th Edition, Laxmi Publications Pvt. Ltd,2018
3. Er.R.K. Rajput, Fluid mechanics and hydraulic machines, 6th Edition, S.Chand Publications Pvt. Ltd, 2016
4. K. Subramaya, Fluid mechanics and hydraulic machines, 1st Edition, Tata McGraw-Hill Pvt. Ltd, New Delhi,

2011
5. Sukumar Pati, A Textbook on Fluid Mechanics and Hydraulic Machines, 1st Edition, Tata McGraw-Hill Pvt. Ltd, New Delhi, 2012

Reference(s)

1. Frank.M. White, Fluid Mechanics, 8th Edition, Tata McGraw-Hill Pvt. Ltd, 2015
2. K.Subramanyam, Fluid mechanics and hydraulic machines, Tata McGraw-Hill Pvt. Ltd, 2nd Edition, 2018

Sample Question(s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	30	20	-
Understand	30	35	-
Apply	40	45	60
Analyze	-	-	40
Evaluate	-	-	-
Create	-	-	-
Total (%)	100	100	100

Remember

1. What are minor losses in pipe flow?
2. Define the terms, Slip and Negative slip in reciprocating pumps
3. Write briefly about different types of Pressure measuring devices
4. List out necessary precautions against cavitation in centrifugal pumps
5. Define Kinematic Viscosity and mention its significance
6. What is the importance of a draft tube in a Francis turbine? Discuss different types of draft tubes
7. Define compressible fluids and Incompressible fluids with examples
8. State the Bernoulli's equation? Explain the significance of each term and write any two applications of the Bernoulli's equation
9. Define Reynold's number
10. What do you mean by single acting and double acting reciprocating pumps?
11. List any two pumps used in mechanical industries for the handling of fluids
12. Write any two characteristics of fluid flows

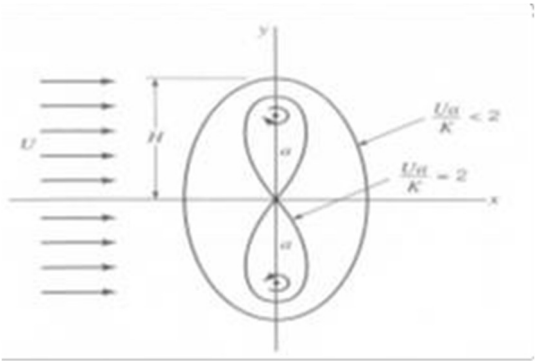
Understand

1. Explain hydraulic gradient line for fluid flow through a piping system
2. Describe the differential manometer with neat sketch
3. Discuss the different types of manometers used in pressure measurement
4. Explain the working of reciprocating pump with neat sketch
5. Discuss about stability of submerged and floating bodies
6. Explain Buoyancy, Buoyancy Force and Centre of Buoyancy
7. Classify and explain the types of fluid flow
8. Explain the phenomenon of surface tension on the top surface of liquids. What are the examples of surface tension?
9. Describe Reynolds experiments to demonstrate the two types of flow
10. Explain the dynamic viscosity of liquid and gases vary with temperature?
11. Explain the behavior of Non-Newtonian fluids with the help of plot and give examples

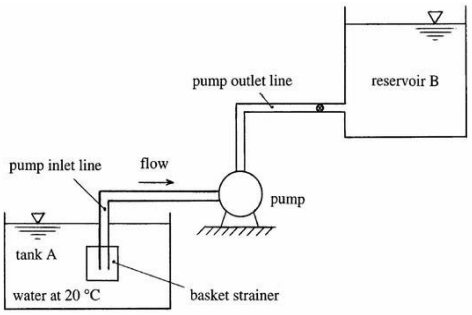
Apply

1. Find the force exerted by a jet of water of diameter 70mm on a stationary flat plate, normally with a velocity of 25m/s
2. A fan delivers 4 m^3 of air per second at 20 ^{0}C and 1.25 bar. Assuming molecular weight of air as 28.97, calculate the mass of air delivered. Also determine the density, specific volume and specific weight of the air being delivered
3. A Kaplan turbine works under a head of 60m at a speed of 145rpm utilizing 175m^3 /s of water. Diameter of runner and hub are 5.60m & 3.20m. Turbine develops 82500 kW. Find i) flow ratio ii) speed ratio iii) overall efficiency iv) specific speed

4. A 60 cm diameter pipeline carries oil (specific gravity= 0.85) at 82500 m^3 per day. The friction head loss is 8.5 m per 1000m of pipe run. It is planned to place pumping stations every 20 km along the pipe. Make calculations for the pressure drop in kN/m^2 between pumping stations
5. Two reservoirs are connected by three pipes laid in parallel, their respective diameters being d, 2d, and 3d. These are all of the same length l. If f is the same for all the pipes find the discharge through the larger pipes if the discharge through the smallest is 0.05 m^3 /sec
6. A glass tube of internal diameter 4 mm is immersed in a liquid of specific gravity 12.2 and surface tension 0.55 N/m. The angle of contact with the glass is 1200. Calculate capillary rise or depression in the tube
7. The right limb of a simple U- tube manometer containing mercury is open to the atmosphere while the left limb is connected to a pipe in which a fluid of sp.gr. 0.9 is flowing. The centre of the pipe is 12 cm below the level of mercury in the right limb. Find the pressure of fluid in the pipe if the difference of mercury level in the two limbs is 20 cm
8. A jet water 15 cm in diameter strikes a curved blade at 20 m/s velocity. The inlet angle and the outlet angles of the vane are 00 and 450 respectively. Determine the resultant force exerted on the blade when (i) the jet is stationary and (ii) the blade moves against the direction of the water at 5 m/s. Neglect friction along the blade
9. Consider a uniform flow with velocity U in the positive x direction combined with two free vortices of equal strength located along the y-axis. Let one vortex located at y = a, be a clockwise vortex ($\psi = K \ln r$) and the other at y = −a be a counter clockwise vortex. where K is a positive constant. It can be shown by plotting streamlines for Ua/K < 2 the streamline $\psi = 0$ forms a closed contour, as shown in the figure below. Thus, this combination can be used to represent flow around a family of bodies called Kelvin ovals. For the case of U = 10 m/s, a = 1 m, if the body has half-height H = 1.5 m: a) calculate the value of K: b) for the same Kelvin oval, calculate its maximum width along x **(For Open Book Examination and not for semester end examination)**



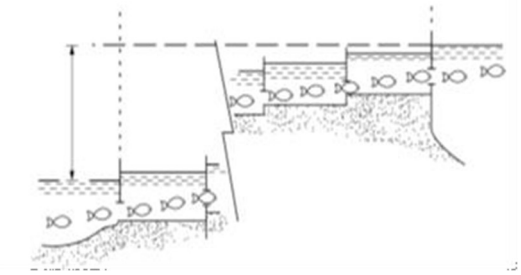
10. In the system shown, water at 20°C is pumped from tank A to reservoir B at a rate of 40 l/s. The piping is all commercial steel. The pump inlet line is 10 m long and 120 mm in diameter. The outlet line is 150 m long and 110 mm in diameter. The piping system also includes a basket strainer at entrance to the inlet line (loss coefficient K = 1.3), two elbows (one on each line, with K = 0.4), and a check valve near exit of the outlet line (K = 4). Determine the electrical power required to drive the pump if its overall efficiency is 88 %. Reservoir B 's free surface is 25 m above that of tank A. Make reasonable assumptions **(For Open Book Examination and not for semester end examination)**



Analyze

1. Differentiate between U-tube and Differential Manometer With a neat sketch
2. Differentiate between: (i) Liquids and gases, (ii) Real fluid and ideal fluids, (iii) Specific weight and specific volume of a fluid

3. Differentiate between (i) Impulse and Reaction turbine, (ii) Radial and Axial flow Turbines, (iii) Inward and Outward Radial flow turbines
4. Distinguish between (i) steady and unsteady flow, (ii) uniform and non-uniform flow, (iii) irrotational and rotational flow
5. Distinguish between atmospheric, gauge and vacuum pressure. What do you understand by equality of pressure at the same level in a static fluid?
6. Differentiate between: (i) The impulse and reaction turbines, (ii) Radial and axial flow turbines, (iii) Inward and outward radial flow turbine, (iv) Kaplan and propeller turbines
7. Incorporated into the hydroelectric dam on the river Tummel in Perthshire, Scotland, is a fish ladder, which is designed to enable spawning salmon that head upriver to reach Loch Faskally to bypass the dam. The fish ladder consists of a series of pools or steps each connected by an underwater pipe through which the fish swim (Figure) and rise up 16 m from the river Tummel to reach the Loch above. If the fish are capable of swimming against a flow through the connecting pipes where the mean velocity is 3 m/s, determine the number of steps in the ladder **(For Open Book Examination and not for semester end examination)**



8. The Falkirk Wheel (Figure) was designed and built to reconnect the Forth & Clyde and Union Canals in central Scotland and is the only rotating boat lift in the world. It consists of two identical tanks to transport simultaneously watercraft between the 35 m difference in elevations. Explain why both tanks will always remain balanced even if one tank should contain two heavily laden barges while the other a single canoe. **(For Open Book Examination and not for semester end examination)**

21ME305 Kinematics of Machinery

3 0 0 3

Course Outcome(s)

1. Understand the concept of mechanism and its inversions
2. Demonstrate the straight line motion mechanisms
3. Determine velocity and acceleration of simple mechanisms
4. Summarize the importance of steering gears and Hooke's joint
5. Develop the profile of a cam for a given follower motion
6. Analyze kinematics of gears and gear trains

COs – POs Mapping

COs	PO_1	PO_2	PO_3
1	3	3	3
2	3	3	2
3	3	3	2
4	3	2	2
5	3	2	3
6	3	3	3

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit- I

Simple Mechanisms and Straight Line Motion Mechanisms

Element or Link, Types of links - Rigid, flexible and fluid links, Types of kinematic pairs - Sliding, turning, rolling, screw and spherical pairs, lower and higher pairs, closed and open pairs, Constrained motions - Completely, partially or successfully constrained and incompletely constrained, Kinematic chain, Inversion, Mechanism, Machine, Types of kinematic chains, four bar or quadric cycle chain, single slider crank chain, double slider crank chain and their inversions. Exact and approximate straight line mechanisms.

Pantograph

15 Hours

Unit- II

Velocity and Acceleration Analysis in Mechanisms

Introduction, Absolute and relative motions, Vectors - Additional and subtraction of vectors, Motion of a link, Four-link mechanism, Displacement, velocity and acceleration analysis of simple mechanisms – Graphical method– Velocity and acceleration polygons – Velocity analysis using instantaneous centres – kinematic analysis of simple mechanisms – Coincident points – Coriolis component of Acceleration.

Crank and slotted lever mechanism

15 Hours

Unit- III

Steering Mechanisms and Cam Profiles

Conditions for correct steering, Davis Steering gear, Ackerman's steering gear, velocity ratio, Hooke's joint and Universal coupling, problems. Classification of followers and cams, nomenclature of cams, displacement, velocity and acceleration diagrams when the follower moves with uniform velocity, uniform acceleration and retardation, simple harmonic motion, construction of cam profiles

Applications of Cams

15 Hours

Unit- IV

Gears and Gear Trains

Higher pairs, friction wheels and toothed gears, types, law of gearing, condition for constant velocity ratio for transmission of motion, Form of teeth, cycloidal and involute profiles. Velocity of sliding, phenomena of interferences, Methods of interference, Condition for minimum number of teeth to avoid interference, path of contact, Introduction, Train value, Types - Simple and reverted wheel train, Epicyclic gear Train, Methods of finding train value or velocity ratio, Epicyclic gear trains

Expressions for arc of contact

15 Hours

Total: 60 Hours

Textbook(s)

1. S.S. Rattan, Theory of Machines and Mechanisms, Tata McGraw-Hill Publishers, 5th Edition, 2019
2. R.S Khurmi and J.K Gupta, Theory of Machines, S. Chand, 14th Edition, 2014

Reference(s)

1. T Bevan, Theory of Machines, CBS Publishers, 3rd edition, 2010
2. JS Rao and RV Dukkipati, Mechanism and Machine Theory, New Age, 2nd edition, 2008
3. Shigley, Theory of Machines, Oxford University Press, 3rd edition, 2010

Sample Question(s)

Inernal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	25	25	--
Understand	35	25	--
Apply	20	25	50
Analyze	20	25	30
Evaluate	--	--	20
Create	--	--	--
Total (%)	100	100	100

Remember

1. What is the magnitude of coriolis component of acceleration?
2. List the advantages and disadvantages of Davis steering gear
3. State the Grubler‟s criterion
4. Define link
5. Define constrained motion
6. What do you mean by velocity of rubbing?
7. List any two steering gear mechanisms
8. Write the various methods of finding the velocity ratio in gear trains

Understand

1. Explain the difference between a simple gear train and a compound gear train?
2. What is reverted gear train? Explain where it is used?
3. Explain different types of constrained motions
4. How do you find that the chain is kinematic chain or not?
5. Derive Coriolis acceleration component
6. Formulate an expression for condition for correct steering
7. Differentiate cycloidal and involute profiles

Apply

1. What condition is to be satisfied by the Davis steering gear-whenever the vehicle is taking a turn - for any radius of curvature of the path of the vehicle? Build the expression for this condition
2. In a crank and slotted lever quick return mechanism, the distance between the fixed centers is 150mm and the driving crank is 75 mm long. Determine the ratio of the time taken on the cutting and return strokes
3. In a four-bar chain ABCD, AD is fixed and is 150 mm long. The crank AB is 40 mm long and rotates at 120 r.p.m. clockwise, while the link CD = 80 mm oscillates about D. BC and AD are of equal length. Find the angular velocity of link CD when angle BAD = 60°
4. A cam is to give the following motion to a knife-edged follower:
   a) Outstroke during 60° of cam rotation
   b) Dwell for the next 30° of cam rotation
   c) Return stroke during next 60° of cam rotation
   d) Dwell for the remaining 210° of cam rotation.

   The stroke of the follower is 40 mm and the minimum radius of the cam is 50 mm. The follower moves with uniform velocity during both the outstroke and return strokes. Draw the pro-file of the cam when

   i. The axis of the follower passes through the axis of the cam shaft

ii. The axis of the follower is offset by 20 mm from the axis of the cam shaft

5. Two parallel shafts, about 600 mm apart are to be connected by spur gears. One shaft is to run at 360 r.p.m. and the other at120 r.p.m. Design the gears, if the circular pitch is to be 25 mm?
6. Two parallel shafts are connected by an Oldham coupling. The distance between the shafts is 35 mm. The speed of the driving shaft is 600 rpm. What is the maximum speed of sliding of the tongue of the intermediate piece with respect to the slot in the flange? **(For Open Book Examination and not for semester end examination)**
7. Construct the KLEIN's diagram for the velocity diagram of a Reciprocating Engine Mechanism? With this construction, how do you find the velocities of the piston and connecting rod in terms of the uniform angular velocity of the crank? **(For Open Book Examination and not for semester end examination)**

Analyze

1. Analyze how a flexible link is different from rigid link?
2. Compare the various types of constraints between Kinematic pairs, and give two examples for each
3. Compare Davis Steering gear, Ackerman‟s steering gear
4. Justify, construction of cam profiles depends on follower motion
5. Show that how to avoid interference in gears
6. Describe a differential with the help of a sketch. Prove that the two rear wheels will rotate at different speeds with its help when rounding a curve **(For Open Book Examination and not for semester end examination)**
7. Distinguish between the Drag-Crank mechanism and Double-crank mechanism, with neat sketches **(For Open Book Examination and not for semester end examination)**

Evaluate

1. How effective is the Ackerman steering mechanism when compared to the Davis steering mechanism?
2. Prove that the Hart's mechanism is used for generating exact straight line motion
3. In a crank and slotted lever quick return motion mechanism, the distance between the fixed centres O and C is 200 mm. The driving crank CP is 75 mm long. The pin Q on the slotted lever, 360 mm from the fulcrum O, is connected by a link QR100 mm long, to a pin R on the ram. The line of stroke of R is perpendicular to OC and intersects OC produced at a point 150 mm from C. Determine the ratio of times taken on the cutting and return strokes
4. How do you assess velocity of ram in crank and slotted lever mechanism?
5. In a Double Universal joint, conclude what happens if the intermediate shaft is inadvertently placed in such a manner that its forks lie in planes perpendicular to each other? **(For Open Book Examination and not for semester end examination)**
6. Determine the condition that is to be satisfied by the Davis steering gear-whenever the vehicle is taking a turn - for any radius of curvature of the path of the vehicle? Also derive the expression of this condition **(For Open Book Examination and not for semester end examination)**

21ME306 Thermodynamics

3 0 0 3

Course Outcome(s)

1. Understand the thermodynamic systems, energy interaction and laws of gas
2. Analyze the flow and non-flow thermodynamic processes
3. Apply zeroth and first law of thermodynamics to various thermodynamic systems
4. Understand the concept of second law of thermodynamics and the gaseous mixtures
5. Understand the properties of the steam
6. Assess the performance of Otto, diesel and dual cycles

COs – POs Mapping

CO_s	PO_1	PO_2	PO_3	PSO_1
1	3	2	1	2
2	3	2	1	2
3	3	2	1	2
4	3	2	1	2
5	3	2	1	2
6	3	2	1	2

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit- I

Introduction to Thermodynamics

Types of thermodynamic systems, state, property, process, reversible and irreversible process, quasi-static process, cycle, point and path function, energy in state and in transition, specific heat and enthalpy. Transfer of heat, work and change in internal energy in various flow process and non-flow processes. Perfect gas – Boyle's law, Charles law and Avogadro's law. Equation of state, deviations from perfect gas model – Vander Waals equation– compressibility charts

Throttling and Free Expansion Processes

15 Hours

Unit- II

Zeroth and first Law of Thermodynamics

Zeroth law of thermodynamics- temperature measurement- two point, triple point and ideal gas temperature scales. Constant volume gas thermometer, Joule's experiments, first law of thermodynamics, steady flow process, SFEE, Applications. Limitations of the first law. Thermal energy reservoir, heat engine, heat pump, parameters of performance

PMM-I

15 Hours

Unit- III

Second law of Thermodynamics and Gaseous mixtures

Second law of thermodynamics statements and their equivalence, PMM- II, irreversibility, causes of irreversibility. -Entropy- entropy a point function, change of entropy in various non-flow processes, Clausius inequality and principle of entropy increase –Availability in closed and open system – Maxwell relations. Gaseous mixtures: mole fraction, mass friction and volume fraction. Partial pressure, Dalton's law, Amagat's law, molecular internal energy, enthalpy, specific heat and entropy of mixture of perfect gases

Gravimetric and volumetric Analysis

16 Hours

Unit- IV

Steam Properties-Air standard Cycles

Phase transformation – properties of the steam, p-v-T surface, triple point and critical point. Entropy of steam, Mollier chart and steam Calorimetry. Carnot cycle- Otto, Diesel and dual combustion cycles- description and representation on p–v and T-s diagram, thermal efficiency, mean effective pressures on air standard basis

Comparison of Cycles

15 Hours

Total: 60 Hours

Textbook(s)

1. PK Nag, Engineering Thermodynamics,6th Edition, TMH, 2017
2. Sonntag, Borgnakke and Van Wylen, Fundamentals of Thermodynamics, 9th Edition, John Wiley & sons (ASIA) Pvt Ltd.2016

Reference(s)

1. Y Cengel & Boles, Thermodynamics – An Engineering Approach, 8th Edition, TMH, 2014.
2. JP Holman, Thermodynamics, 10th Edition, Mc. Graw Hill, 2010.
3. YVC Rao, An Introduction to Thermodynamics, New Age Publications, 2009.
4. K. Ramakrishna, Engineering Thermodynamics, Anuradha Publishers, 2008.

Sample Question(s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	20	20	-
Understand	50	40	-
Apply	30	40	75
Analyze	-	-	25
Evaluate	-	-	-
Create	-	-	-
Total (%)	100%	100%	100%

Remember

1. State Avogadro's Law
2. State the 2nd law of thermodynamics
3. Define entropy
4. Difference between triple pint and critical point
5. Draw p-v and T-s diagram of Dual cycle

Understand

1. Derive the expression for work done and heat transfer in adiabatic and polytropic process
2. Derive steady flow energy equation for control volume
3. Explain different stages of steam formation
4. Explain the Otto cycle and derive a relation for its efficiency
5. Differentiate between Otto and Diesel cycle

Apply

1. A perfect gas is compressed according to the law $PV^{1.25}$ = constant from an initial pressure of 1 bar and volume of 0.9 m^3 to a final volume of 0.6 m^3. Determine the final pressure and change of entropy per kg of gas during the process. Take γ=1.4, R=287 J/kg. K
2. A blower handles 1 kg/s of air at 20^0 C and consumes a power of 15kW. The inlet and outlet velocities of air are 100 m/s and 150 m/s respectively. Find the exit air temperature, assuming adiabatic conditions. Take Cp of air as 1.005 kJ/kg-K
3. 10 grams of water at 20^0C is converted into ice at -10^0C at constant atmospheric pressure. Assuming the specific heat of liquid water to remain constant at 4.2 J/g-K and that of ice to be half of the value, and taking latent heat of fusion of ice at 0^o C to be 335J/g. Calculate the total entropy change of the system
4. A mass of air is initially at 260^0C and 700 kPa, and occupies 0.028 m3. The air is expanded at constant pressure to 0.084 m3. A polytropic process with n=1.50 is then carried out, followed by a constant temperature process completes a cycle. All the processes are reversible. (a) Sketch the cycle in the P-V and T-S planes. (b) Find the heat received and heat rejected in the cycle. (c) Find the efficiency of the cycle
5. An engine working on Otto cycle is supplied with air at 0.1Mpa, 35^0C. The compression ratio is 8, heat supplied is 2100 kJ/kg. Calculate the maximum pressure and temperature of the cycle, the cycle efficiency, and the mean effective pressure, (for air C_p=1.005, C_v=0.718 and R=0.287 kJ/kg K)
6. A steam power plant operates with fixed initial pressure and temperature (assume suitable values) and exhaust to a heating system at 2 bar. The condensate from the heating system is returned to the boiler plant at 65°C, and the heating system utilizes for its intended purpose 90% of the energy transferred from the steam it receives. The turbine efficiency is 70%. (a) What fraction of energy supplied to the steam plant serves as useful purpose? (b) If two separate steam power plants had been set up to produce the same

useful energy, one to generate heating steam at 2 bar, and the other to generate power through a cycle working between 20 bar, 400°C and 0.07 bar, what fraction of the energy supplied would have served a useful purpose? **(For Open Book Examination and not for semester end examination)**

Analyze

1. An inventor claims to have developed an engine that takes in 1000 J of heat and produces 1500 J of work during each cycle. Comment on the validity of this claim
2. From time to time people suggest using the difference in the temperature of water at the surface of the ocean and that near the bottom of the ocean for operating a heat engine. Using 200^0C as the high temperature and 40^0C as the low temperature. What is the efficiency of such a device?
3. Two engines are to operate on Otto and Diesel cycles with the following data: Maximum temperature 1400 K, exhaust temperature 700 K. State of air at the beginning of compression 0.1 MPa, 300 K. Compare the compression ratios, the maximum pressure and efficiencies of the respective cycles
4. By burning a fuel the rate of heat release is 500 kW at 2000 K. what would be the first law and the second law efficiencies if (a) Energy is absorbed in a metallurgical furnace at the rate of 480 kW at 1000K, (b) Energy is absorbed at the rate of 450kW for generation of steam at 500k, and (c) Energy is absorbed in a chemical process at the rate of 300kW at 320 K? Take T_o= 300K. (d) Had the energy absorption rate been equal to 450 kW in all these three cases, what would have been the second law efficiencies? What is the inference that you can draw from this example? **(For Open Book Examination and not for semester end examination)**
5. A quantity of air initially at 1 bar, 300K undergoes two types of interactions: (a) it is brought to a final temperature of 500 K adiabatically by paddle-wheel work transfer; (b) the same temperature rise is brought about by heat transfer from a thermal reservoir at 600 K. Take T_o = 300 K, P_o= 1 atm. Determine the irreversibility (in KJ/Kg) in each case and comment on the results **(For Open Book Examination and not for semester end examination)**

21ME307 Fluid Mechanics & Hydraulic Machines Lab

0 0 3 1.5

Course Outcome(s)

1. Determine the co-efficient of discharge from experimental data by utilizing Venturi, Orifice and Rota meters
2. Recognize the friction factor decreased as the Reynolds number of the fluid increased due to increasing velocity of the fluid
3. Identify & calculate the Reynold's number for transition from laminar to turbulent flow
4. Verify Bernoulli's assumptions and theorem by experimentally proving that the sum of the terms in the Bernoulli equation along a streamline always remains a constant
5. Understand the relation between force and rate of momentum flow in the jet on vanes
6. Calculate the performance analysis in turbines and pumps and can be used in power plants

COs – POs Mapping

COs	PO_1	PO_2	PO_{10}
1	3	3	1
2	3	2	1
3	3	2	2
4	3	3	2
5	3	2	3
6	3	3	2

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

List of Experiments

1. Determine the coefficient of discharge of Venturi meter
2. Determine the coefficient of discharge of Orifice meter
3. Evaluate the Darcy Friction factor in various diameters of pipes
4. Determine the coefficient of discharge of Rotameter
5. Verification of Bernoulli's theorem
6. Illustrate laminar, transitional, and fully turbulent flows in a pipe, and to determine under which conditions each flow regime occurs
7. Determine the coefficient of impact of jet on given vanes
8. Evaluate the overall efficiency of Multistage Centrifugal Pump at constant speed and constant head
9. Evaluate the overall efficiency of Reciprocating Pump at constant speed and constant head
10. Determine the overall efficiency of Francis Turbine at constant speed and constant head
11. Determine the overall efficiency of Pelton wheel at constant speed and constant head
12. Determine the overall efficiency of Kaplan Turbine at constant speed and constant head
13. Calibration of V-notch
14. Performance test on single stage centrifugal pump
15. Determination of loss of head due to sudden contraction in a pipe line
16. Study of hydro power plant

List of Augmented Experiments

1. Performance of a centrifugal pump at different speeds
2. Fabrication of venturi meter suitable for a given pipe
3. Fabrication of working prototype of a Pelton wheel
4. Fabrication of working prototype of a centrifugal pump
5. Fabrication of working prototype of a Francis turbine
6. Fabrication of working prototype of a Kaplan turbine
7. Fabrication of orifice meter suitable for a given pipe
8. Fabrication of Rota meter suitable for a given pipe
9. Fabrication of working prototype of a Reynold's apparatus
10. Fabrication of working prototype of a bottle submarine by using Archimedes principle

Textbook(s)

1. Modi and Seth, Fluid Mechanics and Hydraulic Machines, 22nd Edition, standard book house, 2017
2. Dr. R.K. Bansal, Fluid mechanics and hydraulic machines, 9th Edition, Laxmi Publications (P) ltd., New Delhi, 2015

Reading Material(s)

1. Flow measurements and Hydraulic machinery manual, GMR institute of technology, Rajam

21MA305 Computational Mathematics Lab

(Programme: Mechanical Branch)

0 0 3 1.5

Course Outcome(s)

1. Find the solution for the system of linear equations by Gauss elimination and LU-Decomposition methods
2. Interpret the data by the method of least squares for the straight line and second-degree equation
3. Utilize an appropriate numerical technique to find an approximate solution of Algebraic and Transcendental equations
4. Find the approximate values of finite integrals by Trapezoidal and Simpson's $1/3^{rd}$ rule
5. Solve the first order differential equation with initial condition by Euler's and RK-4^{th} order methods
6. Solve the second order differential equation with two-point boundary value problem by Shooting method

COs – POs Mapping

COs	PO_4	PO_5
1	3	2
2	3	2
3	3	2
4	3	2
5	3	2
6	3	2

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

List of Experiments

Develop the algorithm and program in Scilab to the following experiments:

1. Fit a straight line to the bivariate data by the method of least squares
2. Fit a quadratic curve to the bivariate data by the method of least squares
3. Fit an exponential curve to the bivariate data by the method of least squares
4. Fit a power curve to the bivariate data by the method of least squares
5. Determination of an approximate root of an algebraic or transcendental equation by the Bisection method
6. Determination of approximate root of an algebraic or transcendental equation by the Regula Falsi method
7. Determination of an approximate root of an algebraic or transcendental equation by the Newton-Raphson method
8. Evaluate the definite integral using the Trapezoidal rule
9. Determination of the integral value of a function using Simpson's 1/3rd rule
10. Evaluate the definite integral using Simpson's 3/8th rule
11. Using Boole's rule, determine the integral value of a function
12. Evaluate the definite integral using Weddle's rule
13. Solve the boundary value problem by Euler's method
14. Employ modified Euler's method to solve the boundary value problem
15. Use the Runge method to solve the boundary value problem
16. Solve the boundary value problem by Runge – Kutta 4th order method

List of Augmented Experiments

Develop the algorithm and program in Scilab to the following experiments:

1. Solving the system of equations by Gauss – Jordan method
2. Fitting a nonlinear curve to the bivariate data
3. Determine the approximate root of algebraic or transcendental function by the method of False-Position
4. Finding of an integral function by using Simpson's $3/8^{th}$ rule
5. Solving the initial value problem of first order differential equation by Taylor's series
6. Solving the two-point boundary value problem by finite difference method

Textbook(s)

1. Computational Mathematics Laboratory using Scilab manual, Department of Mathematics (BS&H), GMR Institute of Technology, Rajam
2. M. K. Jain, S. R.K. Iyengar, R. K. Jain, Numerical Methods for Scientific & Engineering Computation, New Age International (P) Ltd, 7^{th} Edition.
3. S. S. Sastry, *Introductory Methods of Numerical Analysis*, 5^{th} Edition, Prentice Hall India Learning Pvt. Ltd.,

2012

4. S. Pal, *Scilab Textbook Companion for Numerical Methods: Principles, Analysis, and Algorithms*, 2019 URL: https://scilab.in/textbook_companion/generate_book/1332

21ESX01 Employability Skills I

0 0 2 0

Course Outcomes(s)

1. Demonstrate oral communication and writing skills as an individual to present ideas coherently
2. Develop life skills with behavioral etiquettes and personal grooming
3. Assess analytical and aptitude skills
4. Develop algorithms for engineering applications
5. Solve engineering problems using software
6. Utilize simulation tools for testing

Co-Po mapping

COs	PO_1	PO_2	PO_5	PO_8	PO_{10}	PO_{12}
1					3	2
2				1	2	2
3	2	1		2		
4	2		2			
5	2		2			
6	2		2			

Communication Skills & Confidence: How Communication Skills affect Confidence? How to communicate effectively.(with Examples)

Listening: Listening? , Listening Vs Hearing, Possible reasons for why people do not Listen at times, Active Listening Vs Passive Listening, How Listening can affect our relationships? How Listening helps in Campus Placements also? (with Examples)

Goal Setting: SMART Technique to Goal Setting, Putting First things First, SWOT Analysis and Time Management

Attitude & Gratitude: Attitude Vs Skills Vs Knowledge, Attitude Vs Behavior, How to develop Positive Attitude? Developing the attitude of Gratitude.

Public Speaking: JAM, J2M, Presentations by Students on General Topics.

Quantitative Aptitude:

Number system, L.C.M and H.C.F, Problems on Ages, Averages, Time and work, Pipes and cisterns

Iron CAD Part- I (Department Skill Oriented Course):

Introduction: Graphic User Interface (GUI) of Iron CAD, Drag and Drop features for geometric modeling in Iron CAD, Conventional geometric modeling in Iron CAD, Tri-ball feature in Iron CAD.

Geometric modeling of Preliminary Components: Geometric modeling of preliminary components like brackets, shaft support, machine block, sliding block, Nuts, Bolts, Simple riveted joints.

Performing Assembly function in Iron CAD: Conventional method of performing Assembly of geometric models using constraints and performing assembly function using the Tri-ball feature.

Generating Orthographic views of the assemblies: Generating the orthographic projections from the simple assemblies of the engineering components, Conversion to pdf from the generated orthographic views.

Text Books:

1. Machine Drawing – K. L. Narayana, P. Kannaiah & K. Venkata Reddy, New Age Publishers, 6th Edition, 2019.
2. Production Drawing – K. L. Narayana, P. Kannaiah, K. Venkata Reddy, New Age International, 3rd Edition, 2014.

Reference Books:

1. Machine Drawing includes AutoCAD – Ajeet Singh, McGraw Hill, 2nd Edition, 2012.
2. Machine Drawing with AutoCAD- Goutam Pohit, Goutam Ghosh, Pearson Education, 1st Edition, 2007.

Weblink

http://www.ironcad.com/learning-center/

21IT306 Object Oriented Programming through Java

3 0 2 4

Course Outcome(s)

1. Implement object-oriented concepts to the problems
2. Implement applications using different types of inheritances
3. Develop user defined packages
4. Identify and recover runtime exceptions arise in the applications
5. Demonstrate parallel processing applications using threads
6. Design interactive applications using Hibernate and spring Framework

COs–POs Mapping

COs	PO_1	PO_2	PO_3	PO_4	PO_5
1	1	3	2	3	2
2	1	3	3	3	2
3	1	2	3	3	2
4	1	2	3	3	2
5	1	3	3	3	2
6	1	3	3	3	2

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit- I

Introduction to Java

Overview of Object-Oriented Programming principles, Importance of Java to the Internet, Byte code, Data types, arrays, control statements, Classes and Objects– constructors, methods, access control, this keyword, overloading methods and constructors, garbage collection

Features of object-oriented programming–Java History–Computer Programming Hierarchy–Role of Java Programmer in Industry

Practical Components

1. Write a program that prints all real solutions to the quadratic equation $ax^2 + bx + c = 0$
2. Write a program that uses both recursive and non-recursive functions to print the nth value in the Fibonacci sequence
3. Write a program to demonstrate String handling methods and tokenizing given string/text using String Tokenizer class
4. Write a program to implement matrix operations using multidimensional arrays

19 Hours

Unit- II

Inheritance, Packages & Interface

Inheritance: Hierarchical abstractions, Base class and subclass, Benefits of inheritance, super keyword, final keyword with inheritance, polymorphism, abstract classes Packages: Defining, Creating and Accessing a Package, Understanding CLASSPATH, importing packages, Member access rules

Interface: Defining an interface, differences between classes and interfaces, implementing interface, variables in interface and extending interfaces

Nested–Inner Class & Anonymous Classes–Generic Class Types

Practical Components

1. Write a program for creating one base class for student personal details and inherit those details into the sub class of student Educational details to display complete student information
2. Write a program that illustrates runtime polymorphism
3. Write a program to create a package which has classes and methods to read Student admission details

18 Hours

Unit- III

Exception Handling & Multithreading

Exception handling: Concepts and benefits of exception handling, exception hierarchy, usage of try, catch, throw, throws and finally, built-in and User Defined Exceptions

Multithreading: Definition thread, thread life cycle, creating threads, synchronizing threads

Control Flow in Exceptions– JVM reaction to Exceptions– Inter Communication of Threads– Critical Factor in Thread– Deadlock

Practical Components

1. Write a program to define and handle User Defined Exceptions (make use of throw - throws)
2. Introduction to Eclipse Environment

17 Hours

Unit- IV

Java JDBC, Hibernate & Spring Framework

Java JDBC: Introduction, JDBC Driver, JDBC Connectivity steps, Connectivity with MySQL/Oracle. Hibernate Framework: Introduction, Object Relational Mapping tool, Java Persistence API, Hibernate Architecture Spring Framework: Introduction, Spring Framework

Spring Application, Spring Boot

Practical Components

1. Implement Hibernate Example without IDE
2. Implement Hibernate Example with Eclipse

21 Hours

Total: 75 Hours

Textbook(s)

1. H. Schildt, Java: The complete reference, 7th Edition, TMH, 2016 2.
2. T. A. Budd, An Introduction to Object–Oriented Programming, 3rd Edition, Addison Wesley Longman, 2012

Reference(s)

1. Dietal & Dietal, Java: How to Program, 8th Edition, PHI, 2010
2. E. Balaguruswamy, Programming with Java A Primer, 4th Edition, Tata McGraw Hill Companies, 2009
3. C. S. Horstmann and G. Cornell, Core Java, Vol 1. Fundamentals, 7th Edition, Pearson Education, 2014
4. C. Horstmann, BIG JAVA Compatible with Java 5 & 6, 3rd Edition, Wiley Publishers, 2008

Sample Question(s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Lab Examination (%)
Remember	25	35	--
Understand	45	35	--
Apply	30	30	40
Analyze	--	--	20
Evaluate	--	--	40
Create	--	--	--
Total (%)	100	100	100

Remember

1. List out 6 different java buzz words
2. List the three OOP principles
3. Define Inheritance
4. List the 5 keywords used in exception handling

Understand

1. Summarize the OOP principles
2. Illustrate the procedure for creating a user defined package
3. Interpret the Thread Life cycle
4. Interpret the Applet Life cycle
5. Define Encapsulation

Apply

1. Implement a java program that read an integer between 0 and 1000 and adds all the digits in the integer
2. Implement an abstract base class shape with two members base and height, a member function for initialization and a function to compute area ( ). Derive two specific classes Triangle and Rectangle which override the function area ( ). Use these classes in a main function and display the area of a triangle and a rectangle
3. Demonstrate an applet that receives two numerical values as input from the user and then displays the sum of these numbers on the screen
4. Given are two one dimensional array A and B which are sorted in ascending order. Develop a program to merge them into a single sorted array C that contains every item from arrays A and B, in ascending order

5. Implement a Java program for creating one base class for student personal details and inherit those details into the sub class of student Educational details to display complete student information

Analyze

1. Compare and Contrast between procedure oriented and object-oriented programming
2. Analyze the concurrent programming using threads
3. Differentiate method overloading and method overriding
4. Differentiate sleep and suspend
5. Analyze platform independency of java with the help of JVM

Evaluate

1. Judge whether Hibernate and spring frameworks are better for java database connectivity.
2. Asses the performance of threads
3. Determine the importance of run time polymorphism
4. Defend why pointer were removed in JAVA
5. Judge why do you java to develop a web-based application

21ME401 Applied Thermodynamics

3 0 0 3

Course Outcome(s)

1. Understand the construction and working principle associated with SI and CI Engines
2. Explain the working of IC engine auxiliary systems
3. List the stages of combustion in IC engines and analyze the engine combustion process
4. Evaluate the performance of IC engines
5. Categorize the effects of emission and its control
6. Estimate the various efficiencies of air compressors

COs – POs Mapping

COs	PO_1	PO_2	PO_3	PO_7	PSO_2
1	3	2	2	2	3
2	3	2	2	1	3
3	3	2	2	2	3
4	3	3	2	2	3
5	3	1	3	3	3
6	3	3	2	2	3

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit- I

I.C. Engines-Engine Systems

Heat engine- IC engines Classification - Working principles, two stroke and four stroke SI and CI engines, Valve and Port Timing Diagrams. Principle of turbo charging and super charging. Simple Carburetor, Fuel Injection System. Ignition, Cooling and Lubrication systems

Multipoint Fuel Injection System

15 Hours

Unit- II

Combustion in S.I. Engines-Combustion in C.I. Engines

Normal Combustion and abnormal combustion – Importance of flame speed and effect of engine variables. Types of Abnormal combustion, pre-ignition and knocking, combustion chamber requirements and types. Stages of combustion, Delay period and its importance, Effect of engine variables on Knock, need for air movement, suction, compression and combustion induced turbulence, Fuel requirements and rating, anti-knock additives

Air squish

16 Hours

Unit- III

Testing and Performance-Emission and Pollution

Parameters of performance, measurement of cylinder pressure, fuel consumption, air intake, exhaust gas composition, Brake power, Determination of frictional losses and indicated power, Performance test, Heat balance sheet and chart. SI Engine and CI Engine emissions and its control and comparison, Indian driving cycles and Emission norms

Motoring test

14 Hours

Unit- IV

Compressors-Rotary and Axial Flow Compressors

Classification – Reciprocating compressors: Principle of operation, work required, Isothermal efficiency volumetric efficiency and effect of clearance, stage compression, saving of work, minimum work condition for stage compression. Roots Blower, vane sealed compressor, screw compressor, principle of working and efficiency considerations. Principle of operation of Axial Flow Compressors, velocity triangles and energy transfer per stage degree of reaction, work done factor - isentropic efficiency, pressure rise calculations

Polytropic efficiency

25 Hours

Total: 60 Hours

Textbook(s)

1. V. Ganesan, Internal Combustion Engines, Tata McGraw Hill, 4th Edition, 2012
2. R.K.Rajput, Thermal Engineering, Lakshmi Publications, 10th Edition, 2018

Reference(s)

1. M.L. Mathur and R.P. Sharma, Internal Combustion Engines, Dhanpat Rai Publications, 2010
2. Rudra Moorthy, Thermal Engineering, Tata McGraw-Hill Education India, 4th Edition, 2010
3. PS Gill and Smith, IC engines, Tata McGraw-Hill Education India, 3rd Edition, 2009
4. John B. Heywood, Internal Combustion Engine Fundamental, Tata McGraw-Hill Education, 1st Edition, 2011

Sample Question(s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	25	25	-
Understand	40	25	-
Apply	35	45	30
Analyze	-	5	40
Evaluate	-	-	30
Create	-	-	-
Total (%)	100	100	100

Remember

1. Define IC engine.
2. Define delay period for petrol and diesel engines
3. List any four parameters affecting knock
4. List any three different losses in an IC engine
5. Define following terms with respect to reciprocating IC engines
   a. Brake power
   b. Brake thermal efficiency
   c. Isothermal efficiency

Understand

1. Explain 4-stroke engine with the help of neat sketch
2. Explain working of cooling system of Hyundai i10 car
3. With the help of P-θ diagram explain the stages of combustion in diesel engine
4. Interpret the factors that affect knocking tendency in a petrol engine
5. How can we estimate frictional power of a multi cylinder engine? Explain
6. Formulate procedure for estimating the performance of an IC engine
7. Classify compressors
8. Exemplify applications of compressors in your day to day life

Apply

1. Demonstrate working of a 2-wheeler in line with Otto cycle
2. Show that IC engine is a heat engine
3. For a particular engine swept volume is 10000 cm^3 and clearance volume is 2000 cm^3. Predict whether it is petrol engine or diesel engine
4. Compression ratios of 2 diesel engines are found to be 18:1 and 20:1, which engine would you select for better power and why?
5. Apply the basic knowledge of compressors and predict which compressor is best suitable for gas turbine power plant of 80 MW. Justify your answer
6. Formulate generalized procedure for estimating performance of a petrol engine
7. The values obtained from a Kirloskar four-cylinder; four-stroke engine diesel engine used for agricultural application is given below:
   Shaft speed N = 2500 rev/min
   Fuel consumption mf = 2 g/s
   Calorific value = 42 MJ/kg
   Stroke L = 100 mm
   Bore D = 100 mm
   Torque = 80 N m

Calculate the brake power, friction power, indicated power, mean effective pressure, brake thermal efficiency (η_{BTh}), indicated thermal efficiency (η_{ITh}) and mechanical efficiency (η_{mech}) **(For Open Book Examination and not for semester end examination)**

8. The royal Enfield engine has the following ultimate analysis: carbon, C, 83.7 and hydrogen, H2, 16.3. If the dry products analysis by volume is CO2, 11.8%, O2, 3.7% and nitrogen, 84.5%. Determine the air–fuel ratio **(For Open Book Examination and not for semester end examination)**

Analyze

1. Compare ideal and actual valve timing diagram
2. Differentiate Diesel engine from petrol engine
3. Criticize knocking in diesel engine
4. Overhead piston arrangement is widely used nowadays due to its specific advantages. Justify above statement with appropriate reasoning
5. What conclusions can you draw by performing Morse test?
6. Contrast advantages of reciprocating compressor and rotary compressor
7. A city implemented the new emission norms of 1.0 g/km for CO in the year 2010, whereas the old norm was 1.5 g/km for the year 2000. The number of vehicles increased from 1 million to 1.5 million in the decade. Assume that the vehicles are of the same class and that the vehicles travelled 100 km per day for both norms:
   Vehicle class = 106 (old), 1.5 × 106 (new)
   Emission factor = 1.5 g/km (old), 1.0 g/km (new)
   Distance travelled = 100 km/day
   Analyse the emission load calculation for the old and new emission norms **(For Open Book Examination and not for semester end examination)**

8. In a commercial bus fitted with Ashok Leyland 6-cylinder Hino engine, a medium-viscosity fuel oil is used with 84.9% carbon, 11.4% hydrogen, 3.2% sulphur, 0.4% oxygen and 0.1% ash content are burnt with 20% excess air. Determine the exhaust gas analysis and air–fuel ratio by weight **(For Open Book Examination and not for semester end examination)**

Evaluate

1. Choose which engine you would select for better brake thermal efficiency
2. How do you assess performance of a reciprocating compressor?
3. Determine air standard efficiency of a diesel whose compression ratio is 14:1 and cutoff ratio is 1.1
4. Combustion process of diesel engine is more efficient than petrol engine. Judge the above statement with critical thinking
5. Evaluate performance of Ashok Leyland bus with reference to fuel properties
6. The raw biogas obtained from the biogas plant was purified by water scrubbing technology. The compositions of raw and purified biogas obtained are tabulated below:

Type of Gas Composition	Raw biogas	Purified biogas	Density (kg/m^3)	Calorific value (KJ/kg)
Methane	60%	95%	0.66	39,820
Carbon dioxide	38%	3%	1.84	-
Nitrogen	1.6%	1.6%	1.16	-
Hydrogen	0.4%	0.4%	0.09	120,210

Estimate the density and calorific value of pure and raw biogas, also find the total volume of the pure gas obtained **(For Open Book Examination and not for semester end examination)**

21ME402 Dynamics of Machinery

3 0 0 3

Course Outcomes

1. Interpret static and dynamic force analysis of simpler planar mechanisms
2. Apply the principle of gyroscope and compute gyroscopic effect for aero planes and ships
3. Make use of the principle of gyroscope and interpret the stability for two wheelers and four wheelers
4. Explain the working of important machine elements like clutches, brakes, flywheels and governors
5. Examine the balancing of rotating and reciprocating masses
6. Summarize free and forced vibrations

COs–POs Mapping

COs	PO_1	PO_2	PO_3
1	3	2	3
2	3	2	3
3	3	3	3
4	2	3	2
5	3	3	3
6	3	2	2

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit- I

Static and dynamic force analysis-Precession

Static and dynamic force analysis of planar mechanisms- four bar mechanism. Gyroscopes, effect of precession motion on the stability of moving vehicles such as motor car, motor cycle, aero planes and ships

Analysis of planar mechanism of slider crank mechanism

12 Hours

Unit- II

Clutches

Friction clutches- single disc or plate clutches and multi disc clutches

Brakes and Dynamometers

Simple block brakes and band brake of vehicles, Absorption and Transmission type dynamometers

Turning moment diagram and fly wheels-Governors

Turning moment - crank effort and turning moment diagrams – fluctuation of energy – fly wheels and their design. Watt, Porter and Proell governors. Sensitiveness, isochronism and hunting

Spring loaded governors - Hartnell and Hartung with auxiliary springs

16 Hours

Unit- III

Balancing of rotating masses-Balancing of reciprocating masses

Single and multiple - single and different planes. Primary, Secondary and higher balancing of reciprocating masses, analytical and graphical methods. Locomotive balancing - Hammer blow, Swaying couple, variation of tractive efforts. Unbalanced forces and couples - examination of "V" multi cylinder in line engines for primary and secondary balancing

Unbalanced forces and couples for radial engines for primary and secondary balancing

16 Hours

Unit- IV

Mechanical vibrations-Torsional vibrations and whirling of shafts

Free Vibration of single DOF system - oscillation of pendulums, centers of oscillation and suspension. Transverse loads, vibrations of beams with concentrated and distributed loads, Dunkerly‟s methods, Raleigh‟s method, Simple problems on forced damped vibration, Vibration Isolation & Transmissibility. Torsional vibrations, two and three rotor systems

Whirling of shafts, critical speed.

16 Hours

Total: 60 Hours

Textbook(s)

1. S.S Rattan, Theory of Machines, McGraw Hill Education (India) Private Limited, 4th Edition, 2014
2. Dr. Jagadish Lal, Theory of Mechanisms & Machines, Metropolitan Book Co. (P) Ltd., 1st Edition, 2002

Reference(s)

1. J S Rao and R V Dukkipati, Mechanism and Machine Theory, New Age International (P) Ltd., 2nd Edition, 2006
2. J J. Uicker, Gordon R. Pennock, J E. Shigley, Theory of Machines and Mechanisms, Oxford University Press, New Delhi, 3rd Edition, 2009
3. Thomas Bevan, Theory of Machines, CBS Publishers, 3rd Edition 2005
4. R. S. Khurmi, Theory of Machines, S. Chand, 14th Edition, 2005

Sample Question(s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	25	25	--
Understand	45	45	--
Apply	30	30	60
Analyze	--	--	40
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Remember

1. Define axis of spin
2. Define axis of precision
3. List out the different centrifugal type governors
4. Define critical speed of a shaft

Understand

1. Compare the function of governor and flywheel
2. Classify different types of governors
3. Explain the difference between Porter and Proell governors
4. Demonstrate the working of Hartnell governor

Apply

1. A conical friction clutch is used to transmit 90 kW at 1500 r.p.m. The semi-cone angle is 20º and the coefficient of friction is 0.2. If the mean diameter of the bearing surface is 375 mm and the intensity of normal pressure is not to exceed 0.25 N/mm2. Find the dimensions of the conical bearing surface and the axial load required
2. The turning moment diagram for a petrol engine is drawn to the following scales: Turning moment, 1 mm= 5 N-m; crank angle, 1 mm= 1°. The turning moment diagram repeats itself at every half revolution of the engine and the areas above and below the mean turning moment line taken in order are 295, 685, 40, 340, 960, 270 mm2. The rotating parts are equivalent to a mass of 36 kg at a radius of gyration of 150 mm. Determine the coefficient of fluctuation of speed when the engine runs at 1800 r.p.m
3. The turbine rotor of a ship has a mass of 3500 kg. It has a radius of gyration of 0.45 m and a speed of 3000 r.p.m. clockwise when looking from stern. Determine the gyroscopic couple and its effect upon the ship:
    a. When the ship is steering to the left on a curve of 100 m radius at a speed of 36 km/h
    b. When the ship is pitching in a simple harmonic motion, the bow falling with its maximum velocity

   The period of pitching is 40 seconds and the total angular displacement between the two extreme positions of pitching is 12 degrees
4. Four masses m1, m2, m3and m4 are 200 kg, 300 kg, 240 kg and 260 kg respectively. The corresponding radii of rotation are 0.2 m, 0.15 m, 0.25 m and 0.3 m respectively and the angles between successive masses are 45°, 75° and 135°. Find the position and magnitude of the balance mass required, if its radius of rotation is 0.2 m
5. A single cylinder reciprocating engine has speed 240 r.p.m., stroke 300 mm, mass of reciprocating parts 50 kg, mass of revolving parts at 150 mm radius 37 kg. If two-third of the reciprocating parts and all the revolving parts are to be balanced, find: 1. The balance mass required at a radius of 400 mm, and the residual unbalanced force when the crank has rotated 60° from top dead centre
6. A shaft 50 mm diameter and 3 meters long is simply supported at the ends and carries three loads of 1000 N, 1500 N and 750 N at 1 m, 2 m and 2.5 m from the left support. The Young's modulus for shaft material is 200 GN/m2. Find the frequency of transverse vibration

21ME403 Metal Cutting and Machine Tools

3 0 0 3

Course Outcome(s)

1. Explain cutting tool geometry; analyze mechanism of chip formation and forces in orthogonal cutting
2. Explain tool failure and influence of various process parameters on tool life
3. Illustrate basic parts and operations of machine tools including lathe, shaper, planer, drilling, boring, milling and grinding machine
4. Select a machining operation and corresponding machine tool for a specific application in real time.
5. Identify the need of super finishing operations like honing, lapping and broaching
6. Design locating and clamping devices to produce a component

COs – POs Mapping

COs	PO_1	PO_2	PO_3
1	3	3	2
2	3	2	2
3	3	1	1
4	3	2	2
5	3	3	3
6	-	3	2

3 Strongly linked | 2 Moderately linked | 1 Weakly linked

Unit- I

Fundamentals of Machining

Elements of machining, Theory of chip formation, Cutting tool materials, Tool geometry, Classification and type of machining of tools, Mechanics of orthogonal cutting, Machining parameters and metal removal rate, Cutting force analysis by Merchant's diagram, work done and power required, Problems, Types of cutting parameters and coolants

Tool Signature- Different systems of tool signature

15 Hours

Unit- II

Rotary Machines

Introduction, Construction and working, Principle of Lathe, Classification of lathes, Specification of a lathe, work and tool holders, Lathe operations, cutting speed, feed and depth of cut, Machining time, Cutting fluids, Tool materials and properties

Drilling and Boring Machines

Introduction, Construction and working, specifications, Classification, Operations performed, Work and tool holding devices, Twist drill nomenclature, Drill size and materials, Boring Machines.

Cutting speed, feed and depth of cut- rotary machines

16 Hours

Unit- III

Reciprocating Machines

Shaping, Slotting and Planning Machines

Introduction, Construction and working, Principle parts, Specifications and operations performed, Machining time calculations

Milling Machines

Introduction, Construction and working, Classification- horizontal, vertical and universal milling machines, Machining operations, Milling cutters, Elements of a plain milling cutter, Methods of indexing, Machining time

Cutting speed, feed and depth of cut- reciprocating machines

18 Hours

Unit- IV

Grinding Machines

Introduction, Construction and working, Classification- cylindrical and surface grinders, tool and cutter grinders, Abrasives, Bonds and bonding processes, Specification and selection of a grinding wheel

Finishing operations- lapping and honing

12 Hours

Total: 60 Hours

Textbook(s)

1. Promotors and Publishers Pvt. Limited, 15th Edition, 2018
2. Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, John Wiley & Sons, Inc., 7th Edition, 2019.
3. B. L. Juneja, G. S. Sekhon and Nitin Seth, Fundamentals of Metal Cutting and Machine tools, New Age International Publishers-2nd Edition, 2005
4. P N Rao, Manufacturing Technology: Metal Cutting and Machine Tools, MC Graw Hill Education (India) Pvt. ltd, 4th Edition, 2018

Reference(s)

1. Winston A. Knight and Geoffrey Boothroyd, Fundamentals of Metal Machining and Machine Tools, CRC Press, 3rd Edition, 2005
2. Serope Kalpakjian and Stephen Schmid, Manufacturing Engineering and Technology, Prentice Hall Publication, 7th Edition, 2014
3. Amitabha Ghosh and Ashok Kumar Mallik, Manufacturing Science, East West Press Private Ltd, 2nd Edition, 2010
4. B. S Raghuwanshi, Workshop Technology Vol-II, Dhanpatrai & Co., 11th Edition, 2013

Sample Question(s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	45	40	-
Understand	35	40	-
Apply	20	20	40
Analyze	-	-	45
Evaluate	-	-	15
Create	-	-	-
Total (%)	100	100	100

Remember

1. What are the adverse effects of the built-up edge formation?
2. What Is an indexing jig? What are the various kinds of indexing devices commonly used?
3. What are the advantages and disadvantages of conical locators?
4. List out the advantages of CNC systems over conventional NC systems.
5. What are the applications of CNC machines? Explain.
6. What is the coordinate system used for CNC milling machine?
7. What is 3-2-1 principle of location? Explain with neat sketch
8. What are different types of clamping elements? Explain with neat sketches

Understand

1. Explain the nomenclature of a single point cutting tool
2. Explain the working principle of a Lathe. What are the operations that can be performed on lathe?
3. Demonstrate the Merchant's force diagram and state its significance in machining
4. Explain the following grinding processes: Form Grinding. Gear tooth grinding, Thread grinding and Cam grinding and Sketch
5. Explain the mechanism behind the working of a shaper in detail
6. Discuss the principles of design of jigs and fixtures

Apply

1. A steel work piece s to be milled. Metal removal rate is 30 cm3 /mm. Depth of cut is 5mm and width of cut is 100 mm. Find the table speed
2. In a turning operation, it was observed that the tool life was 100 min and 50 min at cutting speed of 25m/min and 100 m/min respectively. Find out tool life at 200 m/min under same cutting condition

21ME404 Mechanics of Solids

3 0 0 3

Course Outcome(s)

1. Understand the fundamental concepts of stress, strain and principal stresses
2. Calculate and represent the shear force and bending moment in various beams under different loading conditions
3. Analyze flexural and shear stresses in beams
4. Understand the concepts of torsional stresses
5. Understand the concepts of slope and deflection and able to solve deflection in beam members
6. Perform the stress analysis of thin and thick cylinders

COs – POs Mapping

COs	PO_1	PO_2	PO_3	PO_{10}
1	3	2	2	3
2	3	2	2	3
3	3	2	2	3
4	3	2	2	3
5	3	2	2	3
6	3	2	2	3

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit- I

Simple Stresses & Strains-Shear Force and Bending Moment

Elasticity and plasticity - Types of stresses & strains-Hooke's law - stress - strain diagram for mild steel - Working stress - Factor of safety - Lateral strain, Poisson's ratio &volumetric strain - Elastic moduli & the relationship between them - composite bars –Thermal stresses. Definition of beam - Types of beams – loads - supports - Concept of shear force and bending moment - S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, uniformly distributed and varying loads

Principal stresses- Transformation of plane stresses into normal and shear stresses on inclined plane - principal planes - Mohr's circle - Maximum shearing stress

Moment or couple and combination of loads

16 Hours

Unit- II

Flexural Stresses in Beams-Shear stresses in Beams

Theory of simple bending - Assumptions - Derivation of bending equation, Neutral axis - section modulus of rectangular and circular sections (Solid and Hollow) - Determination bending stresses - I, T, Angle and Channel sections - Shear stress distribution across various beams sections like rectangular, circular, triangular, I, T angle

Shear stress distribution across various beam sections like channel sections

14 Hours

Unit- III

Torsion and Deflection of Beams

Torsional Stresses in Shafts - Analysis of torsional stresses - Power transmitted. Bending into a circular arc - slope, deflection and radius of curvature - Differential equation for the elastic line of a beam - Double integration method - Determination of slope and deflection for cantilever and simply supported beams subjected to point loads, uniformly distributed and varying loads. Mohr's theorem - application to simple cases

Combined bending and torsion

16 Hours

Unit- IV

Thin and Thick cylinders

Thin seamless cylindrical shells - longitudinal and circumferential stresses - hoop, longitudinal and volumetric strains - riveted boiler shells -Thin spherical shells. Lame's equations - cylinders subjected to inside & outside pressures - compound cylinders

Effect of internal fluid pressure on the dimensions of thin cylindrical shell

14 Hours

Total: 60 Hours

Textbook(s)

1. R. K. Bansal, Strength of Materials, Lakshmi publications, 6th Edition, 2017
2. Popov, Solid Mechanics, PHI Learning, 2nd Edition, 2009

Reference(s)

1. S.S Bhavikatti, Strength of materials, Vikas publications, 4th Edition, 2013
2. Jindal, Strength of Materials, Asian Books Private Limited, 1st Edition, 2007
3. Vazirani and Ratwani, Analysis of structures, Khanna Publisher, 18th Edition, 2012
4. S. Timoshenko, Strength of Materials, Krieger (Robert E.) Publishing Co Inc., US, 3rd Edition, 1983

Sample Question(s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	15	15	**-**
Understand	15	15	**-**
Apply	55	55	50
Analyze	15	15	50
Evaluate	**-**	**-**	-
Create	**-**	**-**	-
Total (%)	**100**	**100**	**100**

Remember

1. Define and explain the following terms: Shear force, bending moment, shear force diagram and bending moment diagram
2. (i) Define the following terms: slope and deflection
7. (ii) What is Macaulay's method? Where it is used?
3. Define the terms: Elasticity, elastic limit, Young's modulus and modulus of rigidity
4. Define the terms: Longitudinal strain, Lateral strain and poisons ratio
5. What do you understand by neutral axis, section modulus and moment of resistance?
6. What is Torsion? What are the assumptions made in the derivation of shear stress produced in a circular shaft subjected to torsion?
7. Define thin cylinders. Name the stresses set up in a thin cylinder subjected to internal fluid pressure
8. Find an expression for the change in volume of a thin cylindrical shell subjected to internal fluid Pressure

Understand

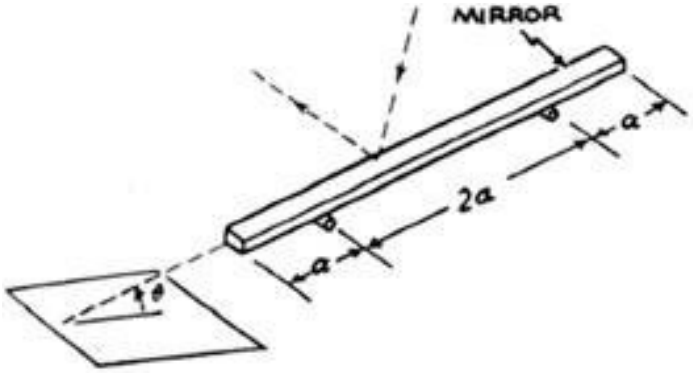
1. Derive an expression between modulus of elasticity and modulus of rigidity
2. Draw the shear force and bending moment diagram for a cantilever of length 'L' carrying a point load 'W' at the free end
3. Explain clearly the different types of stresses and strains
4. Explain the different types of equilibrium equations
5. Show that for a rectangular section of the maximum shear stress is 1.5 times the average stress
6. Explain Macaulay's method
7. Explain thin and thick cylinders

Apply

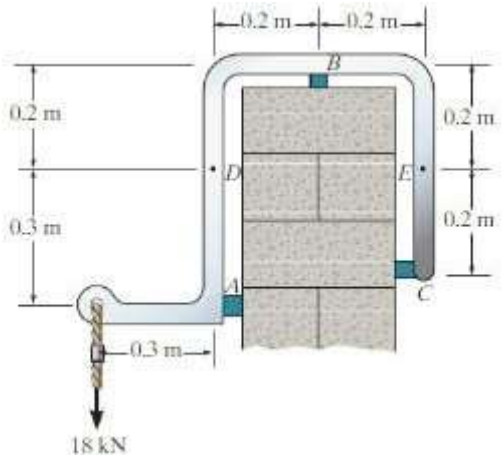
1. A steel rod of 3 cm diameter is enclosed centrally in a hollow copper tube of external diameter 5 cm and internal diameter 4 cm. the composite bar is then subjected to an axial pull of 45000 N. if the length of each bar is equal to 15 cm, determine: i) the stresses in the rod and tube, and ii) load carried by each bar. Take E for steel is 2.1 x 10^5 N /mm^2 and for copper is 1.1 x 10^5 N/mm^2
2. A rod 200cm long and of diameter 3.0cm is subjected to an axial pull of 30 kN. If the Young's modulus of the material of the rod is 2×104 N/mm^2, determine: (i) stress. (ii) Strain and (iii) the elongation of the rod. Previously determined maximum stress?
3. A simply supported beam of 10m long carries a uniformly distributed load 2 kN/m over entire length and point loads 1kN and 2kN at distances 2m and 5m from the left support. Draw the shear force and bending moment diagrams
4. A cast Iron beam has an I- section with top flange 80mm×40mm, web120mm×20mm and bottom flange 160mm×40mm. If tensile stress is not to exceed 30 N/mm^2 and compressive stress 90N/mm^2, what is the

maximum uniformly distributed load the beam can carry over a simply supported span of 6m if the larger flange is in tension

5. Develop an expression for the slope and deflection of a beam subjected to uniform bending moment
6. A thick cylinder of external and internal diameters of 300mm and 180mm is subjected to an internal pressure of 42 N/mm^2 and external pressure 6 N/mm^2. Determine the stresses in the material. If the external pressure is doubled, what internal pressure can be maintained without exceeding the previously determined maximum stress?
7. A strip of mirror glass in a precision optical instrument is to be simply supported by a pair of symmetrically placed supports, as shown in Fig. During operation the angle θ will vary from 0 to 90° so that the bending due to gravity will vary. For what position of the supports will the deviations from flatness be minimized; i.e., at any fixed θ for what value of a will the greatest deflection in the mirror be minimized? **(For Open Book Examination and not for semester end examination)**



8. The sky hook is used to support the cable of a scaffold over the side of a building. If it consists of a smooth rod that contacts the parapet of a wall at points A, B, and C, determine the normal force, shear force, and moment on the cross section at points D and E **(For Open Book Examination and not for semester end examination)**



Analyze

1. Two shafts of the same material and of same lengths are subjected to the same torque, if the first shaft is of a solid circular section and the second shaft is of hollow circular section, whose internal diameter is 2/3 of the outside diameter and the maximum shear stress developed in each shaft is the same, compare the weights of the shafts
2. A timber beam of rectangular section is to support a load of 20 kN uniformly distributed over a span of 3.6m when beam is simply supported. If the depth of the section is to be twice the breadth, and the stress in the timber is not to exceed 7 N/mm^2, find the dimension of the cross section
3. Distinguish between the following, giving due explanation (i) Stress and strain (ii) Force and stress and (iii) Tensile stress and compressive stress
4. Compare the weights of the two shafts if the maximum shear stress developed in the two shafts is equal. A solid circular shaft and a hollow circular shaft whose inside diameter is 3/4 of the outside diameter, are of the same material, of equal lengths and are required to transmit a given torque.
5. Compare slope and deflection of a simply supported beam and cantilever beam.
6. Compare circumferential and longitudinal strains

7. You're building a small-scale wooden model of a structure of interest, and you're in a hurry to get it done quickly. Part of the model needs to be a structural member that has a length L and a square cross-section with side length L/10, and this structural member will be loaded in tension. At the last minute, you realize that you don't have any pieces of wood that are long enough; your longest pieces have a length of 0.8L. You do, however, have a bottle of glue that you can use to glue two pieces together to get the total length that you need. Your glue can withstand 1MPa of shear stress and 3MPa of normal stress. You also have a saw that you can use to cut the ends of the pieces of wood at any angle that you like prior to gluing. Analyze the angle θ should you cut the wood faces if you want the resulting beam to be able to withstand the largest possible tensile load? (For the purposes of this problem, you cannot cut any dove tails or other fancy shapes into the faces of the wood to get a stronger connection) **(For Open Book Examination and not for semester end examination)**

8. A tree trunk with circular cross-section of diameter ***d*** is to be cut to a rectangular cross-section of base *b* and height *h*. Analyze the dimensions b and h, in order to maximize:

a. The bending stiffness
b. The bending strength

(For Open Book Examination and not for semester end examination)

21ME405 Thermal Engineering Lab

0 0 3 1.5

Course outcome(s)

1. Understand the valve timing diagram of IC engine
2. Perform experiments to determine air fuel ratio and volumetric efficiency of engine
3. Determine the performance of IC engines
4. Evaluate the energy distribution by conducting heat balance test on IC engines
5. Assess the efficiency of reciprocating air compressor
6. Determine the performance of refrigeration system

COs – POs Mapping

COs	PO_1	PO_2	PO_3	PO_{10}	PO_{12}	PSO_2
1	3	2	1	2	2	3
2	3	2	1	2	2	3
3	3	2	1	2	2	3
4	3	2	1	2	2	3
5	3	2	1	2	2	3
6	3	2	1	2	2	3

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

List of Experiments

1. Demonstration of valve timing diagram of 4-stroke diesel engine
2. Demonstration of port timing diagram of 2-stroke diesel engine
3. Evaluation of performance characteristics of 4 - Stroke slow speed diesel engine
4. Evaluation of performance characteristics of 4 - Stroke high speed diesel engine
5. Evaluation the performance characteristics of VCR engine
6. Determination of heat balance of single cylinder diesel engine
7. Determination of volumetric efficiency and air-fuel ratio of 4 stroke diesel engine
8. Determination of optimum cooling water temperature of 4 stroke diesel engine
9. Evaluation the performance characteristics of twin cylinder diesel engine
10. Evaluation of engine friction by conducting retardation test on single cylinder 4 stroke diesel engine
11. Determination of emission characteristics of diesel engine
12. Estimation of steam quality by throttling and separating calorimeter
13. Evaluation of performance characteristics of reciprocating air compressor
14. Determination of COP of Refrigeration Unit
15. Demonstration of boiler mountings and accessories
16. Demonstration of I.C. Engine parts (Cylinder block, head, piston and piston ring Connecting rod & crank shaft, spark plug, Carburetor, fuel injector and fuel pump)

List of Augmented Experiments

1. An experimental study on the yielding of two different bio diesel
2. Fabrication of a demonstration model of fuel pump
3. A comparative experimental study on the viscosity of two different biodiesel at different temperatures
4. Fabrication of a cut section model of fuel injector
5. Fabrication of battery ignition system
6. An assembled model of hermetically sealed compressor used in vapor compression system
7. Construction of Thermoelectric generator
8. Construction of Portable wind mill for cell phone charging
9. A comparative experimental study on the fire and flash points of two different biodiesel
10. Experimental investigations on stirring time on the properties of bio diesel blends
11. Experimental study on the lift and drag forces of a selected object using wind mill
12. Fabrication of demonstrative model of solar water purifier
13. Preparation of PVT surface with wood or thermo-coal
14. Fabrication of vacuum pump from cycle pump
15. A poster presentation on the automobile chassis with all mountings

Reading Materials(s)

1. Thermal Engineering manual, GMR institute of technology, Rajam
2. V. Ganesan, Internal Combustion Engines, Tata McGraw Hill, 4th Edition, 2012
3. V.P. Vasandan & D S Kumar, Heat engineering, MPSSB Co. Ltd, 3rd Edition, 2008

21ME406 Mechanics of Solids Lab

0 0 3 1.5

Course Outcome(s)

1. Evaluate the strength of various engineering materials
2. Calculate young's modulus of wood/steel materials
3. Find the stiffness and rigidity modulus of spring
4. Estimate the impact resistance of steel used in various engineering applications
5. Compare the compressive strength of wood/Concrete/Brick materials along and across the grains
6. Measure the deformations in various beam members

COs – POs Mapping

COs	PO_1	PO_2	PO_3	PO_{10}
1	3	2	1	2
2	3	2	1	2
3	3	2	1	2
4	3	2	1	2
5	3	2	1	2
6	3	2	1	3

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

List of Experiments

1. To draw the stress-strain diagram for mild steel
2. To find the deflection and young's modulus of the (steel) cantilever beam.
3. To find the deflection and young's modulus of the (wood) cantilever beam.
4. To determine the deflection and young's modulus of the simply supported beam.
5. To determine the torsion strength of the given material
6. To determine the hardness of the given material
7. To find the shear modulus and stiffness of the given spring material
8. To determine the compression strength of the wood along the grains and across the grains
9. To find the compression strength of the concrete/brick
10. To find the impact strength of the given material by using Izod's impact testing machine
11. To find the impact strength of the given material by using charpy impact testing machine
12. To find the shear strength of the given material
13. To verify the Maxwell's reciprocal theorem on beams.
14. To find the electrical resistance of the given material by using strain gauges
15. To find the deflection of continuous beam
16. To determine Brinell hardness number

List of Augmented Experiments

1. Determine tensile, compressive, bending, shear and fatigue strength of following materials
   a. Cast iron
   b. En-8
   c. Die steel
   d. Copper
2. Design and fabricate a cantilever beam using a suitable material for the following cross-sections and determine its deflection
   a. Hollow circular
   b. Box
3. Design and fabricate a simply supported beam using a suitable material for the following cross-sections and determine its deflection
   a. Hollow circular
   b. Box
4. Mechanical characterization of non-ferrous dissimilar welded joints
5. Mechanical characterization of Ferrous dissimilar welded joints
6. Draw stress vs. strain diagram for heat treated steels

Reading Material(s)

1. Mechanics of Solids lab manual, Department of Civil engineering, GMRIT, Rajam
2. R. K. Bansal, Strength of Materials, Lakshmi publications, 6th Edition, 2017

21ESX01 Employability Skills I

0 0 2 2

Course Outcomes(s)

1. Demonstrate oral communication and writing skills as an individual to present ideas coherently
2. Develop life skills with behavioral etiquettes and personal grooming
3. Assess analytical and aptitude skills
4. Develop algorithms for engineering applications
5. Solve engineering problems using software
6. Utilize simulation tools for testing

Co-Po mapping

COs	PO_1	PO_2	PO_5	PO_8	PO_{10}	PO_{12}
1					3	2
2				1	2	2
3	2	1		2		
4	2		2			
5	2		2			
6	2		2			

Building Confidence: Fear? Steps to Overcoming the Fear of Public Speaking?
Self Esteem: Definition? Types of Self Esteem, Causes of Low Self Esteem, Merits of Positive Self Esteem and Steps to build a positive Self Esteem.
Group Discussions (Practice): GD? GD Vs Debate, Overview of a GD , Skills assessed in a GD, Dos & Don'ts, & Conducting practice sessions (Simple Topics).
Motivational Talk: Team Work: Team Vs Group? Stages in Team Building, Mistakes to avoid and Lessons to Learn (Through Stories or Can be a Case Specific)
Quantitative Aptitude:
Percentages, Profit and loss, Mixtures and Allegations, Simple Interest, Compound Interest

Iron CAD Part- II:
Geometric part modeling of the details of engineering assemblies: Geometric part modeling of the details of stuffing box, screw jack and Plummer block
Assembling the generated part models: Performing the Assemblages of the details of stuffing box, screw jack and plummer block.
Performing Details of the engineering assemblages: Performing the detailed drawings from the given assemblies of Flanged coupling and its types
Generating Orthographic views of the assemblies: Generating the orthographic projections from the assemblies of the engineering components like stuffing box, screw jack and plummer block, Conversion to pdf from the generated orthographic views.

Text Books:

1. Machine Drawing – K. L. Narayana, P. Kannaiah & K. Venkata Reddy, New Age Publishers, Sixth Edition, 2019.
2. Production Drawing – K. L. Narayana, P. Kannaiah, K. Venkata Reddy, New Age International, 3rd Edition, 2014.

Reference Books:

1. Machine Drawing includes AutoCAD – Ajeet Singh, McGraw Hill, 2nd edition, 2012.
2. Machine Drawing with AutoCAD- Goutam Pohit, Goutam Ghosh, Pearson Education, 1st Edition, 2007.

Weblink
http://www.ironcad.com/learning-center/

21ME501 Computer Aided Design and Manufacturing

3 0 2 4

Course Outcome(s)

1. The use of computers in product design and manufacturing.
2. Perform basic 2D and 3D geometric Transformations.
3. Interpret and develop parametric models of simple curves, surfaces and solids.
4. Explain NC, DNC and CNC.
5. Develop manual part programs for machining components on Milling and Turning machines.
6. Summarize GT, CAPP, FMS, CAQC, CIM systems

COs – POs Mapping

COs	PO_1	PO_2	PO_5	PO_9	PO_{10}	PSO_1
1	3	2	1	-	-	-
2	3	3	2	2	1	3
3	3	3	2	1	1	3
4	3	2	3	1	-	-
5	3	3	3	3	2	-
6	3	2	2	-	-	-

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit- I

Basic Design process, Role of computers in Design process, product life cycle. 2D and 3D Transformations Rotation, scaling, translation. Wireframe modeling Geometric Model wireframe model, wireframe entitles, parametric representation method, parametric representation of synthesis curves, Genetic cubic splines, Bezier curves, B-Splines.

Practical Components

1. Write C-programs to draw 2D primitives/basic shapes.
2. Write a C-program to perform 2D-transformations on a given object.
3. Write a C-program to perform 3D-transformations on a given object.
4. Write a program to generate cubic spline curves using C language.

20 Hours

Unit- II

Surface Modeling

Surface model surface entitles, surface representations, parametric representations of surfaces, plane surface, ruled surfaces, surface of revolution, tabulated cylinder, Hermite Bicubic surface. Bezier surface, B- Spline surfaces

Solid modeling-Solid representation Boundary representation (B-Rep), constructive Solid Geometry, examples.

Practical Components

1. Write a program to generate the cubic parametric curve using C language.
2. Write a program to generate the Bezier curve using C language.
3. Write a program to generate a plane Bezier surface using C language.
4. Write a program to generate a B-spline surface using C Language.
5. To study the CSG & boundary representation technique for solid modeling.

20 Hours

Unit- III

Fundamentals of CNC machines

CNC Technology - Functions of CNC Control in Machine Tools - Classification of CNC systems – Contouring System - interpolators, open loop and closed loop CNC systems - CNC Controllers, Hardware features – Direct Numerical Control (DNC Systems). -Automatic tool changers.

Part programming for CNC machines- Numerical control codes - Standards - Manual Programming - Canned cycles and subroutines – Computer Assisted Programming, CAD / CAM approach NC part programming, Machining of free form surfaces.

Practical Components

1. To write manual part programming for practicing simple facing operation, simulate and to machine the given component on CNC milling machine.
2. To write manual part programming for practicing simple turning operation, simulate and to machine the given component on CNC milling machine.
3. To write manual part programming for practicing step turning operation, simulate and to machine the given component on CNC lathe machine.
4. To write manual part programming for practicing multiple taper turning operation, simulate and to machine the given component on CNC lathe machine.

22 Hours

Unit- IV

Group technology

Part families, Part classification and coding, Production flow analysis, Machine cell design, Advantages of GT.

Process planning

Conventional process planning, CAPP, benefits of CAPP, architecture of CAPP, CAPP approaches- variant CAPP, generative CAPP, Hybrid CAPP, CAPP systems.

Flexible manufacturing systems

Introduction, FMS components, types of FMS, FMS layouts, planning for FMS, Advantages and applications.

Practical component:

1. To write manual part programming for practicing multiple threading operation, simulate and to machine the given component on CNC lathe machine.
2. To write manual part programming for practicing linear and circular interpolations, simulate and to machine the given component on CNC milling machine.
3. Performing simple facing and drilling operation with FMS.
4. Performing plane turning and pocketing operation with FMS.

18 Hours
Total: 80 Hours

Textbook(s)

1. Mikell P-Grover, Emory W. Zimmers, Jr., CAD/CAM –5th Edition 2008.
2. Ibrahim Zeid - CAD/CAM Theory and Practice, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2nd Edition, 1992.
3. Michael E. Mortenson, Geometric modeling, Industrial Press, 3rd Edition, 2006.
4. Koren, Computer Control of Manufacturing Systems, Tata McGraw-Hill Education, 2nd Edition, 2005.

Reference(s)

1. P.N Rao, CAD/CAM Principles & Applications, TMH, 2nd Edition, 2008.
2. Chennakesava R. Alavala, CAD/CAM: Concepts and Applications, PHI Learning Pvt. Ltd., 2nd Printing, 2008.
3. David F. Rogers, Mathematical Elements for Computer Graphics, McGraw-Hill, 2nd Edition, 1990.
4. Tien-Chien Chang, Richard A. Wysk, Hsu-Pin Wang, Computer-Aided Manufacturing, Pearson Prentice Hall, 3rd Edition, 2006.

Sample Question(s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)
Remember	35	35
Understand	45	45
Apply	20	20
Analyze	-	-
Evaluate	**-**	**-**
Create	**-**	**-**
Total (%)	**100**	**100**

Remember

1. How does FMC differ from FMS?
2. List the objectives of CAQC.
3. Describe product life cycle.
4. Describe the parametric representation of surface.
5. List the characteristics of B-spline curve.
6. Describe shigly design cycle.

Understand

1. Explain the different computer aided inspection methods.
2. Explain the classification and coding system used in GT in Opitz classification systems.
3. Explain generative CAPP with the help of layout diagram.
4. Explain the function of various components of FMS.
5. Explain the line/polygon classification for B-representation of solids.

Apply

1. Relate constructive solid geometry and boundary representation with neat pictorial examples.
2. With a mathematical example demonstrate trimming of a curve.
3. Write a program to perform 2D-transformations on a given object.
4. Write a program to perform 3D-transformations on a given object.
5. To generate cubic spline curves using C language.

Analyze

1. Write manual part programming for practicing multiple taper turning operation, simulate and to machine the given component on CNC lathe machine.
2. Write manual part programming for practicing multiple taper turning operation, simulate and to machine the given component on CNC lathe machine.
3. Write manual part programming for practicing multiple threading operation, simulate and to machine the given component on CNC lathe machine.

21ME502 Design of Machine Members I

3 0 0 3

Course Outcome(s)

1. Explain the design procedure and selection of materials for a specific application.
2. Analyze the strength and stiffness of a component subjected to static and variable loads.
3. Design riveted, welded, and bolted joints for engineering applications.
4. Design solid and hollow shafts for strength and rigidity.
5. Interpret the theory of columns.
6. Design keys, shaft couplings, and cotter joints

COs – POs Mapping

COs	PO_1	PO_2	PO_3	PSO_1
1	3	2	1	2
2	3	2	2	2
3	3	3	3	2
4	3	2	2	2
5	3	3	3	2
6	3	2	1	2

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit I

Introduction- Design for Static Load& Design for Fatigue Load

Design process, Types of machine design, General considerations in machine design, Engineering Materials – Selection, BIS system of designation of steels. Combined stresses - Various theories of failure - Design for strength and rigidity. Stress concentration - Theoretical Stress Concentration factor - Fatigue stress concentration factor, notch sensitivity, Endurance limit, Estimation of Endurance strength. Design for finite and infinite life. Design for fluctuating stresses – Goodman's line, Soderberg's line

Modified Goodman's line, preferred numbers in design

12 Hours

Unit II

Riveted and welded joints- Bolted joints

Design of riveted, welded and bolted joints with initial stresses and eccentric loading. Design of bolts with pre-stresses

Design of bolted joints under eccentric loading

12 Hours

Unit III

Shafts- Theory of columns

Design of solid and hollow shafts for strength and rigidity - Design of shafts for combined bending and axial loads - Shaft sizes – Failure of a column or a strut, types of end conditions of column, Euler's column theory-Assumptions, Euler's formula- slenderness ratio- limitations, equivalent length of a column, Rankine's formula for column, Johnson's formula for columns, long columns subjected to eccentric loading

Design of shafts subjected to axial loads in addition to combined bending and twisting

12 Hours

Unit IV

Keys, Shaft Couplings and Cotter Joints

Design of Keys-stresses in keys. Shaft couplings-Muff, Split Muff, Flange and bushed pin type flexible coupling. Cotter Joints- Socket and spigot, Sleeve and cotter and Gib and cotter joint, Knuckle joint

Gib and cotter joint for square rods

12 Hours

Total: 48 Hours

Textbook (s)

1. V. B. Bhandari, Design of Machine Elements, TMH Publishers, 4th Edition, 2017.
2. R.S Khurmi and J.K Gupta, Machine Design, S.Chand Publisher, 25th Revised Edition, 2014.

3. SMD Jalaludin, Design Data handbook, Anuradha Publishers,4th Edition, 2019.

Reference (s)

1. Norton R. L., Machine Design – An Integrated Approach, 4th Edition, Pearson, 2019.
2. Shigley J.E. & Mischkie C.R., Mechanical Engineering Design, TMH publishers, 10th Edition, 2014.
3. N. C. Pandya& C. S. Shah, Machine Design, Charotar publishing house Pvt. Ltd., 20th Edition, 2015.

Sample Question (s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam(%)
Remember	15	10	--
Understand	20	15	--
Apply	65	40	50
Analyze	--	35	50
Evaluate	--	--	--
Create	--	--	--
Total (%)	**100**	**100**	**100**

Remember

1. What are the various types of designs?
2. Define factor of safety.
3. Distinguish clearly between direct stress and bending stress.
4. What do you understand by the term riveted joint?
5. Define the following terms
    a. Major diameter
    b. Minor diameter
    c. Pitch
    d. Lead
6. Define the term 'key' and state it's functions.

Understand

1. Explain Rankine's and Guest's theories of failure
2. Explain Notch sensitivity and fatigue stress concentration factor
3. Explain various terms used in riveted joints
4. List various types of screw threads and discuss them with neat sketches and state their applications
5. Explain the function of a key and a keyway? Classify the keys and discuss them in brief
6. Explain the design procedure of a socket and spigot type cottered joint

Apply

1. The load on a bolt consists of an axial pull of 10 kN together with a transverse shear force of 5 kN. Find the diameter of bolt required according to 1. Maximum principal stress theory; 2. Maximum shear stress theory; 3. Maximum principal strain theory; 4. Maximum strain energy theory; and 5. Maximum distortion energy theory
2. A plate 100 mm wide and 12.5 mm thick is to be welded to another plate by means of parallel fillet welds. The plates are subjected to a load of 50 kN. Find the length of the weld so that the maximum stress does not exceed 56 MPa. Consider the joint first under static loading and then under fatigue loading
3. A machine component is subjected to a flexural stress which fluctuates between + 300 MN/m2 and – 150 MN/m2. Determine the value of minimum ultimate strength according to 1. Gerber relation; 2. Soderberg relation. Take yield strength = 0.55 Ultimate strength; Endurance strength = 0.5 Ultimate strength; and factor of safety = 2
4. Design and draw a cotter joint to support a load varying from 30 kN in compression to 30 kN in tension. The material used is carbon steel for which the following allowable stresses may be used. The load is applied statically. Tensile stress = compressive stress = 50 MPa; shear stress = 35 MPa and crushing stress = 90 MPa.

5. Design and make a neat, dimensioned sketch of a muff coupling which is used to connect two steel shafts transmitting 40 kW at 350 r.p.m. The material for the shafts and key is plain carbon steel for which allowable shear and crushing stresses may be taken as 40 MPa and 80 MPa respectively. The material for the muff is cast iron for which the allowable shear stress may be assumed as 15 MPa
6. A polished steel bar is subjected to axial tensile force that varies from zero to Pmax. It has a groove 2 mm deep and having a radius of 3 mm. The theoretical stress concentration factor and notch sensitivity factor at the groove are 1.8 and 0.95 respectively. The outer diameter of the bar is 30 mm. The ultimate tensile strength of the bar is 1250 MPa. The endurance limit in reversed bending is 600 MPa. Find the maximum force that the bar can carry for 105 cycles with 90% reliability **(For Open Book Examination and not for semester end examination)**

Analyze

1. Hydraulic press exerts a total load of 3.5 MN. This load is carried by two steel rods, supporting the upper head of the press. If the safe stress is 85 MPa and E = 210 kN/mm^2, find:
    a. Diameter of the rods
    b. Extension in each rod in a length of 2.5 m
2. A steam engine cylinder has an effective diameter of 350 mm and the maximum steam pressure acting on the cylinder cover is 1.25 N/mm2. Calculate the number and size of studs required to fix the cylinder cover, assuming the permissible stress in the studs as 33 MPa
3. A pair of wheels of a railway wagon carries a load of 50 kN on each axle box, acting at a distance of 100 mm outside the wheelbase. The gauge of the rails is 1.4 m. Find the diameter of the axle between the wheels, if the stress is not to exceed 100 MPa.
4. A pair of wheels of a railway wagon carries a load of 50 kN on each axle box, acting at a distance of 100 mm outside the wheel base. The gauge of the rails is 1.4 m. Find the diameter of the axle between the wheels, if the stress is not to exceed 100 MPa **(For Open Book Examination and not for semester end examination)**

21ME503 Steam and Gas Turbines

3 0 0 3

Course Outcome(s)

1. Interpret Rankine cycle
2. Explain the working of boilers and its performance parameters
3. Asses the performance of steam nozzles
4. Criticize on the performance of steam turbines
5. Explain the working of steam condensers and their performance parameters
6. Asses the performance of gas turbines

COs – POs Mapping

COs	PO_1	PO_2	PO_3	PO_6	PO_7	PSO_2
1	3	2	2	2	2	2
2	3	2	-	2	2	2
3	3	2	-	2	2	2
4	3	2	-	2	2	2
5	3	2	-	2	2	2
6	3	2	2	2	2	2

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit I

Vapor Power Cycles-Steam Generators and Draft system

Rankine Cycle, Performance of Rankine Cycle, Reheating and Regeneration, Problems. Classification of Steam Generators, Cochran, Babcock & Wilcock's, La-mont, HP Boilers Loeffler , Velox and Benson boilers- Introduction to Super critical boiler - Equivalent evaporation and boiler efficiency, Boiler mountings and accessories. Draft System: Theory of Natural, Induced, Forced and Balance Draft

Binary cycle analysis

12 Hours

Unit II

Steam nozzles and impulse turbines

Steam nozzles

Function , types and of applications nozzle , Thermodynamic analysis of flow through nozzles, condition for maximum discharge, critical pressure ratio, criteria decide nozzle shape Its effects, degree of super saturation and degree of under cooling-Problems

Impulse Turbines

Introduction- Classification of turbine, Impulse turbine-Mechanical details, Velocity diagram – effect of friction – power developed, axial thrust and blade efficiency –condition for maximum efficiency- Problems

Compounding of turbines

12 Hours

Unit III

Reaction Turbines and condensers

Reaction turbines

Reaction turbine - principle of operation–velocity diagram , Power and efficiencies of turbine, stage, degree of reaction. Parson's reaction turbine – condition for maximum efficiency

Condensers - Classification– Jet and Surface condensers: – vacuum efficiency and condenser efficiency

Sources and effects of air leakage in condenser

12 Hours

Unit IV

Gas Turbines

Classification – Ideal Brayton cycle, Constant pressure turbines: analysis of open cycle - Inter cooling, reheat and regenerative – combination of intercooling, reheat and regeneration- open cycle turbines –closed cycle turbine-maximum efficiency- Constant volume gas turbines

Gas turbine blade materials

12 Hours
Total: 48 Hours

Textbook(s)

1. R. K. Rajput, Thermal Engineering, Lakshmi Publications, 10th Edition, 2018
2. P K Nag, Power Plant Engineering, 4th Edition, TMH, 2017
3. V. Ganesan, Gas Turbines, TMH, 3rd Edition, 2010

Reference(s)

1. R. Yadav, Steam and Gas Turbines and Power Plant Engineering, Central Book Depot, 7th Edition, 2015
2. H Saravanamuttoo, GFC Rogers, H Cohen , Paul Straznicky, A.C. Nix, Gas Turbine Theory, Pearson, 7th Edition, Reprint, 2017
3. P. Khajuria and S. P. Dubey, Gas Turbines and Propulsive Systems, Dhanpatrai, 5th Edition, 2012.

Sample Question(s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	25	25	-
Understand	35	25	-
Apply	40	50	50
Analyze	-	-	50
Evaluate	-	-	-
Create	-	-	-
Total (%)	**100**	**100**	**100**

Remember

1. Define sensible heat and Latent heat.
2. List any four boiler accessories.
3. Classify the steam nozzles.
4. Mention the elements of a steam condensing plant.
5. Write the expression for maximum efficiency of an impulse turbine

Understand

1. Derive an expression for maximum discharge through the chimney for a given height of chimney.
2. Prove that the $\frac{P_2}{P_1} = \left(\frac{2}{n+1}\right)^{\frac{n}{n-1}}$ for maximum discharge in convergent-divergent nozzle.
3. Define the term 'Degree of reaction' as applied to a steam turbine. Show that for a Parson's reaction turbine's degree of reaction is 50%.
4. Explain reheat Gas turbine cycle with neat sketch and also draw T-s and h-s diagrams.
5. Distinguish between jet condenser and surface condenser.

Apply

1. In a Rankine cycle the steam at inlet to turbine is saturated at a pressure of 35bar and exhaust pressure is 0.2bar. Determine (i) Network output (ii) Rankine efficiency (iii) Dryness at the end of expansion, assume flow rate is 9.5 kg/s
2. A Convergent divergent nozzle is to be designed in which steam initially at 14 bar and 80°C of superheat is to be expanded down to a back pressure of 1.05bar. Determine the necessary throat and exit diameter of nozzle for steam discharge of 500kg/hr, assuming that the expansion is in thermal equilibrium throughout and friction reheat amounting to 125 of total isentropic enthalpy drop to be effective in the divergent part of the nozzle.
3. A 50% reaction turbine (with symmetrical triangles) running at 400 rpm has the exit angle of the blade as 20o and the velocity of steam relative to the blades at the exit is 1.35 times the mean blade speed. The steam flow rate is 8.33 kg/s and at a particular stage the specific volume is 1.381 m^3/kg. Calculate for this stage: (i)

a suitable blade height, assuming the rotor mean diameter 12 times the blade height and (ii) the diagram work.

4. A surface condenser deals with 13625 Kg of steam per hour at a pressure of 0.09 bar. The steam enters 0.85 dry and the temperature at the condensate and air extraction pipes is 36°C. The air leakage amounts to the 7.26 kg/h. Determine (i) the surface required if the average heat transmission rate is 3.97 kJ/cm^2 per second; (ii) the cylinder diameter for the dry air pump, if it is to be single acting at 60 r.p.m. with a stroke to bore ratio of 1.25 and volumetric efficiency of 0.85.
5. Consider the combined gas–steam power cycle. The topping cycle is a gas-turbine cycle that has a pressure ratio of 10. Air enters the compressor at 350 K and the turbine at 1450 K. The isentropic efficiency of the compressor is 80 percent, and that of the gas turbine is 80 percent. The bottoming cycle is a simple ideal Rankine cycle operating between the pressure limits of 9 MPa and 5 kPa. Steam is heated in a heat exchanger by the exhaust gases to a temperature of 500°C. The exhaust gases leave the heat exchanger at 400 K. Determine (a) the ratio of the mass flow rates of the steam and the combustion gases and (b) the thermal efficiency of the combined cycle.) **(For Open Book Examination and not for semester end examination)**

Analyze

1. The following data was obtained during a test on two boilers working under similar conditions, except that the draught in the first boiler was produced by an induced draught fan and in the second boiler by a forced draught fan.
   Boiler house temperature was 20'C.
   Mean temperature of flue gases leaving the boilers ... 190'C
   Air supplied per kg of fuel burnt.. 19 kg
   Density of air under given conditions….1.1205 kg/m^3
   Density of flue gases at the specified temperature.... 0.769 kg/m^3
   Combustion rate. 150 kg of fuel per hour
   Fan draught produced in each case …. 75 mm of water
   Efficiency of fan in both cases - 50%
   Make a comparative analysis on the brake power of fan in each case. Allow 20% leakage air in case of induced draught system and 70% in case of forced draught system.
2. Analyze the effect of super saturation in a nozzles
3. A binary-vapour cycle operates on mercury and steam. Saturated mercury vapour at 4.5 bar is supplied to the mercury turbine, from which it exhaust at 0.04 bar. The mercury condenser generates saturated steam at 15 bar which is expanded in a steam turbine to 0.04 bar.
   (i) Find the overall efficiency of the cycle.
   (ii) If 50000 kg/h of steam flows through the steam turbine, what is the flow through the mercury turbine?
   (iii) Assuming that all processes are reversible, what is the useful work done in the binary vapour cycle for the specified steam flow?
   (iv) If the steam leaving the mercury condenser is superheated to a temperature of 300°C in a super heater**(For Open Book Examination and not for semester end examination)**
4. In a gas turbine plant, the compressor is driven by a high pressure turbine. The exhaust from high pressure turbine enters into a low pressure turbine, which runs the load. The air flow rate is 20 kg/s and minimum and maximum temperatures in the cycle are 300K and 1000K respectively. The compressor pressure ratio is 4. Calculate the pressure ratio of low pressure turbine, temperature of exhaust gases from the unit and thermal efficiency of the plant, compression and expansion are isentropic. Cp of air and exhaust gases can be taken as 1kJ/kg.K and ϒ=1.4.
5. Following data refer to the velocity compounded impulse turbine with two rows of moving blades: Steam supply: 60 bar, 500°C, Speed of rotation: 3600 rpm ,Mean radius of blades: 60 cm, Steam supply: 6 kg/s, Blade speed to steam velocity ratio: 0.2,Nozzle efficiency: 90%, Nozzle angle: 20°, Exit angles: 25°, 25° and 40° for first moving, fixed and second moving blade respectively, Blade velocity coefficient: 0.85 for all blades, Disc friction and Wind age loss: 20 hp., Determine:
   (a) The stage pressure
   (b) The blading efficiency
   (c) The power output
   (d) The state of steam leaving stage

21ME504 Mechanical Measurements and Metrology

3 0 2 4

Course Outcomes

1. Understand the working principles of measuring devices and errors in measurements
2. Identify appropriate transducers and devices for the measurement of displacement, temperature, level and flow rate
3. Identify appropriate transducers and devices for the measurement of pressure, speed, force, torque, humidity, acceleration and vibrations
4. Compute limits, fits and tolerances of work parts and design the inspection gauges
5. Illustrate the different methods of measurement of angles and tapers
6. Infer the working of comparators, screw thread and gear teeth measuring instruments

COs – POs Mapping

COs	PO_1	PO_2	PO_3	PO_4	PO_{10}
1	3	2	2	1	2
2	3	2	2	1	2
3	3	2	2	1	2
4	3	2	2	1	2
5	3	2	2	1	1
6	3	2	2	1	1

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit I

Basic Principles of Measurement-Measurement of Displacement, Temperature, Level & Flow

Types, generalized configuration and functional descriptions of measuring instruments - examples, Static & dynamic performance characteristics - sources of error, classification and elimination of error. Types of transducers to measure displacement, Types of transducers to measure temperature, Types of transducers for level measurement, Type of transducer for flow measurement

Practical experiments:

1. Measurement of level using capacitive transducer
2. Study and calibration of a rotameter for flow measurement
3. Study and calibration of LVDT transducer for displacement measurement
4. Calibration of thermistor RTD and thermocouple

20 Hours

Unit II

Measurement of Pressure, Speed, Force, Torque, Power and Humidity

Principle and working of various low- and high-pressure measuring instruments, types of Mechanical and electrical tachometers for speed measurement, Elastic force meters, load cells, Principle of seismic instruments-vibration and acceleration, humidity-introduction, Principle and working of various humidity measuring instruments.

Practical experiments:

1. Study and calibration of McLeod gauge for low pressure
2. Calibration of load cell
3. Study and calibration of photo and magnetic speed pickups for the measurement of speed
4. Calibration of hot wire anemometer for velocity measurement

20 Hours

Unit III

Systems of Limits and Fits-Measurement of Angles and Tapers

Introduction, normal size, tolerance limits, deviations, allowance, Fits & their types, tolerance systems, hole & shaft basis systems- Interchangeability and Selective assembly. Class & grade of tolerance, Numerical on limits, fit and tolerance. sine bar and rollers for tapers, Taylor's principle, Design of GO & NO-GO gauges, Types of limit gauges, Numerical on limit gauge design

Practical experiments:

1. Performance on linear measurements using Vernier Calliper, Vernier height gauge, and Micrometre
2. Performance on angular measurement of given specimen by using Vernier bevel protractor

3. Performance on angular measurement of given specimen by using sine bar
4. To carry out measurement with the help of different indirect and direct non-graduated measurement

20 Hours

Unit IV

Comparators-Screw Thread & Gear Teeth Measurement

Comparators – types and their uses in mass production. Flat surface measurement: surface plates - optical flat and autocollimator. Screw thread measurement: errors in screw thread, Measurement of effective diameter, angle of thread and thread pitch, Gear measuring instruments, Gear tooth profile measurement, Measurement of diameter, pitch pressure angle and tooth thickness, Coordinate Measuring Machines- Types of CMM, blue light scanning, white light scanning, Role of CMM, and its applications

Practical experiments:

1. Measurement of alignment using Autocollimator / Roller set
2. Measurement of thread parameters using Optical Projector / Toolmaker Microscope
3. Measurement of gear tooth profile using gear tooth Vernier /Gear tooth micrometre
4. Measurement of surface flatness using Optical Flats
5. Measurements of Surface roughness using Talysurf
6. Alignment test on lathe

20 Hours

Total:80 Hours

Textbook (s)

1. N V Raghavendra and Krishnamurthy, Engineering Metrology and Measurement, Oxford University Press, Reprint edition, 2018
2. D.S. Kumar, Mechanical Measurement & Control, Metropolitan Book Co. (P) Ltd, 5th reprint edited, 2015
3. R. K. Rajput, Mechanical Measurements and Instrumentation, S.K. Kataria & Sons, 2nd edition, 2015

Reference (s)

1. R. K. Jain, Mechanical and Industrial Measurements: Process Instrumentation and Control, Khanna Publishers, 12th reprint edition, 2018
2. Beckwith, Thomas G., Marangoni, Roy D., Lienhard V, John H., Mechanical Measurements, 6th Edition, Prentice Hall, 10th reprint, 2018
3. I.C. Gupta, Engineering Metrology, Dhanpat Rai and Sons, 10th edition, 2017
4. R. K. Jain, Engineering Metrology, Khanna Publishers, 20th edition, 2017
5. M.Mahajan, A Textbook Of Metrology, Dhanpat Rai & Co, 17th edition, 2017

Sample Question (s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)
Remember	35	25
Understand	65	50
Apply		25
Analyze	-	-
Evaluate	-	-
Create	-	-
Total (%)	**100**	**100**

Remember

1. Define the generalized configuration and functions of measuring instruments
2. State the principles for pressure and speed measuring instruments
3. Define normal size, tolerance limits, deviations, allowance, Fits & their types
4. State the roll of CMM in measurement
5. List different methods used to measure taper

Understand

1. Explain the principles of seismic instruments
2. Explain the principle and working of McLeod pressure gauge
3. Classify different flat surface measuring instruments with neat sketches
4. Classify temperature measuring instruments. Give brief description about Hot-wire anemometer
5. Classify different types of comparators. Explain them with neat sketch

Apply

1. A hole is specified as 40 (limits: 0.0500,0mm). The mating shaft has a clearance fit with minimum clearance of 0.01 mm. The tolerance on the shaft os 0.04 mm. find The maximum clearance in mm between the hole and the shaft
2. For a particular application, an H 7 fit has been selected for the hole and a K 6 fit for the shaft. The tolerance quoted are 0 +25 for the hole and 12 +18 for the shaft. Find the upper limit and lower limit for the hole and also for bush. The basic size of fit is $50x10^{-3}$ m
3. A 50 mm diameter shaft is made to rotate in the bush. The tolerances for both shaft and bush are 0.050 mm. determine the dimension of the shaft and bush to give a maximum clearance of 0.075 mm with the hole basis system
4. A dowel pin is required to be inserted in a base. For this application H 7 fit for hole and a p 6 fit for the shaft are chosen. The tolerance quoted are 0, + 25 for the hole and 26, + 42 for the shaft. Find the upper and lower limits of the hole and also dowel pin, and the maximum interference between dowel pin and the hole. The basic size of the fit is 50×10^{-3} m
5. A shaft of 25 mm basic size is given as 25 ± 0.02 mm. Find the tolerance

21ME507 Metal cutting and Machine Tools Lab

0 0 3 1.5

Course Outcome(s)

1. Build simple features by performing basic turning operations on lathe
2. Develop simple features by performing basic operations on shaper and planer
3. Create features by making use of grooving, boring and reaming,
4. Demonstrate the features by making use of milling machine
5. Perform basic operations on thread cutting and knurling,
6. Build the basic features by making use of Cylindrical Grinder and Surface.

COs – POs Mapping

COs	PO_1	PO_2	PO_3	PO_4	PSO_1	PSO_2
1	3	2	2	3	1	1
2	3	2	2	2	1	1
3	3	2	2	1	1	1
4	3	2	-	2	1	1
5	3	2	2	3	2	1
6	-	2	2	3	3	2

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

List of Experiments

1. Introduction of general-purpose machine- Lathe, drilling machine, Milling machine, Sharper, Planning machine, Slotting machine, Cylindrical Grinder, Surface grinder and tool and cutter grinder.
2. Perform facing and plain turing on lathe machine.
3. Perform Step turning and taper turning on lathe machine.
4. Perform Thread cutting and knurling on lather machine.
5. Perform grooving and boring operations on lathe machine.
6. Perform drilling and tapping operations by using Drilling machine.
7. Prepare a spur gear by using milling machine.
8. Prepare a helical gear by using milling machine.
9. Prepare V-tool by using tool cutter grinder.
10. Conversion of circular rod into square rod using shaping machine.
11. Generate a flat surface and prepare V-groove using shaping machine.
12. Generate a slotting and key ways using slotting machine.
13. Generate internal splines using slotting machine.
14. Perform of reaming operations on lathe machine
15. Perform on Cylindrical Grinder machine.
16. Perform on tool and cutter grinder machine.

List of Augmented Experiments

1. Study of cutting tool geometry.
2. Preparation of single point cutting tool according to ASA systems.
3. Preparation of tensile test specimen according to ASTM standards using conventional lathe machine.
4. Preparation of tensile test specimen according to ASTM standards using CNC lathe machine.
5. Multiple turning operations on CNC machine.
6. Preparation of Helical Gear.
7. Comparative study between conventional machining and CNC Machining.
8. To study the characteristic features of lathe machine by comparing the observations recorded at low, medium and high speeds.
9. To study the characteristic features of Milling machine by comparing the observations recorded at low, medium and high speeds.
10. Compare the surface roughness of workpiece fabricated using drilling machine and EDM.
11. To study the characteristic features of Shaper by comparing the observations recorded at low, medium and high speeds.
12. Preparation of tensile test specimen according to ASTM standards using shaper machine.

Reading Material (s)

1. Machine cutting and machine tools lab manual, GMR Institute of Technology, Rajam

21MEC11 Automotive Informatics

3 0 0 3

Course Outcome(s)

1. Understand working of various peripherals of automotive controller
2. Distinguish vehicle control systems for different vehicles application
3. Understand basics of modeling, simulation and Hardware in Loop testing of various automotive subsystems
4. Asses different type of automotive subsystems
5. Select suitable vehicular communication system
6. Apply the fundamental knowledge to develop vehicular network simulation

COs – POs Mapping

COs	PO_1	PO_5	PO_6
1	3	2	2
2	3	2	3
3	3	2	3
4	3	2	2
5	3	2	3
6	3	2	3

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit I

Automotive controllers

Introduction to Automotive Controllers: 18-Bit Automotive Microcontroller, Port Integration, Memory mapping control, memory protection, External bus interface, interrupts, clock and reset, ADC, Scalable Controller Area Network, periodic interrupt timer, serial peripheral interfaces, Timer Module

Pulse width modulation

12 Hours

Unit II

Vehicle control systems

Body Controller Application Example, Programming using code warrior IDE. Introduction to longitudinal and lateral vehicle control, Modeling and simulation study of ABS, Adaptive cruise control, Electronic Stability control, Active suspension control

Integrated vehicle control

12 Hours

Unit III

Automotive subsystems

Basics of rapid control, Prototyping and hardware in the loop simulation. X-by-wire technology: Brake by- wire, Steer-by-wire and Throttle-by-wire, Controllers, Fault-tolerant electronic sub-systems

Parlex Flexible Printed Circuits

12 Hours

Unit IV

Vehicular communication

Communication for Intelligent Transportation Systems, Security and Privacy in Vehicular Networks; Vehicular Network Simulation – mobility models, bidirectional coupled road traffic, GPS for vehicles and communication network simulators for vehicular network simulation

Wireless Access in hybrid and unmanned vehicles

12 Hours

Total: 48 Hours

Textbook(s)

1. Rajesh Rajamani, Vehicle Dynamics and Control, Springer, 2nd Edition, 2012
2. UweKiencke and Lars Nielsen, Automotive Control Systems: For Engine, Driveline, and Vehicle, Springer, 2nd Edition, 2005
3. Christophe Sommer and Falko Dressler, Vehicular Networking, Cambridge University Press, 2014

Reference(s)

1. James E Duffy, Modern Automotive Technology, Goodheart Willcox , 7th Edition, 2011
2. Joseph Lemieux, Programming in the OSEK/VDX Environment, CMP Books, 2001
3. Anis Laouiti, Amir Qayyum, Mohamad Naufal Mohamad Saad. Vehicular Ad-hoc Networks for Smart Cities, Springer, 1st Edition. 2020

Web reference(s)

1. https://www.tue.nl/en/education/graduate-school/master-automotive-technology/
2. https://dhi.nic.in/userview/index?mid=1319
3. https://www.sae.org/publications/magazines/automotive-engineering

Video links

1. https://www.youtube.com/watch?v=F-nxgeEBanY
2. https://www.youtube.com/watch?v=cQt11pt8lWs
3. https://www.youtube.com/watch?v=vHQy6ryf2Bg

Sample Question(s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	35	30	-
Understand	45	40	-
Apply	20	30	30
Analyze	-	-	70
Evaluate	-	-	-
Create	-	-	-
Total (%)	100	100	100

Remember

1. Define pulse mode fuel control.
2. List any four requirements of lookup table
3. Classify the BUS
4. Define active suspension and list any four types of suspension.
5. Classify the automotive subsystems
6. List any four requirements of intelligent transportation system

Understand

1. Mention the purpose of LIM BUS and MOST BUS.
2. Illustrate the layout of ABS.
3. Explain the functions of digital cruise control
4. How to know stability of automobile?
5. Mention the purpose of automotive controllers and write their types.
6. Draw the layout of closed loop ignition timing.

Apply

1. Automobile uses various modules of control unit. Justify the statement
2. CAM protocol layers are key elements in automotive transmission. Express your opinion
3. Illustrate the digital cruise control in Automotive vehicle with neat sketches
4. Describe the construction and working of recirculating ball type steering gear box in automotive vehicle with sketch.
5. Describe the features of accelerometer-based air bag system in automotive vehicle **(For Open Book Examination and not for semester end examination)**
6. Explain antilocking braking system with necessary circuitry design **(For Open Book Examination and not for semester end examination)**

Analyze

1. Compare steer-by wire to throttle-by wire in automotive vehicle
2. Analyze the reasons for failure of serial peripheral interfaces used in vehicles.
3. List the necessity of vehicle motion control system.
4. How solenoids and actuators are comparable as relays in vehicles? **(For Open Book Examination and not for semester end examination)**
5. Simplify the role of vehicular networking in road safety.

21MEC21 Fundamentals of Digital Manufacturing Science

3 0 0 3

Course Outcome(s)

1. Familiarize with the basic concepts of Digital Manufacturing Systems (DMS)
2. Identify the architecture and modeling of DMS
3. Understand the technical knowledge in virtual prototyping and reverse engineering
4. Explain the concepts of intelligent manufacturing and Management of Technology
5. Outline the R&D machinery framework and management emphases
6. Concept of key information about cyber security and security risk analysis

COs – POs Mapping

COs	PO_1	PO_5	PSO_2
1	3	2	2
2	3	3	2
3	3	3	3
4	3	2	2
5	3	2	3
6	2	3	1

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit- I

Digital Manufacturing

Introduction, Concepts and Research and Development Status, Features and Development, Basic Concept and Connotation of Digital Manufacturing Science, Operation Reference Mode, Architecture of Digital Manufacturing System, Modelling and Critical modelling Theories, IDEF0, IDEF1X, GRAI, Petri Net and Object-Oriented Modelling Method, Organization Model, Function Model, Information Model, Operation and Control Model.

Connotation and research method

12 Hours

Unit- II

Information of Computing Manufacturing

Computing Manufacturing Methodology, C-Space, Screw Space, Virtual Prototyping and Virtual Manufacturing, Reverse Engineering, Discrete Model, Information Model, Geometric Modeling and Reasoning, Computational Geometry, Convex Analysis, Information Principles of Manufacturing, Measurement, Synthesis and Materialization of Manufacturing Information, Integration, Sharing and Security of Manufacturing Information.

Discrete model and computational geometry

12 Hours

Unit- III

Concept of Intelligent Manufacturing

Intelligent Multi information Sensing and Fusion, knowledge Engineering in the life cycle, representation and base, Autonomy, self –learning, Intelligent manufacturing system, features and multi-agent, science of bionic manufacturing, machinery, biological manufacturing and development of bio-manufacturing Management of Technology, concept and development process of MOT, R&D system framework and *management*

Collaborative management mode of R&D

12 Hours

Unit- IV

Information of key and security technology manufacturing

Various digital technologies in product lifecycle, digital equipment and processing, digital logistic technology, resource and environment technology, resource organization and management, threats to information system, security threat source, threat agents, information assurance, cyber security and security risk analysis, application security, database security, e-mail security and internet, security threats, virus, worms.

Network and services attack

12 Hours

Total: 48 Hours

Textbook(s)

1. Z. Zhou, S. Xie, D. Chen, Fundamentals of Digital Manufacturing Science, Springer, 2012.
2. Mayank bhushan rajkumar singh rathore aatif jamshed, fundamental of cyber security, bpb publication, 1st edition 2017.
3. H.A. Almeida, J.C. Vasco, Progress in Digital and Physical Manufacturing, Springer, 1st edition, 2019

Reference(s)

1. Bi, Zhuming, practical guide to digital manufacturing, First-time–right for design of products, machines, processes and system integration, Springer International Publishing,2021.
2. K. Kumar, D. Zindani, J.P. Davim, Digital Manufacturing and Assembly Systems in Industry 4.0, CRC Press, 1st edition, 2021
3. Y. Tan, Digital Manufacturing & Automation III, Trans Tech Publications Limited, 1st edition, 2012

Sample Question(s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	30	30	-
Understand	50	50	-
Apply	20	20	50
Analyze	-	-	50
Evaluate	-	-	-
Create	-	-	-
Total (%)	**100**	**100**	**100**

Remember

1. Define Architecture of Digital Manufacturing System
2. Define Object-oriented modelling method
3. What is the mechanism of Sharing Manufacturing Resources?
4. List out the biological manufacturing and development of bio-manufacturing
5. Illustrate the management and database security

Understand

1. Explain the Information model of Digital Manufacturing System
2. Explain Virtual Prototyping and its applications
3. Explain Reverse Engineering and its applications
4. Discuss the digital equipment and processing, digital logistic
5. Demonstrate the features and multi-agent science of bionic manufacturing

Apply

1. Illustrate the operation reference mode
2. Demonstrate the fundamentals of geometric modeling and reasoning
3. Discuss the security threats
4. Interpret the management and scheduling of resources
5. Prepare the resource and environment technology **(For Open Book Examination and not for semester end examination)**

Analyze

1. List out the principles of manufacturing
2. Analyse the main object-oriented modelling method
3. Contrast the knowledge of engineering in the life cycle
4. Compare the cyber security and security risk analysis
5. Inspect the various digital technologies in product lifecycle **(For Open Book Examination and not for semester end examination)**

21MEC31 Data Analytics and Operations Management

3 0 0 3

Course Outcome(s)

1. Understand the fundamental concepts of descriptive and inferential statistics
2. Explain the concepts of regression, ANOVA analysis
3. Summarize the machine learning fundamentals
4. Apply the concepts of operations management and strategies
5. Interpret the concepts of project planning processes
6. Understand the concepts of project implementation

COs – POs Mapping

COs	PO_1	PO_2	PO_{11}
1	3	3	-
2	3	3	-
3	3	2	-
4	3	-	2
5	3	-	3
6	3	-	3

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit- I

Descriptive and Inferential Statistics

Introduction to the course, Descriptive Statistics, Probability Distributions, Inferential Statistics through hypothesis tests.

Permutation & Randomization test

12 Hours

Unit- II

Regression, ANOVA and Machine Learning

Regression, ANOVA (Analysis of Variance), Machine Learning – Differentiating algorithmic and model based frameworks, Ordinary Least Squares, Ridge Regression.

Lasso Regression

12 Hours

Unit- III

Operations Management and Strategy

Operations Strategy, Competitive Capabilities and Core Competencies, Operations Strategy as a Competitive Weapon, Linkage Between Corporate, Business, and Operations Strategy, Developing Operations Strategy, Elements or Components of Operations Strategy, Competitive Priorities, Manufacturing Strategies, Service Strategies, Global Strategies and Role of Operations Strategy, Case-lets.

Manufacturing Strategies and Service Strategies

12 Hours

Unit- IV

Project Management

Project planning process – Introduction, need, Project Management Principles, Essentials of Project Management Philosophy, Project Planning

Project Implementation Control and Closure – Project Management Life Cycle, Project Monitoring and Control, Change Control, Risk Management, Project Closure

Working Knowledge of software package in operations and project management

Project Process Flows

12 Hours

Total: 48 Hours

Textbook(s)

1. Clifford Gray and Erik Larson, The Managerial Process, Mcgraw Hill, 7th edition, 2017.
2. Montgomery, Douglas C., and George C. Runger. Applied statistics and probability for engineers. John Wiley & Sons, 7th edition, 2020.
3. Ethem Alpaydin. Introduction to Machine Learning, 4th Edition, The MIT Press, 2020.

Reference(s)

1. Cachon and Terwiesch, Matching Supply with demand- An introduction to Operations Management, McGraw-Hill Higher Education, 4th Edition, 2018.

2. Douglas C. Montgomery, Georgy C. Runger and Noorma Faris Hubele, Engineering Statistics, Wiley India Pvt. Ltd., 5th Edition, 2012
3. V.K. Jain, Machine Learning, Khanna Book Publishing Co. (P) Ltd., 2019

Web reference(s)

1. https://onlinecourses.nptel.ac.in/noc21_cs24/preview
2. https://nptel.ac.in/courses/110/106/110106064/
3. https://onlinecourses.nptel.ac.in/noc20_me30/preview
4. https://onlinecourses.nptel.ac.in/noc19_mg30/preview

Sample Question(s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	15	15	**-**
Understand	15	15	**-**
Apply	55	55	50
Analyze	15	15	50
Evaluate	**-**	**-**	-
Create	**-**	**-**	-
Total (%)	**100**	**100**	**100**

Remember

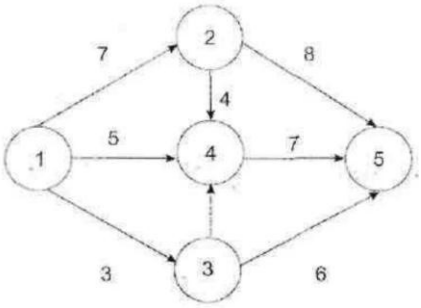
1. What do you mean by hypothesis testing?
2. What do you understand about probability distribution?
3. Define randomization test.
4. What is descriptive statistics?
5. What is inferential statistics?

Understand

1. Compare between null and alternate hypothesis testing citing an example
2. Classify the different manufacturing strategies.
3. Outline the project planning process.
4. Explain the regression techniques.
5. Explain the concepts of machine learning.

Apply

1. Apply the competitive strategy technique in a manufacturing unit
2. Identify the application for operations strategy in a a corporate and business environment.
3. Develop the Critical path for the given flow diagram. Relate the given network for a suitable engineering application by performing reverse engineering process. Explain how this relates to operations management concepts (For open book examination)



Analyze

1. Analyze the project management life cycle with emphasis on supply chain and logistics in an automobile assembly unit. You are expected to assume the required data and clearly state the assumptions in your answer. (For open book examination)
2. Demonstrate the working knowledge of any computer software package in operations and project management. Clearly trace the flow of the logic involved in the software.
3. Analyze the project process flow citing an example in the form of a case study.

21ME005 Alternate Fuels and Emission control in Automotives

3 0 0 3

Course Outcome(s)

1. Classify alternate fuels
2. Criticize the effect of alternate liquid fuels on IC engines
3. Illustrate the effect of gaseous fuels on IC engines
4. Understand the solar, electric and hybrid vehicles.
5. Asses the emissions of SI and CI Engines
6. Understand the emission control methods

COs – POs Mapping

COs	PO_1	PO_6	PO_7
1	3	2	2
2	3	2	3
3	3	2	3
4	3	2	3
5	3	2	2
6	3	2	2

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit I

Need for Alternative Fuels and Liquid fuels

Need for alternate fuels

Need for Alternative Fuels, availability and comparative properties of alternate fuels, classification of alternative fuels.

Liquid fuels

Alcohol: Sources of Methanol and Ethanol, Properties of Methanol and Ethanol. Use of alcohols in S.I. and C.I. engines, performance of blending methanol with gasoline. Bio Diesels: raw materials used for production of Bio Diesel (Karanji oil, Neemoil, Sunflower oil, Soyabeen oil, Musturd oil, Palm oil, Jatropha seeds). The process of preparation of Bio-diesel performance of Engine with biodiesel-diesel blends

Production methods of Alcohol fuels

12 Hours

Unit II

Gaseous fuels

Gaseous Fuels - Availability, properties, and engine modifications required. Hydrogen as a substitute fuel . Study Properties, Sources and methods of Production of Hydrogen, Storage and Transportation of hydrogen. Application and advantages of liquid hydrogen used as fuel in IC engines. Biogas: Introduction to Biogas system, Process during gas formation, Factors affecting biogas formation. Biogas used as fuel in the SI & CI engines. LPG & CNG: Properties of LPG & CNG, fuel metering systems, performance and emission analysis.

Fuel Cells: Concept of fuel cells and Layout of fuel cell vehicle.

12 Hours

Unit III

Solar and Electric vehicles

Solar cells for energy collection. Storage batteries for solar energy, Layout of solar powered automobiles, advantages and limitations of solar powered vehicles. Layout of an electric vehicles, advantages & limitations. Systems components, electronic controlled systems, high energy and power density batteries.

Maintenance of hybrid vehicle

12 Hours

Unit IV

Emission measurement and control

Effects of constituents of Exhaust gas emission on environmental condition of earth (HC, CO_2, CO, NOx, SO_2 and O_2). Bharat Emission norms, Measurement & instrumentation for HC, CO_2, CO, NOx & PM, smoke meters, calibration checks on emission equipment's, SI engine emission control: Engine design and fuel system parameters, Engine

add-ons to enable reduction of engine-out emissions and Exhaust after treatment. CI engine emission control: Diesel Oxidation Catalyst, Impact of Sulphur on Oxidation Catalysts. Filters NOx Reduction: Exhaust Gas Recirculation, Lean NOx Catalysts NOx Absorber Catalysts
Selective catalytic reduction

12 Hours
Total: 48 Hours

Textbook(s)

1. V. Ganeshan, Internal Combustion Engines, McGraw Hill publishers, 4th Edition, 2017
2. A.K.Babu, Electric & Hybrid Vehicles, Khanna Books, 1st Edition, 2019
3. G. Amba Prasad Rao, T. Karthikeya Sharma, Engine Emission Control Technologies, Apple Academic Press, 1st Edition, 2020

Reference(s)

1. Tom Denton , Alternative Fuel Vehicles, Taylor & Francis, 7th Edition, 2019
2. John B Heywood, Internal Combustion Engines, McGraw Hill Education, 1st Edition, 2017
3. Simona, Hybrid Electric Vehicles, Springer India, 1st Edition, 2019.

Sample Question(s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	30	20	-
Understand	50	30	-
Apply	20	50	70
Analyze	-	-	30
Evaluate	-	-	-
Create	-	-	-
Total (%)	100	100	100

Remember

1. List any four desired properties of alternative fuels.
2. Classify the alternative fuels.
3. List the sources of hydrogen.
4. Identify the components of hybrid vehicles.
5. List any four sources of SI engine emissions.

Understand

1. Explain the reasons for alternative fuel sources.
2. Explain how the alcohol affects the IC engine performance.
3. Explain the process of making biodiesel.
4. Illustrate the required engine modifications to suit the gaseous fuels.
5. Explain any to electronic controlled systems in electric vehicles.

Apply

1. Govt. of India planning to implement the 20% Alcohol based fuel. Express your opinion about the decision made by government.
2. Pure biodiesel are not suitable for CI engine operation. Justify the statement
3. Emissions from the CNG are quite favourable than diesel fuels. Justify the statement
4. Is the vehicle shown in Fig A, have any emission control method? If No, give the reasons. If Yes, explain the techniques

Fig A

5. The vibrations of electric vehicles are less than the diesel vehicles. Express your opinion in supporting the statement. **(For Open Book Examination and not for semester end examination)**

Analyse

1. Made a comparative analysis with respect to diesel when a CI is operated with B20 biodiesel and diesel fuel blend
2. Analyse the reasons for operating the CI engines with lower blends of biodiesel
3. For the Biodiesel operated engines the formation NOx is quite more. Analyse the reasons for such results.
4. Made a comparative analysis on the CI Engine emissions operating with biofuels at different compression ratios
5. Is it possible to replace the existing vehicles completely with electric vehicle? Made a detail analysis **(For Open Book Examination and not for semester end examination)**

21ME006 Industrial Robotics and Applications

3 0 0 3

Course Outcome(s)

1. Explain fundamentals of the robotics and its anatomy
2. Infer basic configurations and components of robotic systems
3. Model the robot motion through forward kinematics and inverse kinematics
4. Develop mathematical models for dynamic motions and trajectory planning
5. Explain various feedback components in robotic systems
6. Understand the field of applications of robots

COs – POs Mapping

COs	PO_1	PO_2	PO_3	PSO_1
1	3	3	1	-
2	3	3	2	-
3	3	3	3	3
4	3	3	3	3
5	3	3	3	-
6	3	-	1	-

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit I

Introduction-Components of the Industrial Robotics

Industrial automation and Robotics, CAD/CAM and Robotics – An overview of Robotics – present and future applications – classification by coordinate system and control system. Function line diagram representation of robot arms, common types of arms. Components, Architecture, number of degrees of freedom, determination of the end effectors

Requirements and challenges of end effectors

12 Hours

Unit II

Robot Kinematics and Dynamics

Kinematic Modelling: Translation and Rotation Representation, Coordinate transformation, DH parameters, forward kinematics, Jacobian, Singularity and Statics

Dynamic Modelling: Forward and inverse dynamics, Equations of motion using Euler-Lagrange formulation, Newton Euler formulation

Inverse Kinematics

12 Hours

Unit III

Path and Trajectory planning

General considerations in path description and generation. Trajectory planning and avoidance of obstacles, path planning, Skew motion, joint integrated motion –straight line motion

Sensors

Sensor devices, Types of sensors - contact, position and displacement sensors, Force and torque sensors -Proximity and range sensors - Robot vision systems - sensing and digitizing – Image processing and analysis

Acoustic sensors

12 Hours

Unit IV

Industrial Applications

Application of robots - Material handling - Machine loading and unloading, Assembly, Inspection, Welding, spray painting, Mobile robot, Microbots - Recent developments in robotics

Safety considerations of robots in industry

12 Hours

Total: 48 Hours

Textbook (s)

1. M P Groover, Industrial Robotics - Technology, Programming and Applications (SIE), Tata McGraw-Hill Education, 2nd Edition,2017
2. R K Mittal and Nagrath, Robotics and Control, Tata McGraw-Hill Education, 3rd Edition, 2017
3. Deb S.R., Robotics Technology & Flexible Automation, Tata McGraw Hill, 2nd Edition, 2017

Reference (s)

1. John J. Craig, Introduction to Robotics: Mechanics and Control, Pearson/Prentice Hall, 4th Edition, 2017
2. S K Saha, Introduction to Robotics, Tata McGraw-Hill Education, 2nd Edition, 2014
3. Philippe Coiffet, Michael Chirouze, An Introduction to Robot Technology, Springer Science & Business Media, Illustrated Edition, 2012
4. K S Fu, Ralph Gonzalez, C S G Lee, Robotics: Control Sensing. Vision, and Intelligence, Tata McGraw-Hill Education, 2nd Edition, 2008
5. Richard David Klafter, Thomas A. Chmielewski, Michael Negin, Robotic Engineering: An Integrated approach, Prentice Hall, 1st Edition, 1993

Sample Question (s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam(%)
Remember	35	25	
Understand	45	40	50
Apply	20	35	50
Analyze	-	-	-
Evaluate	-	-	-
Create	-	-	-
Total (%)	**100**	**100**	**100**

Remember

1. Define the terms Robot and Robotics
2. Discuss the different feedback components used in robots
3. What are the main characteristics of a robot?
4. What is an industrial robot? State its applications in industry

Understand

1. Explain the principle of entropy increase.
2. Discuss different ways of classifying robots
3. Explain the various robot configurations with neat sketches
4. Draw the graphical representation of Rotational joint in DH notation
5. Discuss the application of Lagrangian Newtonian techniques in writing the equation of motion for Robotics
6. Explain the application of robots in welding
7. In an open chain kinematic manipulator robotics, there are two kinematic tasks:
    a. Direct (also forward) kinematics
    Given: Joint relations (rotations, translations) for the robot arm.
    Task: What is the orientation and position of the end effector?
    b. Inverse kinematics
    Given: The desired end effector position and orientation.
    Task: What are the joint rotations and orientations to achieve this?
8. Consider the arm shown in Figure
    a. Solve the forward kinematics problem.
    b. Given the location of the end effector (x; y; z)T , solve the inverse kinematics problem (assume d3 ≥ 0). **(For Open Book Examination and not for semester end examination)**

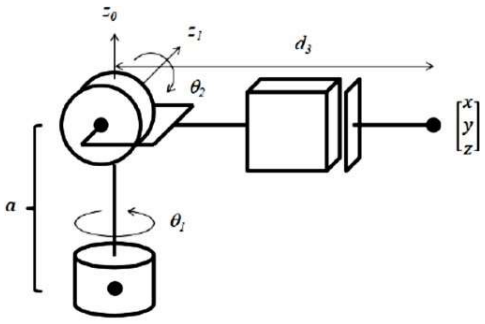
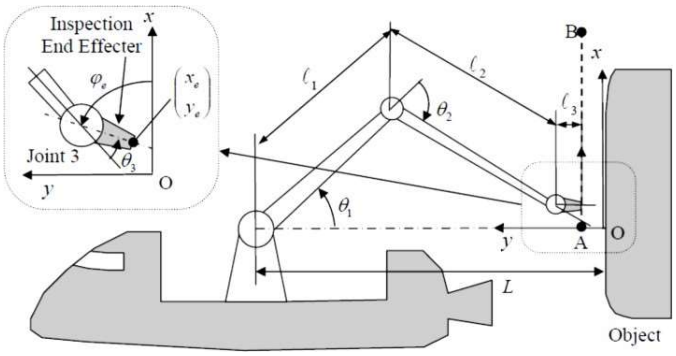


Figure 1: In this figure, θ_1 and θ_2 are shown at 0°.

Apply

1. Discuss the role of robots in engineering.
2. What are the various fields in which the robots used?
3. Explain the application of robots in loading\unloading
4. Explain various technical features required of robot for spot welding
5. An astronaut is operating a shuttle manipulator with an inspection end effecter attached to the tip of the arm. For the sake of simplicity, we consider only the three revolute joints, θ_1, θ_2, θ_3, and the three links, as shown in the figure. A Cartesian coordinate system, *O-xy,* is attached to the object to be inspected. The distance of the coordinate origin *O* is *L* from the location of the first joint. Answer the following questions using the notation shown in the figure.
    - *a.* Obtain the forward kinematic equations relating the end effecter position and orientation, X_e, Y_e, ϕ_e to the three joint angles, θ_1, θ_2, θ_3. Note that the end effecter position and orientation are viewed from the Cartesian coordinate system attached to the object, *O-xy.*
    - **b.** Obtain the Jacobian matrix associated with the kinematic equations of Part a). Sketch a block diagram of Resolved Motion Rate Control where the astronaut uses a joystick for generating velocity commands, $V_x = X_e$, $V_y = Y_e$, $\varphi = \phi_e$ with reference to the Cartesian coordinate system *O-xy.* **(For Open Book Examination and not for semester end examination)**



21ME007 Non-Traditional Machining and Forming Processes

3 0 0 3

Course Outcomes

1. Outline the need for unconventional machining processes and their classification
2. Understand the underlying mechanism of mechanical energy processes
3. Summarize working principles of chemical machining and ECM processes
4. Explain working principles of EDM, EBM
5. Understand the underlying principle of LBM and PAM processes
6. Summarize the working principle of various forming and finishing processes

COs – POs Mapping

COs	PO_1	PO_2	PSO_2
1	3	2	1
2	3	2	1
3	3	2	3
4	3	2	1
5	2	2	1
6	3	2	1

Unit I

Introduction-Mechanical energy processes

Need for modern machining methods, Classification, Considerations in process selection, Materials. Basic principles, equipment, process variables, elements of the process, mechanics of metal removal, economic considerations in Ultrasonic Machining, Abrasive Jet Machining and Water Jet Machining

Applications and limitations

12 Hours

Unit II

Chemical Machining

Introduction to chemical machining, maskants, etchants, equipment, process variables, mechanics of metal removal

Electrochemical Machining (ECM)

Principle of electro chemical machining, electro chemical grinding, electro chemical honing and deburring process. Material removal rate in ECM, tool design. Surface finish and accuracy, economic aspects in ECM, Estimation of metal removal rate

Electron Beam Machining-Principle, Theory, Generation and control of electron beam for machining

Advantages and applications

12 Hours

Unit III

Electric Discharge Machining(EDM) - Wire EDM

Principle of EDM, Electric Discharge Wire Cutting Process and Electric Discharge Grinding, Power circuits for EDM, Mechanics of metal removal - formulae, Process parameters, selection of electrode and dielectric fluids

Plasma Arc Machining(PAM)-Working principle and types of PAM, metal removal mechanism, process parameters, accuracy and surface finish

Laser Beam Machining(LBM)-Principle, Laser system, Construction and operation of LBM, Laser materials

Advantages and disadvantages of EDM, PAM, LBM.

12 Hours

Unit IV

Non-Traditional forming, Hydro forming and super plastic forming

Working principle of Non-Traditional forming, Hydro forming and super plastic forming, HERFs- explosive forming, Electrohydraulic forming, magnetic pulse forming.

Finishing processes-Magnetic abrasive finishing, Abrasive flow finishing.

Advantages and disadvantages

12 Hours

Total: 48 Hours

Textbook(s)

1. V K Jain, Advanced machining processes, Allied publishers PVT Ltd, 12th Reprint, 2019

2. P C Pandey and H S Shah, Modern Machining Process, McGraw Hill, 10th Reprint, 2018
3. P K Mishra, Non-conventional machining, Narosa Publishing House, 9th Reprint, 2018

Reference(s)

1. Hassan Abdel and Gawad El Hofy, Advanced Machining Processes: Nontraditional and Hybrid Machining Processes, McGraw Hill-Mechanical Engineering Series, 13th Reprint, 2018
2. Gary F. Benedict, Nontraditional Manufacturing Processes, CRC Press LLC, Reprint edition, 2019
3. ASM Handbook, Forming and Forging, Volume 14, 9th Edition, 2003

Sample Question (s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	25	25	-
Understand	35	25	-
Apply	40	50	50
Analyze	-	-	50
Evaluate	-	-	-
Create	-	-	-
Total (%)	100	100	100

Remember

1. What is conventional machining process?
2. List the advantages and disadvantages of nontraditional machining process?
3. Define the EDM?
4. What is ECM?
5. Name the types of machining process?
6. What are the benefits of wire EDM?
7. Write about non-traditional forming process

Understand

1. Classify and explain the machining process
2. Explain the USM process with neat sketch of the equipment used
3. Outline underlying process of chemical machining
4. Explain the role of non-traditional machining processes in modern era?
5. Compare the traditional and non-traditional machining process in three points each

Apply

1. An electric discharge machining operation is being performed on two work materials: tungsten and tin. Determine the amount of metal removed in the operation after 1 hour at a discharge current of 20 amps for each of these metals. Use metric units and express the answers in mm^3/hr. The melting temperatures of tungsten and tin are 3410^0C and 232^0C, respectively.
2. In a chemical milling operation on a flat mild steel plate, it is desired to cut an ellipse-shaped pocket to a depth of 10mm. The semiaxes of the ellipse are a = 228mm and b = 152mm. A solution of hydrochloric and nitric acids will be used as the etchant. Determine (a) metal removal rate in mm^3/hr, (b) time required to etch to depth, and (c) required dimensions of the opening in the cut and peel maskant required to achieve the desired pocket size on the part.
3. For the following application, identify one or more nontraditional machining processes that might be used, and present arguments to support your selection. Assume that either the part geometry or the work material (or both) preclude the use of conventional machining. The application is an engraved aluminum printing plate to be used in an offset printing press to make 275 × 350 mm posters **(For Open Book Examination and not for semester end examination)**

Analyze

1. A furniture company that makes upholstered chairs and sofas must cut large quantities of fabrics. Many of these fabrics are strong and wear-resistant, which properties make them difficult to cut. What nontraditional process(es) would you recommend to the company for this application? Justify your answer by indicating the characteristics of the process that make it attractive. **(For Open Book Examination and not for semester end examination)**
2. Make a table of the process capabilities of the advanced machining processes described in this course. Use several columns and describe the machines involved, the type of tools and tool materials used, the shapes of blanks and parts produced, the typical maximum and minimum sizes, surface finish, tolerances, and production rates. **(For Open Book Examination and not for semester end examination)**

21ME001 Fundamentals of Optimization Techniques

3 0 0 3

Course Outcome(s)

1. Explain the need of optimization of engineering systems.
2. Apply classical optimization techniques on single and multivariable.
3. Solve linear programming and transportation problems.
4. Apply dynamic programming and use numerical methods for optimization.
5. Solve the problems of project management using CPM and PERT.
6. Apply one-dimensional search methods and classical techniques to obtain maxima and of non-linear programming problems.

CO-PO Mapping

COs	PO_1	PO_2
1	3	2
2	3	2
3	2	2
4	2	2
5	2	2
6	2	2

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit- I

Introduction and Classical optimization Techniques:

Statement of an Optimization problem – design vector – design constraints – constraint surface – objective function – objective function surfaces – classification of Optimization problems.

Classical Optimization Techniques: Single variable Optimization – multi variable Optimization without constraints – necessary and sufficient conditions for minimum/maximum – multivariable Optimization with equality constraints. Solution by method of Lagrange multipliers – Multivariable Optimization with inequality constraints – Kuhn – Tucker conditions.

12 hours

Unit- II

Linear Programming Problem: Standard form of a linear programming problem – geometry of linear programming problems – definitions and theorems – solution of a system of linear simultaneous equations – pivotal reduction of a general system of equations – motivation to the simplex method – simplex algorithm.

Transportation Problem: Finding initial basic feasible solution by north – west corner rule, least cost method and Vogel's approximation method – testing for optimality of balanced transportation problems.

12 hours

Unit- III

Dynamic Programming (D.P): Multistage decision processes. Concepts of sub optimization, Recursive Relation-calculus method, tabular method, LP as a case of D.P.

Numerical Methods For Optimization: Nelder Mead's Simplex search method, Gradient of a function, Steepest descent method, Newton's method.

12 hours

Unit- IV

CPM and PERT: Drawing of networks, Removal of redundancy, Network computations, Free slack, Total slack, Crashing, Resource allocation.

Non-Linear Programming: Characteristics, Concepts of convexity, maxima and minima of functions of n-variables using Lagrange multipliers and Kuhn-Tuker conditions, One dimensional search methods, Fibonacci, golden section method and gradient methods for unconstrained problems.

12 hours

Total: 48 hours

Textbook(s)

1. Operations Research: An Introduction, Prentice Hall of India (2007) 8th ed.
2. Kasana, H.S., Introductory Operation Research: Theory and Applications, Springer Verlag (2005).

3. Rardin, Ronald L., Optimization in Operations research, Pearson Education (2005). Ravindran A, Phllips D.T. and Solberg J.J.
4. Operation Research: Principles and Practice, John Wiley (2007).
5. Engineering Optimization Theory and Practice, S.S.Rao, New Age International (P) Ltd, Publishers
6. Kalyanmoy Deb Multi-objective optimization using evolutionary algorithms John Wiley Publications
7. Jasbir S. Arora Introduction to Optimum Design McGraw Hill Publication
8. Optimization for Engineering Design by Kalyanmoy Deb, PHI Publishers
9. Genetic algorithms in Search, Optimization, and Machine learning – D.E.Goldberg, Addison-Wesley Publishers

Sample Question(s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination(%)
Remember	10	10	-
Understand	10	10	20
Apply	80	80	80
Analyze	-	-	-
Evaluate	-	-	-
Create	-	-	-
Total (%)	**100**	**100**	**100**

Remember

1. What are the types of classical optimization techniques?
2. What are the draw backs of classical optimization techniques?
3. State the assumptions of CPM and PERT.
4. Discuss simplex algorithm of LPP.

Understand

1. What are the limitations of PERT and CPM?
2. How non-linear programming problems are different from linear programming problems?
3. What kind of problems can be solved through dynamic programming technique?

Apply

1. By using simplex method, minimize $Z = 2X_1+9X_2+ X_3$ Subjected to the constraints: $X_1+4X_2 +2X_3 \geq 5$, $3X_1+X_2 +2X_3 \geq 48$, $X_1 \geq 0$, $X_2 \geq 0$, $X_3 \geq 0$.
2. Find the optimal solution to the following transportation problem for which the cost, origin-availabilities and destination-requirements are as given below

	A	**B**	**C**	**D**	
I	1	2	-2	3	**70**
II	2	4	0	1	**38**
III	1	2	-2	5	**32**
	40	**28**	**30**	**32**	

3. A college student has 7 days remaining before final examinations begin in her four courses, and she wants to allocate this study time as effectively as possible. She needs at least 1 day on each course, and she likes to concentrate on just one course each day, so she wants to allocate 1, 2, 3, or 4 days to each course. Having recently taken an OR course, she decides to use dynamic programming to make these allocations to maximize the total grade points to be obtained from the four courses. She estimates that the alternative allocations for each course would yield the number of grade points shown in the following table:

Solve this problem using dynamic programming.

	Estimated Grade Points			
	Course			
Study Days	1	2	3	4
1	3	5	2	6
2	5	5	4	7
3	6	6	7	9
4	7	9	8	9

21ME601 Design of Machine Members II

3 0 0 3

Course Outcome(s)

1. Design journal, ball and roller bearings subjected to static and dynamic loads
1. Analyze curved beams under static loads
2. Design connecting rod, crank shaft, pistons and cylinders
3. Design belt, rope and chain drives
4. Design spur and helical gears
5. Design power screws and springs

COs – POs Mapping

COs	PO_1	PO_2	PO_3	PSO_1
1	3	3	3	2
2	3	3	2	2
3	3	3	2	2
4	3	2	2	2
5	3	3	3	2
6	3	2	2	2

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit I

Bearings and Curved Beams

Types of Journal bearings, Lubrication, Bearing Modulus, Full and partial bearings, Clearance ratio, Heat dissipation of bearings, bearing materials, Journal bearing design, Petroff's equation, Ball and roller bearings, Static loading of ball & roller bearings, Bearing life. Design of curved beams: introduction, stresses in curved beams, Expression for radius of neutral axis for rectangular, circular, trapezoidal, and T-Section-

Crane hook, Design of C – clamp

12 Hours

Unit II

Engine parts

Connecting Rod, thrust in connecting rod, Stress due to whipping action on connecting rod ends, Cranks and Crank shafts, strength and proportions of over hung and center cranks, Crank pins, Crank shafts. Pistons, Forces acting on piston, Construction, Design and proportions of piston, Cylinder, Cylinder Liners-

Crank pins

12 Hours

Unit III

Power transmission systems - Pulleys, Spur & Helical Gears

Transmission of power by Belt and Rope drives, Transmission Efficiencies, Belts – Flat and V types – Ropes - pulleys for belt and rope drives, Materials. Spur & Helical gear drives: Spur gears- Helical gears – Load concentration factor – Dynamic load factor. Surface Compressive strength – Bending strength – Design analysis of spur gears – Estimation of Centre distance, module and face width, check for plastic deformation. Check for dynamic and wear considerations-

Chain drive

12 Hours

Unit IV

Design of power screws

Design of screw, Square, ACME, Buttress screws, design of nut, compound screw, differential screw, ball screw-possible failures. Types of springs, end connection for tension and compression helical springs, Helical spring subjected to fatigue loading stress and deflections in helical springs – circular wire, springs series and parallel, composite springs-

Leaf springs

12 Hours

Total: 48 Hours

Textbook(s)

1. V. B. Bhandari, Design of Machine Elements, TMH Publishers, 5th Edition, 2020
2. S MD Jalaludin, Design Data hand Book, Anuradha Publishers, 2nd Edition, 2016
3. Shigley J.E. & Mischkie C.R., Mechanical Engineering Design, TMH publishers, 10th Edition, 20014.

Reference(s)

1. Robert L. Norton., Machine Design – An Integrated Approach, Pearson, 6th Edition, 2020
2. Data Books : (i) P.S.G. College of Technology (ii) Mahadevan
3. N. C. Pandya & C. S. Shah, Machine Design, Charotar publishing house Pvt. Ltd. 20th Edition, 2015

Sample Question(s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	15	15	-
Understand	15	15	-
Apply	55	55	50
Analyze	15	15	50
Evaluate	-	-	-
Create	-	-	-
Total (%)	100	100	100

Remember

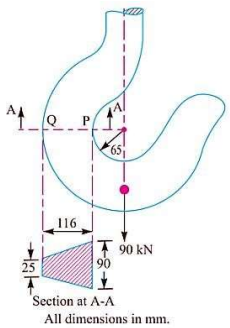
1. List the commonly used materials for sliding contact bearings and state any four desirable properties of a good bearing material
2. How do you prefer trapezoidal section with wider edge inside for the cross section of a crane hook?
3. Write a short note on piston rings?
4. Discuss about the various types of belt drives with neat sketches?
5. Discuss the design procedure of spur gears?
6. Classify the springs

Understand

1. What is meant by hydrodynamic lubrication? (ii) Explain wedge film and squeeze film journal bearings (iii) Explain Bearing characteristic number for journal bearings
2. Discuss the nature of stresses developed at the inner and outer fibers of a crane hook. Also explain the nature of failure of a crane hook during loading
3. Explain the various stresses induced in the connecting rod
4. On what a factor does the power transmitted by a belt depends?
5. Show that the efficiency of self-locking screws is less than 50%?
6. Differentiate between differential screw and compound screw?

Apply

1. Design a journal bearing for a centrifugal pump from the following data :
2. Load on the journal = 20 000 N; Speed of the journal = 900 r.p.m.; Type of oil is SAE 10, for which the absolute viscosity at 55°C = 0.017 kg / m-s; Ambient temperature of oil = 15.5°C; Maximum bearing pressure for the pump = 1.5 N/mm^2. Heat dissipation coefficient = 1232 W/m^2/°C. Calculate also mass of the lubricating oil required for artificial cooling, if rise of temperature of oil be limited to 10°C.
3. A crane hook has a trapezoidal section at A-A as shown in Fig. Find the maximum stress at points P and Q.



4. The bore of a cylinder of the four stroke diesel engine is 200 mm. The maximum gas pressure inside the cylinder is limited to 4 MPa. The cylinder head is made of grey Cast-iron FG200 (Sut = 200 N/m2) and the factor of safety is 5. Determine the thickness of the cylinder head. Studs are used to fix the cylinder head to the cylinder and obtain a leak proof joint. They are made of steel FeE 250 (Syt = 250 N/mm2) and the factor of safety is 5. Calculate. (i) number of studs, (ii) nominal diameter of studs and (iii) pitch of studs.
5. Design a connecting rod for an I.C. engine running at 1800 r.p.m. and developing a maximum pressure of 3.15 N/mm^2. The diameter of the piston is 100 mm ; mass of the reciprocating parts per cylinder 2.25 kg; length of connecting rod 380 mm; stroke of piston 190 mm and compression ratio 6 : 1. Take a factor of safety of 6 for the design. Take length to diameter ratio for big end bearing as 1.3 and small end bearing as 2 and the corresponding bearing pressures as 10 N/mm^2 and 15 N/mm^2. The density of material of the rod may be taken as 8000 kg/m^3 and the allowable stress in the bolts as 60 N/mm^2 and in cap as 80 N/mm^2. The rod is to be of I-section for which you can choose your own proportions.
6. A gear drive is required to transmit a maximum power of 25 kW. The velocity ratio is 1:2 and r.p.m. of the pinion is 200. The approximate center distance between the shafts may be taken as 500 mm. The teeth has 20° stub involute profiles. The static stress for the gear material (which is cast iron) may be taken as 60 MPa and face width as 10 times the module. Find the module, face width and number of teeth on each gear. Check the design for dynamic and wear loads. The deformation or dynamic factor in the Buckingham equation may be taken as 80 and the material combination factor for the wear as 1.4. (Take service factor, Cs=1).
7. A double-threaded power screw, with ISO metric trapezoidal threads is used to raise a load of 500 kN. The nominal diameter is 100 mm and the pitch is 12 mm. The coefficient of friction at the screw threads is 0.15. Neglecting collar friction, calculate (i) torque required to raise the load; (ii) torque required to lower the load; and (iii) efficiency of the screw.
8. Design a Crane Hook of trapezoidal section, which can be capable of carrying 90kN, find the maximum and minimum stress induced in the section? **(For Open Book Examination and not for semester end examination)**

Analyze

1. A journal bearing with a diameter of 200 mm and length 150 mm carries a load of 20 kN, when the Journal speed is 150 r.p.m. The diametral clearance ratio is 0.0015. If possible, the bearing is to operate at 35°C ambient temperature without external cooling with a maximum oil temperature of 90°C. If external cooling is required, it is to be as little as possible to minimize the required oil flow rate and heat exchanger size. (i) What type of oil do you recommend? (ii) Will the bearing operate without external cooling? (iii) If the bearing operates without external cooling, determine the operating oil temperature? (iv) If the bearing operates with external cooling, determine the amount of oil in kg/min required to carry away the excess heat generated overheat dissipated, when the oil temperature rises from 85°C to 90°C, when passing through the bearing.
2. Suggest the suitable size of 6 × 19 hoisting steel wire rope for an inclined mine shaft of 1000 m length and inclination of the rails 60° with the horizontal. The weight of the loaded skip is 100 kN. The maximum acceleration is limited to 1.5 m/s^2. The diameter of the drum on which the rope is being wound may be taken as 80 times the diameter of the rope. The car friction is 20 N / kN of weight normal to the incline and friction of the rope on the guide roller is 50 N / kN of weight normal to the incline. Assume a factor of safety of 5. The following properties of 6 × 19 flexible hoisting rope are given : The diameter of the rope (d) is in mm. The weight of the rope per meter = 0.0334 d2 N; breaking load = 500 d^2 N; wire diameter = 0.063 d mm; area of wires in rope = 0.38 d^2 mm^2; equivalent elastic modulus = 82 kN/mm^2.
3. A 8 mm thick leather open belt connects two flat pulleys. The smaller pulley is 300 mm diameter and runs at 200 r.p.m. The angle of lap of this pulley is 160° and the coefficient of friction between the belt and the pulley is 0.25. The belt is on the point of slipping when 3 kW is transmitted. The safe working stress in the belt material is 1.6 N/mm2. Determine the required width of the belt for 20% overload capacity. The initial tension may be taken equal to the mean of the driving tensions. It is proposed to increase the power transmitting capacity of the drive by adopting one of the following alternatives: 1. by increasing initial tension by 10%, and 2. by increasing the coefficient of friction to 0.3 by applying a dressing to the belt. Examine the two alternatives and recommend the one which will be more effective. How much power would the drive transmit adopting either of the two alternatives? **(For Open Book Examination and not for semester end examination)**

21ME602 Finite Element Methods

3 0 0 3

Course Outcome(s)

1. Apply the Minimum potential energy principle to solve 1D problems
2. Understand the role and significance of linear, quadratic shape functions in finite element formulations
3. Understand the finite element formulation of a 2D Truss and Beam
4. Understand the 2D FE modeling of CST and Iso-parametric elements
5. Analyze the 1D transient and steady state heat conduction problems
6. Evaluate eigen values and eigenvectors of 1D bar and 2D Beam element

COs PO~~s~~ Mapping

COs	PO_1	PO_2	PO_3	PSO_1
1	3	2	-	2
2	3	2	-	2
3	3	3	-	3
4	3	3	-	2
5	3	2	2	2
6	3	3	-	2

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit I

General Concept-One Dimensional Problems

Introduction Finite Element Method- historical back ground - Finding Circumference of a circle by Finite Element Method - Finding area of a circle by Finite Element Method - Applications -brief description on Boundary value problems - Rayleigh Ritz method of finite element formulations -simple problems using Rayleigh Ritz method. Finite Element Modeling - Co-ordinates and shape functions - Potential Energy approach - Assembly of stiffness matrix and load vector - Finite Element equations - treatment of boundary conditions

Simple Problems covering structural and Thermal loads.

12 Hours

Unit II

Analysis of Trusses-Analysis of Beams and frames

Finite Element modeling - Coordinates and shape functions - assembly of global stiffness matrix and load vector - Finite Element equations - treatment of boundary conditions - stress, strain and support reaction calculations. Hermit shape functions - Element stiffness matrix - Load vector

Simple problems on beams and frames.

12 Hours

Unit III

Constant Strain Triangular Elements-Isoperimetric Elements

Finite Element modeling of two-dimensional stress analysis with Constant strain triangles - treatment of boundary conditions simple problems. Two - dimensional four node isoparametric elements

Numerical integration.

12 Hours

Unit IV

Application to conduction heat transfer problems-Dynamic Analysis

One dimensional transient and steady state heat conduction - finned geometry and other simple problems. Formulation of finite element model- element consistent mass matrices - Evaluation of Eigen values - Eigen vector - free vibration analysis

Problems on free vibration analysis.

12 Hours
Total: 48 Hours

Textbook (s)

1. T.R Chandrupatla, and A.D Belegundu, Introduction to Finite Elements in Engineering, Pearson education, 4th Edition, 2012
2. Junuthula Narasimha Reddy, An Introduction to the Finite Element Method, McGraw-Hill, 3rd Edition, 2006

Reference (s)

1. S.S Rao, The Finite Element Method in Engineering, Butterworth-Heinemann, 4th Edition, 2005
2. Cook Robert Devis, Concepts and Application of finite Element Analysis, Wiley, 2nd Edition, 1981
3. O. C. Zienkiewicz and R.L.Taylor, The Finite Element Methods, Vol.1, The basic formulation and linear problems, Vol.1, Butterworth Heineman, 5th Edition, 2000
4. Segerlind L.J., Applied Finite Element Analysis, Wiley Publication, 2nd Edition, 1984

Sample Question (s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	25	25	-
Understand	45	45	-
Apply	30	30	30
Analyze	-	-	70
Evaluate	-	-	-
Create	-	-	-
Total (%)	100	100	100

Remember

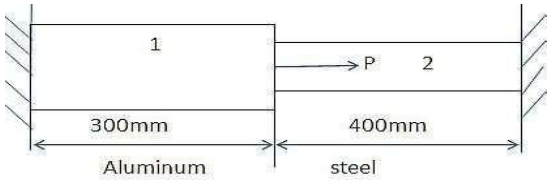
1. List out the fundamental steps in FEM to solve a problem
2. Define interpolation function
3. Define shape functions
4. Define plane stress
5. List out the different 2-D elements

Understand

1. Explain the fundamental steps involved in FEM to solve a problem
2. Describe mathematical principle involved in Trapezoidal rule and Simpson's 1/3 Rule
3. Explain the importance of quadratic shape functions in 1-D analysis
4. Compare elimination approach and penalty approach

Apply

1. Consider the bar shown in fig. An axial load P = $200x10^3$ N is applied as shown. Using the penalty (or) elimination approach for handling boundary conditions, do the following a) Determine the nodal displacements b) Determine the stress in each material. Take A_1 = 2400 mm^2, A_2 = 600 mm^2 E_1 = $70x10^9$ N/m^2, E_2=$200x10^9$ N/m^2



2. The (x, y) coordinates of the nodes i,j and k of a triangular element are (1,1), (4,2) and (3,5) respectively. The shape functions of a point P located inside the element are given by N_1=0.15 and N_2 = 0.25. Determine the x and y coordinates of the point "P"

3. Estimate the stiffness matrix and the deflection at the centre of the simply supported beam of length 3 m with 50 kN of load is acting at the centre of the beam.
4. One side of brick wall of width 5m, height 4 m and thickness 0.5 m are exposed to a temperature of -25^{0}C while the other surface is maintained at 32^{0}C. If the thermal conductivity is maintained at 32^{0}C. Ifthe thermal conductivity is 0.75w/mk and the heat transfer coefficient is 50 w/m^{2}k. Determine the temperature distribution in the wall and heat loss from the wall by two element methods.

Evaluate

1. Compare elimination approach and penalty approach in finite element analysis.
2. Compare potential energy method and Galerkin method.
3. Determine the temperature distribution in the wall, which has heat generation in a large plate (k= 0.8 W/m 0 C) at the rate of 4000 W/m3. The plate is 25 cm thick. The outside surfaces of the plate are exposed to ambient air at 300C with a convective heat-transfer coefficient of 20 W/m^2.
4. Determine the shape functions at the point of P(22,45) of a CST with the coordinates I(1,10),J(45,15) and K(30,60).

21ME603 Heat Transfer

3 0 0 3

Course Outcome(s)

1. Explain basic modes of heat transfer and compute temperature distribution in steady state and unsteady state heat conduction
2. Asses the performance of extended surfaces
3. Interpret and analyze free & forced convection heat transfer
4. Illustrate phenomena and flow regimes of boiling and condensation
5. Apply LMTD and NTU methods to design heat exchangers
6. Explain the principles of radiation heat transfer

COs – POs Mapping

COs	PO_1	PO_2	PO_3	PO_7	PSO_1	PSO_2
1	3	2	2	1	2	2
2	3	3	2	1	2	2
3	3	3	2	2	2	2
4	3	3	2	1	-	2
5	2	3	2	2	2	2
6	3	3	2	1	-	2

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit I

Introduction- One Dimensional Steady State Conduction Heat Transfer

Modes and mechanisms of heat transfer – Basic laws of heat transfer. General heat conduction equation in Cartesian, Cylindrical and Spherical coordinates. Homogeneous slabs, hollow cylinders and spheres – overall heat transfer coefficient – electrical analogy – Critical radius of insulation. Systems with variable Thermal conductivity – systems with internal heat generation, extended surface (fins). Heat Transfer – Long Fin, Fin with insulated tip and short fin.

Twisted Fins

12 Hours

Unit II

One dimensional transient conduction heat transfer-Convective heat transfer

Systems with negligible internal resistance – Significance of Biot and Fourier Numbers - Chart solutions of transient conduction systems., Dimensional analysis as a tool for experimental investigation – Buckingham Pi Theorem and method, application for developing semi – empirical non- dimensional correlation for convection heat transfer – Classification of Convection heat transfer

Significance of non-dimensional number

12 Hours

Unit III

Convection and Phase change heat transfer

Convection heat transfer

Hydrodynamic and thermal boundary layer and use of empirical correlations for forced convective heat transfer - Flat plates and Cylinders. **Free Convection** - Development of Hydrodynamic and thermal boundary layer along a vertical plate for free convection – Use of empirical relations for Vertical plates and pipes

Phase change heat transfer

Pool boiling – Regimes, Calculations on Nucleate boiling, Critical Heat flux and Film boiling. Film wise and drop wise condensation. Film condensation on vertical cylinders using empirical correlations

Film condensation on horizontal cylinders

12 Hours

Unit IV

Heat Exchangers and Radiation Heat Transfer

Heat Exchangers

Classification of heat exchangers – overall heat transfer Coefficient and fouling factor – Concepts of LMTD and NTU methods - Problems using LMTD and NTU methods

Radiation Heat Transfer - Emissivity characteristics and laws of blackbody radiation – Irradiation– laws of Planck, Wien, Kirchoff, Lambert, Stefan and Boltzmann– heat exchange between two black bodies –shape factor, Heat exchange between grey bodies, Radiation shields.

Electrical analogy

12 Hours

Total: 48 Hours

Textbook(s)

1. R. K. Rajput, Heat and Mass Transfer, S. Chand Publishers, 7th Edition, 2019
2. R. C. Sachdeva, Fundamentals of Engineering Heat and Mass Transfer, New Age publishers, 5th Edition, 2017
3. J. P Holman, Heat Transfer, McGraw Hill publishers, 10th Edition, 2017
4. C P Kothandaraman, S. Subramanyan, Heat and Mass Transfer Data Book, New Age Publishers, 9th Edition,2018

Reference(s)

1. M. L. Mathur & F. S. Mehta, Fundamentals of Heat and Mass Transfer,2nd Edition, 2017
2. Welty, Wicks, Wilson, Rorrer, Fundamentals of momentum, heat, and mass transfer, Wiley, 5th Edition, 2016
3. F.P. Incropera, D. Dewitt, T Bergman, A.S. Lavine, Principles of heat and mass transfer, Wiley, 7th Edition, 2017

Sample Question(s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	30	20	-
Understand	30	30	-
Apply	40	50	50
Analyze	-	-	50
Evaluate	-	-	-
Create	-	-	-
Total (%)	**100**	**100**	**100**

Remember

1. Define various modes of heat transfer.
2. Define Buckingham's π – theorem.
3. Define lumped system analysis. When is it applicable?
4. Define boundary layer thickness.
5. List any two examples of counter flow heat exchanger.
6. Define the properties reflectivity and transmissivity and discuss the different forms of reflection

Understand

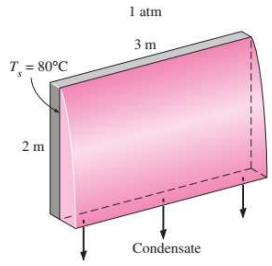
1. Explain the method of heat transfer occurs when particles with a lot of energy take place of those with less.
2. When you get into a car with hot black leather in the middle of the summer and you get your buns toasted, justify the above statement.
3. Explain over all heat transfer coefficient.
4. List and explain the various non-dimensional parameters used in forced convection.
5. Explain the differences between natural convection and forced convection, give some examples to free and forced convection.

Apply

1. Air at 20°C, at a pressure of 1 bar is flowing over a flat plate at a velocity of 3 m/s. if the plate maintained at 60°C, Calculate the heat transfer per unit width of the plate. Assuming the length of the plate along the flow of air is 2m.
2. Water is to be boiled at atmospheric pressure in a mechanically polished steel pan placed on top of a heating unit. The inner surface of the bottom of the pan is maintained at 110°C. If the diameter of the

bottom of the pan is 25 cm, determine (a) the rate of heat transfer to the water and (b) the rate of evaporation.

3. Calculate the following for an industrial furnace in the form of a black body and emitting radiation at 2500 ^{o}C. i) monochromatic emissive power at 1.2μm wave length ii) Wave length at which the emission is maximum iii) Maximum emissive power iv)Total emissive power.
4. Consider a 0.8-m-high and 1.5-m-wide double-pane window consisting of two 4-mm-thick layers of glass (k = 0.78 W/m °C) separated by a 10-mm-wide stagnant air space (k=0.026 W/m °C). Determine the steady rate of heat transfer through this double-pane window and the temperature of its inner surface for a day during which the room is maintained at 20°C while the temperature of the outdoors is = 10°C. Take the convection heat transfer coefficients on the inner and outer surfaces of the window to be h_1 =10 W/m^2 °C and h_2 =40 W/m^2 °C, which includes the effects of radiation. **(For Open Book Examination and not for semester end examination)**
5. Consider a 0.6 m X 0.6 m thin square plate in a room at 20^{o}C. One side of the plate is maintained at a temperature of 90˚C, while the other side is insulated. Determine the rate of heat transfers from the plate by natural convection if the plate is vertical. **(For Open Book Examination and not for semester end examination)**
6. Saturated steam at atmospheric pressure condenses on a 2-m-high and 3-mwide vertical plate that is maintained at 80°C by circulating cooling water through the other side (Fig). Determine (a) the rate of heat transfer by condensation to the plate and (b) the rate at which the condensate drips off the plate at the bottom. **(For Open Book Examination and not for semester end examination)**



Analyze

1. The inside and outside surfaces of a hollow sphere of radii r1 and r2 are maintained at t1 and t2 respectively. The thermal conductivity of sphere material varies with temperature as given below. k=k0(1+αt1+βt2), derive the expression for total heat flow rate through the sphere.
2. Consider heat transfer between two identical hot solid bodies and the air surrounding them. The first solid is being cooled by a fan while the second one is allowed to cool naturally. Compare Biot number for both cases.
3. What is the heat transfer through a fluid conduction and when is it a convection process? For what case is the rate of heat transfer being higher? How does the convection heat transfer coefficient differ from the thermal conductivity of a fluid?
4. Physically, what does the Grashof number represent? How does the Grashof number differ from the Reynolds number explain it by taking a suitable example?
5. Consider film condensation on a vertical plate. Will the heat flux be higher at the top or at the bottom of the plate? Why?
6. A short brass cylinder of diameter D 10 cm and height H 12 cm is initially at a uniform temperature Ti 120°C. The cylinder is now placed in atmospheric air at 25°C, where heat transfer takes place by convection, with a heat transfer coefficient of h 60 W/m^2 ·°C. Compare the temperatures at (a) the center of the cylinder and (b) the center of the top surface of the cylinder 15 min after the start of the cooling. **(For Open Book Examination and not for semester end examination)**
7. Consider a 0.6 m X 0.6 m thin square plate in a room at 30^{o}C. One side of the plate is maintained at a temperature of 90˚C, while the other side is insulated. Determine and compare the rate of heat transfers from the plate by natural convection if the plate is (a) vertical, (b) horizontal with hot surface facing up, and (c) horizontal with hot surface facing down. **(For Open Book Examination and not for semester end examination)**

21MEC12 Sensors and Actuators for Automotive Electronics

3 0 2 4

Course Outcome(s)

1. Recall the basic knowledge about the vehicle sensors
2. Compare various types of digital systems
3. Understand the different types of intelligent sensors and actuators
4. Explain the working of different types of circuits in vehicles
5. Make use of the knowledge on automotive safety
6. Apply the knowledge of automotive sensors to develop modern vehicle parts

COs – POs Mapping

COs	PO_1	PO_4	PO_{10}	PSO_2
1	3	2	2	2
2	3	2	2	2
3	3	2	2	2
4	3	2	2	2
5	3	2	2	2
6	3	2	2	2

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit I

Automotive electronics

Introduction to electronic systems in automotive – Sensors and actuators for power train and chassis systems. Body electronics domain- Automotive alarms, lighting, and electric windows, climatic control, driver information and Parking

Central locking system

Practical experiments

1. Temperature measurement using thermocouple
2. Temperature measurement using RTD and thermistor
3. Calibration of temperature sensors
4. Capacitive and resistive type transducer for humidity measurement

20 Hours

Unit II

Vehicle sensors and actuators

Vehicle sensors- crankshaft sensors, lambda sensor, intake air temperature sensor, idle speed controller/idle speed actuator, coolant temperature sensor, transmission range sensor, ABS sensor, knock sensor, air-mass sensor, camshaft sensor, accelerator pedal sensor, and exhaust gas temperature sensor. Hardware implementation of simple automotive systems using sensors , controller and actuators.

Traction Control

Practical experiments

1. Piezoelectric pressure sensor and crank angle encoder for combustion characteristics
2. Experiments with thermostat in car cooling system
3. Automobile exhaust tail pipe temperature measurement
4. Experiments with solenoid injector controlled by ECU

20 Hours

Unit III

Automotive safety and control

Electrical circuits and wiring in vehicles, vehicle network and communication buses – Digital engine control systems, Introduction to automotive controllers, On-Board Diagnostics (OBD). Warning devices- under run protection devices- Collision warning and avoidance systems. Comfort and convenient systems.

off-board vehicle diagnostics

Practical experiments

1. Troubleshooting in cooling system
2. Troubleshooting in ignition system, setting of contact breaker points and spark plug gap
3. Fault diagnosis in transmission system
4. Experiments with anti-locking braking system

20 Hours

Unit IV

Intelligent vehicle systems

Technologies relevant to intelligent vehicle systems including systems architecture, in-vehicle electronic sensors, traffic modeling and simulation, design and implement algorithms and simulate driver highway interactions. The study of intelligent vehicle systems including system architectures, sensors, and algorithms

Energy autonomous sensors

Practical experiments

1. Machine learning based predictive analysis of engine parameters using MATLAB
2. Neuro fuzzy optimization of vehicle characteristics using MATLAB
3. Experiments with CRDI injection system
4. Experiments with energy autonomous triboelectric sensors

20 Hours

Total: 80 Hours

Textbook(s)

1. Bosch, Automotive Electrics and Automotive Electronics. System and components, Networking and Hybrid drive , 5th Edition, Springer view 2014
2. NajamuzZaman, Automotive Electronics Design Fundamental, Springer, 1st Edition, 2015.
3. Nathan Ida. Sensors, Actuators, and Their Interfaces: A multidisciplinary introduction IET.2020.

Reference(s)

1. William B. Ribbens, "Understanding Automotive Electronics, Elsevier Newnes, 6th Edition, 2012
2. Rupitsch, Stefan Johann. Piezoelectric Sensors and Actuators: Fundamentals and Applications, Springer. 2018
3. Hillier's, Fundamentals of Motor Vehicle Technology on Chassis and Body Electronics, Nelson Thrones, 5th Edition, 2007.

Sample Question(s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)
Remember	35	30
Understand	45	40
Apply	20	30
Analyze	-	-
Evaluate	-	-
Create	-	-
Total (%)	100	100

Remember

1. State the function and applications of RTD.
2. List any four types of proximity sensor.
3. Label the elements of the closed loop control system.
4. List any two types of feedback loop.
5. Define primary transducer.
6. List any four factors responsible in selection of a transducer.
7. Define zero order transducer.

Understand

1. Distinguish between position sensors and light sensors

2. Illustrate the adaptive cruise control.
3. Explain the functions of ABS sensor.
4. Infer the input characteristics of the transducer.
5. Explain the functions of passive sensors.

Apply

1. Identify the features of active sensor.
2. Asses the working of engine management system
3. Demonstrate the knock sensor with neat sketches
4. Piezoelectric pressure sensors play their own role in automotive sector. Justify the statement.
5. Design sensors for a bottling system where bottles are segregated by defect at the crown of the bottle when moving on a conveyor system
6. Design sensors for a bottling system where bottles are segregated by defect at the crown of the bottle when moving on a conveyor system (OBE)
7. A temperature-sensitive transducer is subjected to a sudden temperature change. It takes 10 s for the transducer to reach equilibrium condition (5 times constant). How long will it take for the transducer to read half of the temperature difference? (OBE)
8. Describe the importance of intelligent vehicle embedded sensor's fault detection and isolation using analytical redundancy and nonlinear transformations (OBE)

Web references

1. https://www.elprocus.com/different-types-of-sensors-used-in-automobiles/
2. https://www.avnet.com/wps/portal/abacus/solutions/technologies/sensors/pressure-sensors/applications/automotive/
3. https://www.tdk-electronics.tdk.com/download/1421664/0228ab4ceefb0f4ffd65c26462f3dbf9/ntc-automotive-sensors-pb.pdf

Video references

1. https://youtu.be/aPMENSvwTWc
2. https://youtu.be/CdfL7IaR7xQ
3. https://youtu.be/iTppTFbuQxY

21MEC22 Artificial Intelligence & Robotics

3 0 2 4

Course Outcome(s)

1. Describe human intelligence and AI Explain how intelligent system works.
2. Apply basics of Fuzzy logic and neural networks.
3. Explain Expert System and implementation.
4. Apply Knowledge representation and semantic in Knowledge representation.
5. Develop some familiarity with current research problems and research methods in AI.
6. Demonstrate and illustrate the functionalities of Robots and Robotics.

Co-Po Mapping

COs	PO_2	PO_5	PO_{12}
1	3	2	2
2	3	2	2
3	2	3	2
4	2	3	2
5	2	2	3
6	2	2	3

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit- I

Introduction: Artificial Intelligence (AI) and its importance, AI Problems (tic tac toe problem, water jug problems), Application area of AI.

Problem Representations: State space representation, problem-reduction representation, production system, production system characteristics and types of production system.

Practical Components:

1. Study of PROLOG. Write the following programs using PROLOG.
2. Write a Program to add two numbers.
3. Program to read address of a person using compound variable.
4. Program to count number of elements in a list .
5. Program to reverse the list.
6. Program to append an integer into the list .

21 Hours

Unit- II

Heuristic Search Techniques and Game Playing: Heuristic Search Techniques :AI and search process, brute force search, depth-first search, breadth-first search, time and space complexities, heuristics search, hill climbing, best first search, A* algorithm and beam search, AO search, constraint satisfaction.

Game Playing: AI and game playing, plausible move generator, static evaluation move generator, game playing strategies, problems in game playing.

Practical Components:

1. Solve any problem using depth first search.
2. Solve any problem using best first search.
3. Solve 8-puzzle problem using best first search.

19 Hours

Unit- III

Logic and Knowledge Representation: Knowledge Representation and Structured Knowledge: Associative networks, frame structures, conceptual dependencies and scripts, ontologies.

Logic: Prepositional logic: syntax and semantics, First Order Predicate Logic (FOPL): Syntax and semantics, conversion to clausal form, inference rules, unification, and the resolution principles.

Knowledge Acquisition and Expert System:

Type of learning, Knowledge Acquisition, Early work in machine learning, learning by induction. Introduction to expert system, Phases of expert system, characteristics of expert system and a case study; Introduction of Executive Support System and Decision Support System.

Practical Components:

1. Solve Robot (traversal) problem using means End Analysis.
2. Solve traveling salesman problem.
3. Implementation of Data Structures using Prolog.
4. Implementation of If Else rule using Prolog.

20 Hours

Unit- IV

Robotics and Its applications: DDD concept, Intelligent robots, Robot anatomy-Definition, law of robotics, History and Terminology of Robotics-Accuracy and repeatability of Robotics-Simple problems-Specifications of Robot-Speed of Robot, Robot joints and links-Robot classifications-Architecture of robotic systems-Robot Drive systems-Hydraulic, Pneumatic and Electric system.

Core of AI: Introduction to Neural Network; Fuzzy Logic; LISP and Prolog; Research orientation of soft computing techniques; Knowledge management, Ontology.

Practical Components:

1. Introduction to LISP.
2. Robot Programming Using Java.
3. Robot movement program**.**

20 Hours
Total: 80 Hours

Textbook(s)

1. S.R. Deb, Robotics Technology and flexible automation, Tata McGraw-Hill Education., 2009 Max Braber, Logic Programming with Prolog, Springer, 2019.
2. Russell Stuart, Norvig Peter, "Artificial Intelligence Modern Approach", Pearson Education series in AI, 3rd Edition, 2019.
3. Dan.W.Patterson, "Introduction to Artificial Intelligence and Expert Systems", PHI Learning, 2009.
4. Applied Machine Learning By M.Gopal · 2018
5. Machine Learning in Production Developing and Optimizing Data Science Workflows and Applications By Andrew Kelleher, Adam Kelleher · 2019

Reference(s)

1. V S Janakiraman, K Sarukesi, P Gopalakrishan, Foundations of Artificial Intelligence and Expert Systems, Macmillan India Ltd. Dan W. Patterson - 2019
2. Introduction to AI and Expert System, PHI - 2017
3. Donald.A.Waterman, "A guide to Expert Systems", Pearson, 2018.
4. Applied Machine Learning By David Forsyth · 2019

Sample Question(s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)
Remember	40	40
Understand	60	60
Apply	-	-
Analyze	-	-
Evaluate	**-**	**-**
Create	**-**	**-**
Total (%)	**100**	**100**

Remember

1. What are the different components in gaming search probles?
2. what are the issues in knowledge representation in artificial intelligence?
3. What is the significance of knowledge representation in AI?

Understand

1. Which algorithm you apply for heuristic search techniques? Explain.
2. Which is used to improve the performance of heuristic search?
3. How does the knowledge is represented in artificial intelligence?
4. How does predicate logic help in knowledge representation in AI?

21MEC32 Smart Supply Chain Analytics

3 0 2 4

Course Outcomes

1. Explain the different models of Business Analytics to Supply Chain Management
2. Understand the applications of descriptive analytics
3. Understand the Predictive Analytics
4. Apply the prediction techniques to assess the demand requirements
5. Choose the criteria for optimizing the process by prescriptive analytics
6. Explain the significance of Cognitive Analytics

COs – POs Mapping

COs	PO_1	PO_2	PO_3	PO_5
1	1	2	2	1
2	1	2	3	2
3	1	3	3	2
4	3	2	2	3
5	2	1	3	2
6	3	2	1	3

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit – I

Introduction To Smart Management Analytics

Definition of Business Analytics, Overview of Business Analytics, Classification of Data and Types of Data, Big Data, Practical Applications of Business Analytics, Role of Analytics in Production and Service Supply Chain Operations, Push and Pull Systems, Overview of Demand and Inventory, Transportation Analytics.

Practical experiments

1. Study and demonstrate the usage of Statistical Software Packages
2. Study and demonstrate Basics of Decision Optimization Tools/Software Packages
3. Study Measures of Central Tendency
4. Study Probability Distributions
5. Study and Analyze the Case of Dabbawalla

20 Hours

Unit – II

Business Analytics Applications

Basics of Descriptive Statistics, Measures of Central Tendency, Data Visualization-Definition, Visualization Techniques – Tables, Cross Tabulations, charts, Dashboards using Software Tools and Packages, Overview of Machine Learning Algorithms, Linear & Multiple Regression, Logistic Regression, Forecasting Techniques.

Practical experiments

1. Study and Demonstrate Data Visualization by Excel
2. Study and Demonstrate Data Visualization by using Suitable Statistical Software Packages
3. Analyze the Demand Visualization Patterns by using Scatter Plot
4. Analyze the Demand Visualization Patterns by using Regression
5. Analyze the Demand Visualization Patterns by using Multiple Regression

20 Hours

Unit – III

Supply Chain Analytics in Manufacturing

Supply Chain Analytics Applications in Manufacturing, Supply Chain Performance, Basics of Data Mining, Techniques in Data Mining, Exploratory Data Analysis, Classification, and Association Rules, AI (Artificial Intelligence), and ML (Machine Learning) applications in Manufacturing.

Practical experiments

1. Study and Analyze the GATI Supply Chain Management case
2. Study and analyze the various Prediction Techniques and Forecasting Methods
3. Study and Analyze the Time Series Analysis Applications
4. Study and Analyze Inventory Issues in Retail/ Agriculture/Manufacturing.
5. Study and Demonstrate the Stock Out Prediction by using any decision optimization tools.

20 Hours

Unit – IV

Prescriptive and Cognitive Analytics in Manufacturing

Introduction to Robotic Process Automation, RPA applications in Warehouse Management and Manufacturing, Overview of Prescriptive Analytics, Optimization Methods, Introduction to Artificial Intelligence, Overview of Genetic Algorithms. Analytics applications for different domains, Inventory Optimization.

Practical experiments

1. Study and Analyze the Transportation Problem
2. Study and Analyze the Demand Problem
3. Study and Analyze the Inventory Problem
4. Study and Analyze the HR Problems
5. Study and Demonstrate the Price Optimization by using any decision optimization tools

20 Hours

Total: 80 Hours

Textbooks(s)

1. Camm, Cochran, Fry, Ohlmann, Anderson, Sweeney, Williams- Essentials of Business Analytics, Cengage Learning, 2nd Edition,2016.
2. Peter W Robertson, Supply Chain Analytics using Data to Optimize Supply Chain Process, 1st Edition,2021
3. James Evans, Business Analytics, Pearson, 2nd Edition, 2017.
4. David Simchi Levi, Philip Kaminsky & Edith Simchi Levi, Ravi Shankar, Designing and Managing the Supply Chain: Concepts, Strategies and Case studies, 3rd Edition, 2019.

Reference(s)

1. Christian Albright, Wane L Winston, Business Analytics,2017
2. Albright Winston, Business Analytics- Data Analysis-Data Analysis and Decision Making, Cengage Learning, Reprint 2016.
3. Micheal Hugos, Essentials of Supply Chain Management,4th Edition, Wiley Publications
4. Yao Zhao, Supply Chain Analytics, Coursera.
5. Rajat Agrawal, Supply Chain Analytics, Nptel.
6. Haytham Omar, Supply Chain Analytics, Udemy

Sample Question(s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	15	15	**-**
Understand	15	15	**-**
Apply	55	40	50
Analyze	15	15	50
Evaluate	**-**	15	-
Create	**-**	**-**	-
Total (%)	**100**	**100**	**100**

Remember

1. What are the differences between Prescriptive and Predictive Analytics?
2. Define Business Analytics.
3. What is the difference between Prediction and Forecasting?
4. List any two programming languages for Analytics.
5. What is Digital SCM?

Understand

1. Explain the steps involved in Forecasting?
2. Summarize the steps involved in SCM process.
3. Compare Push Analytics with Pull Analytics
4. Interpret is Pull Analytics with suitable example?
5. Explain the steps involved in SCM process.

Apply

1. Apply the appropriate algorithms for prediction process?
2. Identify the appropriate algorithms for optimization process?
3. Choose the inventory decisions under uncertain conditions.
4. Develop optimum criteria for the Push systems.
5. Build optimum criteria for the Pull systems

Analyze

1. Analyze the issues in traditional SCM process.
2. Examine the seasonal demand patterns by using demand planning
3. Analyze the inventory decisions under uncertain conditions.
4. Examine the Push systems under uncertain conditions.
5. Compare the Pull systems under uncertain conditions.

21ME008 Additive Manufacturing

3 0 2 4

Course Outcome(s)

1. Explain the importance of AM in Manufacturing
2. Distinguish different AM Technologies
3. Illustrate STL file processing
4. Select suitable materials for AM
5. Analyze different methods for Post-processing of AM parts
6. Explain the non-thermal and thermal AM techniques

Co-Po Mapping

COs	PO_1	PO_2	PO_3	PSO_2
1	3	1	1	1
2	3	1	1	1
3	3	3	2	2
4	3	1	2	2
5	3	1	1	2
6	3	1	2	2

3 Strongly linked | 2 Moderately linked | 1 Weakly linked

Unit I

Introduction to Additive Manufacturing: Introduction to AM, AM evolution, Distinction between AM & CNC machining, Advantages of AM, AM process chain: Conceptualization, CAD, conversion to STL, Transfer to AM, STL file manipulation.

Experiments: -

1. Study on 3D printing machine and slicing software analysis.
2. Create and print a Screw Jack by 3D printer with PLA materials
3. Create and print a Gear Tooth by 3D Printer with PLA materials
4. Create and print Knuckle joint by 3D Printer with PLA materials

20 Hours

Unit II

Classification of AM processes-Design for AM: Liquid polymer system, discrete particle system, molten material systems and solid sheet system. Motivation, DFMA concepts and objectives, AM unique capabilities, exploring design freedoms, Design tools for AM, Part Orientation, Removal of Supports, Hollowing out parts, Inclusion of Undercuts and Other Manufacturing Constraining Features, Interlocking Features.

Experiments: -

1. Study the 3D printing plastic materials and orientation Analysis
2. Create and print a NUT & BOLT by 3D printer with PLA materials
3. Create and print Cotter joint by 3D printer with PLA materials
4. Create and print Hoocks Joint by 3D printer with PLA materials

20 Hours

Unit III

Guidelines for process selection- AM Applications: Introduction, selection methods for a part, challenges of selection, example system for preliminary selection, production planning and control. Functional models, Pattern for investment and vacuum casting, Medical models, art models, Engineering analysis models, Rapid tooling, new materials development, Bi-metallic parts, Re-manufacturing, application examples for aerospace, defense, automobile.

Experiments:-

1. Study on 3D printing parts applications and its manufacturing process.
2. Create and print a Piston by 3D printer with ABS materials
3. Create and print a Cylinder by 3D printer with with ABS materials
4. Create and print a piston ring by 3D printer with with ABS materials

20 Hours

Unit IV

3D Scanners, Post processing of AM parts-Future Directions of AM: Introduction to 3D Scanners and its applications, Support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques. Introduction, new types of products and employment.

Experiments:-

1. Study on 3D Scanners and Post processing process
2. Create and print a Connecting rod by 3D printer with PLA materials
3. Print the any physical object by 3D scanner
4. Scan and print the Human Teeth by 3D scanner

20 Hours
Total: 80 Hours

Textbook (s)

1. C C Kai, L K Fai, Rapid Prototyping: Principles & Applications, World Scientific Publishing Co. Pvt. Ltd, 3rd Edition, 2010
2. I Gibson, D W Rosen, Brent Stucker, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, 2nd Edition, Springer, 2010

Reference (s)

1. D.T. Pham, S.S. Dimov, Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer Science & Business Media, Technology & Engineering, 2012
2. Paul F. Jacobs, Rapid prototyping & Manufacturing: Fundamentals of Stereolithography, Society of Manufacturing Engineers, computer and Automated systems, Association of SME, 1992
3. Ali K. Kamrani, Emand Abouel Nasr, Rapid Prototyping: Theory & Practice, Springer, 2006

Web Reference(s)

1. https://nptel.ac.in/courses/112103306
2. https://www.studocu.com/en-gb/document/swansea-university/additive-manufacturing/additive-manufacturing-notes/1538858
3. https://home.iitk.ac.in/~nsinha/Additive_Manufacturing%20I.pdf

Sample Question (s)
Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)
Remember	35	30
Understand	45	45
Apply	20	25
Analyze	-	-
Evaluate	-	-
Create	-	-
Total (%)	100	100

Remember

1. What is additive manufacturing?
2. List the advantages and disadvantages of RP.
3. Define the Rapid Tooling.
4. What is Virtual prototyping?
5. Name the inputs required for product development.
6. What are the benefits of rapid tooling?

Understand

1. Classify and explain the AM process.
2. Explain how AM has influenced the 3D printing technology.
3. Outline a note on the impact of AM on product development.
4. Explain the transition of RP to AM.
5. Classify the role of process planning in SLA?
6. Compare the liquid based and solid based AM systems

Apply

1. Identify the solid, liquid and powder-based system of 3DP.
2. Apply the pre and post processing in BPM.
3. Choose the few case studies of 3DP.
4. Why surface deviation occurs in SLS?
5. Identify are the materials used in SLS.
6. Why pre-build process is required in SLA?

Analyze

1. Compare the liquid based and solid based AM systems.
2. Classify and explain the AM process.
3. Classify the need and development of AM systems.
4. List out the basic requirements of product development.
5. Formulate the applications of rapid tooling.
6. List the merits of virtual prototyping.

21ME009 Mechatronics

3 0 2 4

Course Outcome(s)

1. Explain different control methods used in the typical mechatronics systems
2. Infer signal condition and the hardware used for signal conditioning
3. Outline the use of common electrical and mechanical components to achieve precision in Mechanical, Electrical, Fluid & Thermal systems
4. Explain the need and working of interfacing circuits and their components
5. Illustrate the working principles of various electromechanical drives and micro controllers
6. Compare PLCs, and PMCs and their applications in Mechatronic systems

COs – POs Mapping

COs	PO_1	PO_2	PO_3	PO_4	PO_9	PSO_1
1	3	-	-	3	2	2
2	3	3	2	-	2	2
3	3	3	3	3	3	2
4	3	3	3	1	2	2
5	3	-	2	2	2	2
6	3	3	3	2	3	2

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit I

Introduction

Mechatronics systems, elements, levels of mechatronics system, Mechatronics design process, system, measurement systems, control systems, advantages, and disadvantages of mechatronics systems. Sensors and transducers, types, displacement, position, proximity, velocity, motion, force, acceleration, torque, fluid pressure, liquid flow, liquid level, temperature, and light sensors

Signal Conditioning

Introduction – Hardware - Digital I/O, Analog input – ADC, resolution, sped channels Filtering Noise using passive components – Resistors, capacitors - Amplifying signals using OP amps – Digital Signal Processing – Low pass *High pass, notch filtering*

Practical experiments:

1. Sensor and transducer kit
2. Sensors for automotives
3. Study and test R-2R ladder DAC Circuit
4. Study and test binary weighted DAC circuit

20 Hours

Unit II

Precision Mechanical Systems

Hydraulic and pneumatic actuating systems, Fluid systems, Hydraulic and pneumatic systems, components, control valves, electro-pneumatic, hydro-pneumatic, electro-hydraulic servo systems: Mechanical actuating systems and electrical actuating systems

Electronic interface subsystems

TTL, CMOS interfacing - Sensor interfacing – Actuator interfacing – solenoids, motors Isolation schemes- opto-coupling, buffer IC's - Protection schemes – circuit breakers, over current sensing, resettable fuses, thermal dissipation - Power Supply *Bipolar transistors / MOSFETs*

Practical experiments:

1. Pneumatic trainer kit
2. Design and simulate of fluid power circuits to control (i) Velocity (ii) Direction of a single and double acting actuators
3. Run the stepper motor at different speed and different direction

4. Run the stepper motor in forward and reverse direction
5. Study and test ADC- 0808 circuit

20 Hours

Unit III

Electromechanical drives

Relays and Solenoids - Stepper Motors - DC brushed motors – DC brushless motors - DC servo motors - 4-quadrant servo drives, PWM's - Pulse Width Modulation – Variable Frequency Drives, Vector Drives - Drive System load calculation.

Microcontroller's overview

8051 Microcontroller, microprocessor structure – Digital Interfacing - Analog Interfacing - Digital to Analog Convertors - Analog to Digital Convertors - Applications. Programming –Assembly, C (LED Blinking, Voltage measurement using ADC)

Voltage measurement using ADC

Practical experiments:

1. AC Servo motor with drive and applications (Closed Loop)
2. Assembly language program for LED blinking using 8051
3. Assembly language program for interfacing stepper motor with 8051
4. Write a C program to show the on off control of DC motor
5. Write a C program to rotate stepper motor in clockwise/anticlockwise direction.

20 Hours

Unit IV

Programmable Logic Controllers

Basic Structure - Programming: Ladder diagram - Timers, Internal Relays and Counters - Shift Registers - Master and Jump Controls - Data Handling - Analog input / output - PLC Selection

Programmable Motion Controllers

Introduction - System Transfer Function – Laplace transform and its application in analyzing differential equation of a control system

PLC Applications

Practical experiments:

1. Basics of Ladder logic programming
2. PLC Programming with CX-Programming
3. Two switches Normally Open and both have to be closed for the motor to operate.
4. Either of the two Normally Open switches to be closed for the coil to be energized
5. Devise a timing circuit that will switch on for 20s and then switch it off.
6. Device a timing circuit that will switch on 10s and off 20s and so on....

20 Hours

Total: 80 Hours

Textbook (s)

1. W. Bolton, Mechatronics, Pearson Education India, 4th Edition, 2010
2. Lawrence J. Kamm, Understanding Electromechanical Engineering – An Introduction to Mechatronics, wiley, 2nd Edition, 2015
3. Michael B. Histand and David G. Alciatore, Introduction to Mechatronics and Measurement Systems, McGraw Hill International Editions, 4th Edition, 2012

Reference (s)

1. Sabri Cetinkunt, Mechatronics with Experiments, John Wiley & Sons, Illustrated Reprint, 2015
2. HMT, Mechatronics, Tata McGraw-Hill, 5th Edition, 2017
3. Nitaigour Mahalik, Mechatronics, McGraw Hill Education, 1st Edition, 2017
4. David and Alcaire Michael B. Histand, Introduction Mechatronics, TMH, 4th Edition, 2006
5. Bradley, D.A., Dawspn, D, Buru, N.C. and Loader, AJ., Mechatronics, Chapman and Hall, 2nd Edition, 1993

Web Reference (s)

1. http://www.engr.sjsu.edu/sjlee/vendors.htm

2. www.engr.colostate.edu/~dga/mechatronics/resources.html
3. www.NI.com
4. www.cambridgemechatronics.com/contact/terms
5. www.pdf-free-download.com/mechatronics-labs.pdf
6. www.mechatronics.me.wisc.edu

Video Reference (s)

1. http://video_demos.colostate.edu/mechatronics/index.html#actuators
2. http://video.designworldonline.com/channel/MECHANICAL

Sample Question(s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)
Remember	**25**	25
Understand	55	50
Apply	20	25
Analyze		
Evaluate	**-**	**-**
Create	**-**	**-**
Total (%)	**100**	**100**

Remember

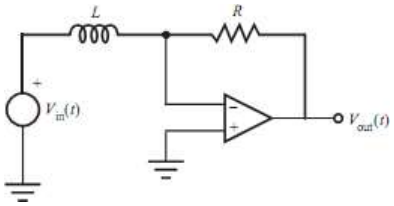
1. What is signal conditioning?
2. List various control methods using in mechatronic systems
3. What are the different types of fluid systems available for mechatronic system?
4. List the application of PLCs in computers.
5. Name some future mechatronics system.

Understand

1. Explain role of various hardware components used in the signal conditioning.
2. Outline the purpose and role of interfacing unit in the electronic circuits.
3. Explain the construction and principle of operation of permanent magnet stepper motor.
4. Briefly explain the difference between microprocessor and microcontroller.
5. Explain the construction and principle of operational amplifier.

Apply

1. Choose appropriate electronic circuit components suitable for building an interfacing circuit for a circuit.
2. Explain how to select a specific microcontroller for a given application. Briefly give different applications of 8051 microcontroller.
3. Distinguish the features of analog and digital Data Acquisition Systems.
4. Briefly explain the importance and location of Counters and Registers in PLC with suitable examples.
5. Find Vout(t) given Vin(t) in the op amp circuit that follows.



6. Choose a PIC Basic Pro program to turn an LED on and off at 1 Hz while a pushbutton switch is held down. Draw the schematic required for your solution

21ME010 Computational Fluid Dynamics

3 0 2 4

Course Outcome(s)

1. Understand the mathematical representation of the governing equations of fluid flow and heat transfer
2. Enable to solve one and two-dimensional ordinary and partial differential equations using traditional CFD tools
3. Express derivatives and differential equations through discretization techniques
4. Understand the general transformation equations for grid generation
5. Apply explicit, implicit and semi-implicit methods of finite differencing
6. Apply fluid flow field using popular CFD techniques

COs – POs Mapping

COs	PO_1	PO_2	PO_3	PO_4	PO_5
1	3	1	2	2	2
2	3	2	2	2	1
3	3	1	1	2	2
4	2	3	3	1	1
5	1	3	1	2	2
6	1	2	2	3	3

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

Unit I

Governing equations for basic fluid flow- Introduction to CFD, Basic Philosophy of CFD, Governing equations of fluid dynamics, Incompressible
Inviscid flows - Vortex flow model.
Applications of CFD in R&D

Practical Experiments

1. Introduction to CFD
2. Introduction to ICEM CFD
3. Introduction to Ansys fluent
4. Introduction to static and dynamics forces

20 Hours

Unit II

Implementation of finite difference techniques in fluid flow- Transformations and grids, MacCormack's method, finite difference- discretization, consistency, stability,
fundamentals of fluid flow modeling, elementary finite difference quotients, implementation aspects of finite difference equations.
Error analysis of FDM

Practical Experiments

1. Flow over a flat plate
2. Flow through Pipe
3. Flow over a Circular Cylinder
4. Flow over a Wedge

20 Hours

Unit III

Application of finite difference technique in heat transfer - Finite difference applications in heat conduction and convection- Heat conduction, steady heat conduction in a rectangular geometry, transient heat conduction, finite difference application in convective heat transfer.
Application of FDM to transient heat conduction

Practical Experiments

1. Heat transfer analysis in heat exchanger and around Finned Heat Sink
2. Heat transfer analysis in solar flat plate collector
3. Flow over a Cambered Airfoil
4. External Flow over a 2d/3d Car

20 Hours

Unit IV

Finite Volume Methods & Overview on Commercial Packages- Introduction of finite volume methods in computational fluid dynamics, Approximation of surface integrals, volume integrals, interpolation and

differentiation practices, Cell Centered formulation, LAX- Wendroff time stepping. Aspects of CFD computations with commercial package Like Fluent.

Difference between FDM and FVM

Practical Experiments

1. Heat transfer analysis in solar air heater
2. Pressure drop analysis in a valve
3. One dimensional wave equation using explicit method of lax
4. Shock wave around a cone

20 Hours
Total: 80 Hours

Textbook(s)

1. S.V. Patankar, Numerical Heat Transfer and Fluid flow, CRC Press, Special Indian Edition, 2017.
2. John D. Anderson, Jr., Computational Fluid Dynamics – The Basics with Applications, McGraw Hill,
3. Inc., New York. 2019.
4. K. Muralidhar, T. Sundararajan, Computational Fluid Flow and Heat Transfer, Narosa Publication House, New Delhi, 2nd Edition, 2014.
5. Atul Sharma, Introduction to Computational Fluid Dynamics - Development, Application and Analysis, Ane Books Pvt. Ltd, New Delhi, 2018

Reference(s)

1. Niyogi, Computational fluid flow and heat transfer, Cengage India Private Limited; 1st Edition, 2017.
2. John F. Wendt, John David Anderson, Computational Fluid Dynamics: An Introduction, Springer, 3rd Edition Illustrated, 2008.
3. Jiyuan Tu, Guan Heng Yeoh, Chaoqun Liu, Computational Fluid Dynamics: A Practical Approach, Elsevier, 3rd Edition, 2018.
4. Atul Sharma, Introduction to Computational Fluid Dynamics: Development, Application and Analysis, Wiley, 1st Edition, 2016

Sample Question(s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)
Remember	30	25
Understand	30	30
Apply	40	45
Analyze		
Evaluate	--	--
Create	--	--
Total (%)	100	100

Remember

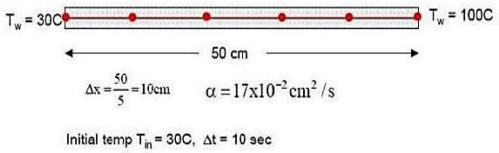
1. Define CFD
2. List practical applications of CFD
3. Reproduce governing equation for 2-d incompressible flow
4. Define conservation and non-conservation forms of governing equations
5. List the practical applications of Finite difference method
6. Reproduce conservation form of 1-d steady state heat conduction equation
7. Define substantial derivative

Understand

1. Derive basic governing equation for non-conservation form of Navier stokes equation
2. Exemplify mathematical behavior of PDEs (Hyperbolic and parabolic) used in CFD with relevant examples
3. Brief the following terms in context to CFD, a. Quasi linear PDEs b. Finite difference method c.
4. Forward and central finite difference
5. Derive 2-d steady state heat conduction equation for a rectangular geometry
6. Discuss about LAX- Wendroff time stepping used in FVM
7. Discuss about grid generation in Finite Difference methods

Apply

1. Find 1-D unsteady temperature distribution till steady state for following case,



2. Determine the forward difference representation for the following PDE which is to be the order of (Δx), given evenly spaced grid points

$$\partial^3 f / \partial x^3$$

3. Given the function f(x) = sin (2πx), determine first derivative at x= 0.375 using central difference representation of the order (Δx), use the step size of 0.1
4. Construct all the practical steps that have to proceed when performing a CFD study of a well described flow problem.
5. Identify the three parts of information that are needed to perform a wind comfort study. What are the advantages and disadvantages of using wind tunnel modelling or CFD for such studies?
6. Figure shows turbulent flow around a vertical cylinder in a horizontal cross-section. The flow direction is indicated with the arrow. Identify the type of lines. What is the meaning of the reduced or increased spacing between these lines? Is this figure realistic? If not, what is incorrect, and what are the consequences for the flow pattern and the pressures and forces?

21ME002 Principles of Entrepreneurship

3 0 0 3

Course Outcomes

1. Explain the role of entrepreneur in economic development
2. Demonstrate methods of generating ideas
3. Develop the business plan to start enterprises
4. Analyze various production aspects such as manufacturing costs control, marketing management and waste reduction strategies
5. Assess financial and marketing plans and control for enterprises
6. Find the institutional support for entrepreneurship

COs POs Mapping

COs	PO_1	PO_{11}
1	3	2
2	3	-
3	3	3
4	3	2
5	3	3
6	3	3

3 Strongly linked, 2 Moderately linked, 1 Weakly linked

UnitI

Introduction to Entrepreneurship Definition of Entrepreneur, Entrepreneurial Traits, Entrepreneur Vs. Manager, Entrepreneur Vs Entrepreneur. The Entrepreneurial decision process- Role of Entrepreneurship in Economic Developments, Ethics and Social responsibility of entrepreneurs, Woman as entrepreneur. *Opportunities for entrepreneurs in India and abroad*

12 Hours

UnitII

Creating and starting the venture Sources of new Ideas, Methods of generating ideas, creating problems solving- Product planning and development process, The business plans Writing Business plan, Evaluating Business plans, Using and implementing business plans, marketing plan, financial plan and the organizational plan launching formalities.

Nature and scope of business plan

12 Hours

UnitIII

Financing and managing the new venture Source of Capital, record keeping, recruitment, motivating and leading teams, financial controls, Marketing and sales controls. E Commerce and Entrepreneurship New venture expansion strategies and issues Features evaluation of joint ventures, acquisitions, merges, franchising, Public issues, rights issues, bonus issues

Internet advertising

12 Hours

UnitIV

Institutional support Entrepreneurship Role of Dire crate of Industries, District Industries, Centers (DICS), Industrial development Corporation (IDC), state Financial corporation (SFCs), Small Scale Industries Development Corporations (SSIDCs), Khadi and village Industries Commission (KVIC), Technical Consultancy Organization (TCO), small Industries Service Institute (SISI), National Small Industries Corporation (NSIC), Small Industries Development Bank of India (SIDBI), salient provision under Indian Factories Act, Employees State Insurance Act, Workmen‟s Compensation Act and payment of Bonus Act.

Labor legislation

12 Hours

Total: 48 Hours

Textbook (s)

1. Robert Hisrich & Michael Peters, Entrepreneurship, TMH, 5th Edition, 2009.

2. Dollinger, Entrepreneurship, Pearson Education, 4th Edition, 2004.
3. Robert J. Calvin, Entrepreneurial Management, Tata McGraw-Hill Education, 2004.
4. Vasant Desal, The Dynamics of Entrepreneurial Development and Management Himalaya publishing House, 5th Edition, 2017.
5. Kaplan, Patterns of Entrepreneurship, Willey, 4th Edition, 2005

Reference (s)

1. William A. Sahlman, James Stancill, Arthur Rock, Harvard Business Review on Entrepreneurship, Harvard Business School Press, Revised Edition, 2019.
2. Gurmeet Naroola, The Entrepreneurial Connection: East Meets West in the Silicon Valley, Special edition, TiE, 2001.
3. Bill Bolton & John Thompson, Entrepreneurs Talent, Temperament, Technique, Routledge, 7th Edition, 2016.
4. Agrawal, A.N. & Agarwal, M.K., Indian Economy: Problems of Development and Planning, New Age International, 42nd Edition, 2017.
5. Gaurav Datt & Ashwani Mahajan, Dutt & Sundaram‟s Indian Economy, S. Chand, 72nd Edition, 2016.
6. Srivastava, Industrial Relations Labour Laws, Vikas Publishing House, 6th Edition, 2005.
7. Aruna Kaulgud, Entrepreneurship Management by Vikas publishing house, 2003.
8. Thomas W. Zimmerer & Norman M. Scalbrorough, Essential of Entrepreneurship and small business management, PHI, 4th Edition, 2005.
9. Mary Coulter, Entrepreneurship in Action, PHI 2nd Edition, 2005.
10. ND Kapoor, Industrial Law, Sultan Chand & Sons, 14th Revised Edition, 2013.

Sample Question (s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open book examination (%)
Remember	30	40	-
Understand	70	60	40
Apply	-	-	60
Analyze	-	-	-
Evaluate	-	-	-
Create	-	-	-
Total (%)	100	100	100

Remember

1. List the different methods of generating ideas and explain any four methods.
2. List the difference between entrepreneur vs manager.
3. What are the objectives of market research?
4. What are the market research activities? List them.
5. List the important functions of IDBI.

Understand

1. Compare between entrepreneur vs manager.
2. Illustrate the characteristics or traits of an entrepreneur.
3. Outline the sources of new ideas for entrepreneur.
4. Explain the various steps involved in writing a business plan.
5. Summarize the various sources of capital required for business venture.
6. Demonstrate the role of E-commerce in entrepreneurship with its applications.
7. Illustrate marketing plan and financial plans required for an entrepreneur.
8. Show the factories act 1948.
9. Rephrase the reasons for the need of labor legislation becomes important.

Apply

1. Develop the business plan to establish a startup by taking an industrial case.
2. Identify the various sources of capital required to meet the new ideas of an entrepreneur for the economic development of a business venture.
3. Organize the role of entrepreneur in choosing the institutional supports to entrepreneurship.

4. In recent years, the entrepreneurial educator and author Steve Blank began applying lean startup principles to various US governmental agencies. Through a Hacking for Diplomacy course, students at Stanford University began tackling problems for the Department of State. A former US ambassador to the United Nations, a State Department representative to Silicon Valley and senior advisor for technology and innovation, a retired US Army colonel, and other entrepreneurial educators joined Blank in applying lean startup methods to State Department issues. Then Secretary of State John Kerry even visited the Stanford students and said he was looking forward to the solutions students develop during the ten weeks. One project that emerged was from a group calling themselves Team Space Evaders. The team was tasked with working on the problem of satellite collision. Members charted satellite positioning data and explored how information about potential collision was shared by commercial operators and governmental entities ranging from the Federal Aviation Administration to the Department of Defense.
    a. Apply the lean startup methodology to identify potential customer segments and problems and solutions that students such as yourself could identify for the State Department on the issue of satellite collision.
    b. Choose a unique value proposition for a State Department solution to this issue. Identify a high-level concept pitch work when selling the concept within the State Department?

21ME606 Heat Transfer Lab

0 0 3 1.5

Course Outcome(s)

1. Find thermal conductivity of common metallic materials
2. Determine the amount of heat transfer between fluid and solid boundaries
3. Estimate the amount of heat exchanged between fluids in heat exchangers
4. Determine the emissivity and Stefan Boltzmann constant of radiative heat transfer
5. Evaluate heat transfer coefficient in natural and forced convections
6. Analyze the Fabricated simple heat transfer systems

COs – POs Mapping

COs	PO_1	PO_2	PO_3	PO_4	PO_7	PO_{10}
1	3	2	2	2	2	2
2	3	2	2	2	2	2
3	3	2	2	2	2	2
4	3	2	2	2	2	2
5	2	2	2	2	2	2
6	3	2	2	2	2	2

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

List of Experiments

1. Determination of the overall heat transfer co-efficient using Composite Slab Apparatus
2. Determination of heat transfer through lagged pipe
3. Estimation of the heat Transfer through a Concentric Sphere
4. Determination of thermal Conductivity of given metal rod
5. Evaluation of the performance of heat transfer in pin-fin for forced convection
6. Demonstration of experiment on Transient Heat Conduction
7. Determination of the heat transfer in forced convection apparatus
8. Determination of the heat transfer in natural convection
9. Evaluation of the performance of Parallel and counter flow heat exchanger
10. Evaluation of the performance of Emissivity apparatus
11. Determination of Stefan-Boltzmann constant using Stefan-Boltzmann Apparatus
12. Evaluation of the performance of heat transfer in drop and film wise condensation
13. Evaluation of the Critical Heat flux apparatus
14. Evaluation of the performance of heat pipe
15. Evaluation of heat transfer in Two phase flow apparatus
16. Evaluation of the performance of heat transfer in pin-fin for free convection

List of Augmented Experiments

1. Experimental investigation on effectiveness of heat exchanger using nanofluids
2. Determination of thermal conductivity of liquids
3. Fabrication and demonstration of a model for Conduction
4. Fabrication and demonstration of a model for Convection
5. Fabrication and demonstration of a model for radiation
6. Evaluation of the performance of heat transfer in a Shell-Tube heat exchanger
7. Evaluation of the performance of natural convection in rectangular fin
8. Evaluation of the performance of forced convection in rectangular fin
9. Determination of optimum fin-Spacing
10. Applications of Heat exchanger in real life-Poster Presentation
11. Analysis of fluid flow in a pipe using CFD
12. Analysis of turbulent flow in a pipe using CFD
13. Analysis of temperature distribution in an insulated wall using CFD
14. Evaluation of the performance of forced convection heat transfer using liquids
15. Evaluation of the performance of natural convection using liquids

Reading Material(s)

1. Heat transfer manual, GMR institute of technology, Rajam
2. R. C. Sachdeva, Fundamentals of Engineering Heat and Mass Transfer, New Age Publishers, 5th Edition, 2017
3. J. P Holman, Heat Transfer, McGraw Hill, 10th Edition, 2017
4. S. Subramanyan, C P Kothandaraman, Heat and Mass Transfer Data Book, New Age Publishers, 9th Edition, 2018.

21ESX02 Employability Skills II

0 0 2 2

Course Outcomes(s)

1. Demonstrate oral communication and writing skills as an individual to present ideas coherently
2. Develop life skills with behavioral etiquettes and personal grooming
3. Assess analytical and aptitude skills
4. Develop algorithms for engineering applications
5. Solve engineering problems using software
6. Utilize simulation tools for testing

Co-Po mapping

COs	PO_1	PO_2	PO_5	PO_8	PO_{10}	PO_{12}
1					3	2
2				1	2	2
3	2	1		2		
4	2		2			
5	2		2			
6	2		2			

Soft Skills:

Sl No.	6th Semester (Topic & Content)	No. of Periods
1.	**Resume (Recap):** Resume? Templates? Mistakes to be avoided in a Resume and Steps to be followed in preparing it.	**01**
2.	**Group Discussions (Recap) & Practice:** GD? Stages of a GD, Skills assessed in a GD, Blunders to be avoided, How to excel in a GD? Practice sessions and sharing Feedback. (Screening sample Videos)	**01**
3.	**Interview Skills:** Interview? Types of Interview, Dos & Don'ts, Skills assessed in an Interview, Mistakes to be avoided, How to equip oneself to excel? How to handle the Typical Interview Questions? (with Examples)	**03**
4.	**Mock Interviews**: Practice sessions with Feedback.	**02**
5.	**Exercises related to Communication:** Email Writing, Voice Versant., etc.	**01**
	Total Periods	**08**

Quantitative Aptitude:

Sl No.	Semester-VI (Topic)	No. of Periods
1.	Time and Distance	01
2.	Time and Distance	01
3.	Problems on Trains	01
4.	Problems on Trains	01
5.	Blood relations	01
6.	Ratio and Proportions	01
7.	Calendars	01
8.	Clocks	01
	Total Periods	**08**

Domain Specific:

Sl. No.	Topic	No. of Periods
1.	Structural Static Analysis of a 3D Truss	02
2.	Structural Static Analysis of 2D beam with supports of simply supported and Fixed ends	02
3.	Analysis of Plane strain	01
4.	Modal Analysis of 2D beam with supports of simply supported and Fixed ends	02
5.	Convective heat transfer analysis of a 2D Plate	01
	Total Periods	**08**

Textbooks:

1. Computer aided Analysis and Simulation Lab manual, GMR institute of technology, Rajam
2. University of Alberta - ANSYS Tutorials, https://sites.ualberta.ca/~wmoussa/AnsysTutorial/
3. Cornell University, ANSYS Learning Modules,https://confluence.cornell.edu/display/SIMULATION/ANSYS+Learning+Modules
4. R. V Dukkipati, MATLAB for Mechanical Engineers, New Age Science, 1st Edition, 2009

21MEC13 Automotive Instrumentation and Diagnostics

3 0 0 3

Course Outcome(s)

1. Gain the basic knowledge of microcomputers in automotive systems
2. Distinguish various elements of automotive instrumentation
3. Understand the modern automotive instrumentation
4. Analyze the fundamental working of computer based instrumentation
5. Acquire the fundamental knowledge about automotive display devices
6. Enable the students to apply the knowledge of automotive electronics towards vehicle diagnostics

COs-POs mapping

COs	PO_1	PO_2	PO_5
1	3	2	2
2	3	2	3
3	3	2	3
4	3	2	3
5	3	2	3
6	3	2	3

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

UNIT I

Microcomputer Instrumentation and Control- Microcomputer Fundamentals -Digital Computer, Microcomputers Versus Mainframe Computers. Microcomputer Tasks, Microcomputer Operations, CPU Registers, Reading Instructions, Example Use of a Microcomputer, Microcomputer Applications in Automotive Systems.
AUTOSAR

12 Hours

UNIT II

Automotive Instrumentation- Modern Automotive Instrumentation, Input and Output Signal Conversion- Multiplexing, Multirate Sampling. Advantages of Computer-Based Instrumentation, Measurement Examples - Fuel Quantity Measurement, Coolant Temperature Measurement, Oil Pressure Measurement, Vehicle Speed Measurement,
Trip Information Function of the System

12 Hours

UNIT III

Display Devices- Introduction to automotive display devices. Types Galvanometer-Type Display, Electro Optic Displays, Light-Emitting Diode, Liquid-Crystal Display, Transmissive LCD, Vacuum-Fluorescent Display, Alpha-Numeric Display, Flat Panel Display Instrument Clusters, Pictorial Display Capability of FPD, Touch Screen.
Digital maps

12 Hours

UNIT IV

Diagnostics- Electronic Control System Diagnostics, Service Bay Diagnostic Tool, Onboard Diagnosis (OBD II) - Misfire Detection, Expert Systems in Automotive Diagnosis.
Diagnostic Fault Codes

12 Hours
Total: 48 hours

Textboook(s)

1. William B. Ribbens," Understanding Automotive Electronics. An Engineering Perspective", 8th Edition Elsevier, 2017.
2. Dorris Ow, "The Big Book Of Automotive: Basic Things About Your Automotive You Should Know", 1st Edition, Kindle ,2022.

Reference(s)

1. Kavati Venkateswarlu and B.S.R. Murphy, "Alternative Fuels and Advanced Vehicle Technologies", 1st Edition, PHI Learning, 2021.
2. Rolf Isermann, "Automotive Control: Modeling and Control of Vehicles (ATZ/MTZ-Fachbuch)" 1st Edition, Springer, 2021
3. Cascanet and Schnell, Robert Schnell, et al.. A Guide To Vehicle Diagnostics: Understanding DTCs and Their Descriptions, Kindle. 2022

Sample Question (s)
Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open book examination (%)
Remember	35	30	-
Understand	45	40	30
Apply	20	30	70
Analyze	-	-	-
Evaluate	-	-	-
Create	-	-	-
Total (%)	100	100	100

Remember

1. What is mainframe computer? State its applications.
2. List down the types of registers
3. What are the elements of automotive instrumentation?
4. List two types of feedback loop
5. Define I/O signal conversion
6. List the factors responsible in selection of a display electronics
7. Define OBD.

Understand

1. Distinguish between microcomputers and mainframe computers
2. Illustrate the microcomputer architecture.
3. List the functions of modern instrumentation systems
4. Enumerate the characteristics of Electro Optic Displays
5. Why service bay diagnostics preferable?

Apply

1. Explain the features of fuel quality measurement system.
2. Explain the elements of LCD
3. Explain the working of touch screen
4. Write the fault diagnostics code for the faulty CRDI injection system **(For Open Book Examination and not for semester end examination)**
5. Describe the importance of intelligent vehicle embedded sensors fault detection and isolation using analytical redundancy and nonlinear transformations **(For Open Book Examination and not for semester end examination)**

21MEC23 3D Printing

3 0 0 3

Course Outcome(s)

1. Understand the fundamentals of 3D printing Technologies for engineering applications
2. Understand the liquid-based systems to manufacture the products using 3D printing technologies
3. Understand the solid based systems to manufacture the products using 3D printing technologies
4. Understand the powder-based systems to manufacture the products using 3D printing technologies
5. Explore fundamentals of 4D printing Technologies and their future applications
6. Evaluate 3D/4D printing industry and their perspective at global level

COs – POs Mapping

COs	PO_1	PO_5	$PS0_2$
1	3	3	2
2	3	3	2
3	2	3	2
4	2	2	2
5	2	2	2
6	2	2	2

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit I

Basics of 3D printing

Introduction, Prototyping fundamentals, Historical development, Basic principle, Materials for 3D printing, Advantages and Disadvantages of 3D printing**,** process chain, 3D modelling, Data Conversion, and transmission, Checking and preparing, Building, Post processing, RP data formats, Classification of 3D printing process, Applications to various fields.

In Lab Training on design and STL conversion for any mechanical components for 3D printed objects.

Slicing and STL files

12 Hours

Unit II

Liquid based systems

Stereo lithography apparatus (SLA): process, working principle, photopolymers, photo polymerization, layering technology, laser and laser scanning, applications, advantages and disadvantages, case studies. Solid ground curing (SGC): Models and specifications, process, working, principle, applications, advantages and disadvantages, case studies.

Solid Based 3D Printing

Laminated object manufacturing (LOM): Models and specifications, Process, Working principle, Applications, Advantages and disadvantages, Case studies. Fused Deposition Modeling (FDM): Models and specifications, Process, Working principle, Applications, Advantages and disadvantages, Case studies, practical demonstration.

In Lab Training on slicing for any mechanical components for 3D printed objects.

Bio-Materials for 3D Printing

12 Hours

Unit III

Powder based systems

Selective laser sintering (SLS): Models and specifications, process, working principle, applications, advantages and disadvantages, case studies. Three-dimensional printing (3DP): Models and specification, process, working principle, advantages and disadvantages, applications, case studies.

In Lab Training on 3D printing for any mechanical components using 3D printing machine

3D Printing in Product Design

12 Hours

Unit IV

Basics of 4D Printing

History of 4D printing, Shape change effect, smart materials used in 4D printing, Additive Manufacturing (AM) Technologies for Four-Dimensional (4D) Printing, Material Selection for 3D/4D printing, Simulation methods for 4D Printing, Properties of 4D Printed Parts, Conceptual framework for 4D printing, Factors Influencing 4D Printing, Potential Applications of 4D Printing.

In Lab Training on 3D scanning for any mechanical components using 3D scanner.

Selection of 4D Printing

12 Hours

Total: 48 Hours

Textbook(s)

1. From Additive Manufacturing to 3D/4D Printing, Jean-Claude André, Wiley publications, 1st ed. (2017).
2. Chua C.K., Leong K.F. and LIM C.S Rapid prototyping: Principles an Applications, World Scientific publications, 3rd Ed., (2010).
3. Ian Gibson, Davin Rosen, Brent Stucker "Additive Manufacturing Technologies, Springer, 2nd Ed, (2014).

Reference(s)

1. Tibbits, S. The Emergence of 4D Printing"; TED Conference LLC: New York, NY, USA, (2013).
2. Chua, C.K., Leong K.F. and Lim C.S., Rapid prototyping: Principles and applications, 2nd Ed., World Scientific Publishers, (2010).
3. Ibrahim Zeid, Mastering CAD CAM Tata McGraw-Hill Publishing Co., (2007).
4. Joan Horvath, Mastering 3D Printing, A Press, 2014
5. Ian M. Hutchings, Graham D. Martin, Inkjet Technology for Digital Fabrication, John Wiley and Sons, 2013.

Sample Question(s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examinations (%)
Remember	30	30	-
Understand	40	40	-
Apply	30	30	60
Analyze	-	-	30
Evaluate	-	-	10
Create	-	-	-
Total (%)	100	100	100

Remember

1. What is 3D Printing?
2. List any four tangible and intangible benefits of 3D Printing?
3. Define 4D Printing?
4. List out the various 3D printing technologies?
5. What are process parameters used in 3D and 4D printing technologies?
6. Which types components can be manufactured by 4D printing?

Understand

1. Describe the advantages and limitations of each 3D printing technology.
2. Explain current and emerging 3D printing applications in a variety of industries
3. Differentiate between 3D and 4D printing.
4. Explain the construction and working 3D/4D printing.
5. What different methods of additive manufacturing for 4D printing?

Apply

1. Discuss the economic implications of 3D printing including its impact on start-up businesses and supply chains
2. What is influence of processing parameters on the productivity of 4D printing.
3. What are stimuli methods for 4D printing?
4. Explain an insight into geometric shapes to be produced by 3D printing.
5. Which types components can be manufactured by 4D printing,
6. Elucidate general pathway for production of 3D printed parts **(For Open book examination question not for end semester examination).**
7. Smart materials for 4D materials explain industrial applications. **(For Open book examination question not for end semester examination).**
8. Which objects you can manufacture by 3D and 4D printing. **(For Open book examination question not for end semester examination).**
9. Name any four companies manufacturing additively manufactured components. in recent times **(For Open book examination question not for end semester examination).**

Analyze

1. Discuss the economic implications of 3D printing including its impact on start-up businesses and supply chains
2. What is influence of processing parameters on the productivity of 4D printing.
3. What are stimuli methods for 4D printing?
4. Explain an insight into geometric shapes to be produced by 3D printing.
5. Which types components can be manufactured by 4D printing?'
6. What parameters influence the productivity of 3D and 4D printing. **(For Open Book Examination questions not for end semester examination)**
7. How shape memory alloys can be processed by 4D printing. **(For Open Book Examination questions not for end semester examination)**

Evaluate

1. Evaluate real-life scenarios and recommend the appropriate use of 3D printing technology. **(For Open Book Examination and not for semester end examination)**
2. Identify key areas where there is potential for 3D printing in engineering applications. **(For open book Examination not semester end examination)**
3. Write 3D printing role in manufacturing of Prosthetic Limbs & Body Parts, stents. **(For Open book Examination not end semester examination)**
4. Establish the role of 3D printing in Industry 4.0 for manufacturing revolution.
5. Assess the application of smart materials based on 4D printing. **(For Open book Examination not end semester examination)**

21MEC33 Quality Assurance and Reliability Engineering for Sustainability

3 0 0 3

Course Outcome(s)

1. Develop conceptual understanding of Quality of Product and Process and its Management for sustainability
2. Develop Control charts for process control
3. Develop understanding of sampling plans for acceptance of materials
4. Understand the key concepts in reliability engineering and application to a manufacturing environment for sustainability
5. Manage the manufacturing organizations with highest possible Reliability
6. Explain strategies for achieving sustainability in various sectors

COs POs Mapping

COs	PO_1	PO_3	PO_5
1	3	3	3
2	3	2	3
3	2	3	3
4	3	3	3
5	3	2	3
6	3	3	3

3- Strongly linked | 2- Moderately linked | 1- Weakly linked

Unit 1

Quality Assurance Tools and Techniques- Concept of quality characteristics, Value of quality, Quality of design and conformance, Process capability, selective assembly, concept in total quality control and quality system, Quality assurance for sustainability.

12 Hours

Unit 2

Statistical Quality Control- Quality cost aspects. Job plan. Case study in value analysis. Process control, Concept of S.Q.C. control chart for variable additives and attributes. Multi characteristics control chart. Acceptance sampling plan, single, Double and sequential sampling, ACL, LTPD concept. AOQL and rectification plan. Economic of inspection. Motivation for quality assurance. Total quality management principles, Zero defect program, Quality circle.

12 Hours

Unit 3

Reliability Engineering principles and methods- Definition of reliability, reliability vs quality, the failure distribution, the reliability function, mean time to failure, Hazard rate function, bathtub curve, conditional reliability, constant failure rate model, time dependent failure models e.g., exponential, Weibull and normal distribution.

12 Hours

Unit 4

Sustainable Design for Reliability of Systems- Serial configuration, parallel configuration, combined series parallel systems, Reliability specification and system measurements, reliability allocation, design methods, FMEA failure analysis, system safety and fault tree analysis.

Sustainability of Design for Reliability- Beyond reliability of systems, keeping the capability, keep the customers in mind and involved, make the most with vision and leadership, infrastructure, reinforcement and control organizational culture.

12 Hours

Total: 48 Hours

Textbook(s)

1. Introduction to Reliability and Maintenance engineering by Charles E Ebeling, Tata McGrawhill, India
2. Introduction to statistical quality control, 4th Edition by Douglas C Montgomery, John Wiley & Sons, Inc
3. K. C. Jain and A. K. Chitale, Quality Assurance and Total Quality Management, Khanna Publication, 3rd Edition, 2003

Reference(s)

1. Fundamentals of quality control and improvement by Amitava Mitra, Pearson Education Asia.
2. Total Quality Management by Besterfield et al., Pearson Education, India, 2013
3. David J Smith, "Reliability, Maintainability and Risk: Practical Methods for Engineers", Butterworth,2015.
4. Narayana V. and Sreenivasan N.S., Quality Management Concepts and Tasks, New Age International, 2015.
5. Vincent K. Omachonu and Joel E. Ross, Principles of Total Quality, 7th Edition, Taylor & Francis, 2017

6. Failure Modes and Effects Analysis (FMEA) Reference Manual, AIAG The Automotive Industries Action Group, 3rd Edition, 2015

Web Links

1. https://archive.nptel.ac.in/courses/110/101/110101010/
2. https://archive.nptel.ac.in/courses/112/107/112107259/

Video Links

1. https://archive.nptel.ac.in/courses/112/106/112106249/
2. https://archive.nptel.ac.in/courses/112/106/112106253/

Sample Question(s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	30	30	-
Understand	30	30	-
Apply	40	40	30
Analyze	-	-	70
Evaluate	-	-	-
Create	-	-	-
Total (%)	100	100	100

Remember

1. Examine the strategies of quality assurance
2. List out the basic concepts of SQC
3. Define quality circle
4. Explain the zero defect principle
5. Explain the purpose of design for reliability

Understand

1. Explain concept of sampling plans
2. Briefly explain the reliability function
3. Contrast and compare quality and reliability
4. Explain about Quality assurance for sustainability

Apply

1. Identify the need of control charts
2. Develop the quality circle for a manufacturing and a service organizations
3. Identify the need of process capability in a manufacturing sector
4. Develop a fault tree by taking a machine break down in a manufacturing sector
5. Vadhodara furniture is manufacturer of executive tables for corporate institutions. In order to control the quality of its table its QC manager selects 15 tables at random and inspects the number of scratches on each one of them. The following results are obtained. Develop an appropriate chart for the quality assurance programme. **(For Open Book Examination and not for semester end examination)**

Sample No.	No. of defects
1	13
2	9
3	19
4	7
5	8
6	10
7	12
8	0
9	2
10	5
11	7
12	11

13	9
14	13
15	1

Analyze

1. Analyze the available quality assurance strategies for sustainability
2. Compare series and parallel configurations reliability analysis
3. Classify and explain acceptance sampling plans
4. Analyze various reliability allocation methods
5. In the manufacture of mechanical seals for centrifugal pumps, inspection results of 30 sample of each having 100 units of seals in given in the following table. Calculate the average fraction defective and control limit. Construct a "control-chart" and comment about the process **(For Open Book Examination and not for semester end examination)**

Sample No.	No of Defectives	Sample No.	No of Defectives
1	7	10	11
2	3	13	13
3	6	13	5
4	9	11	10
5	11	14	5
6	3	15	9
7	6	16	4
8	4	10	11
9	7	19	7
10	8	20	10

Evaluate

1. Evaluate the fundamental equation for reliability in terms of hazard rate function.
2. Explain different design methods used to incorporate reliability into a product.
3. In the manufacture of armatures for electric motors, inspection results pf 20 sample of each having 100 units of armatures in given in the following table. Calculate the average fraction defective and control limit. Construct a "p chart" and comment about the process **(For Open Book Examination and not for semester end examination)**

Sample No.	No of Defectives	Sample No.	No of Defectives
1	8	11	12
2	4	12	14
3	7	13	6
4	9	14	9
5	11	15	5
6	4	16	8
7	5	17	4
8	3	18	10
9	8	19	7
10	9	20	11

21ME011 Automobile Engineering

3 0 0 3

Course Outcome(s)

1. Explain different types of automobiles, engine construction, turbo charging and supercharging
2. Illustrate the necessity and working of elements of transmission system
3. Demonstrate the elements of vehicle control systems viz., steering, suspension, braking and electrical systems
4. Illustrate the fuel cells and its working principle
5. Summarize the emission control methods used in automobiles
6. Identify different causes for engine failures and outline engine service

Co-PO Mapping

COs	PO_1	PO_6	PO_7
1	3	1	1
2	3	1	1
3	1	1	1
4	3	1	1
5	3	3	3
6	3	1	1

3 Strongly linked | 2 Moderately linked | 1 Weakly linked

Unit I

Engine Body Components and Transmission system: Introduction, components of four-wheeler automobile - chassis and body - power unit - power transmission - rear wheel drive, front wheel drive, 4-wheel drive - types of automobile engines, engine construction, turbo charging and super charging - oil filters, oil pumps - crank case ventilation reboring, de carbonization

Transmission system: Clutches, principle, types, cone clutch, single plate clutch, multi plate clutch, magnetic and centrifugal clutches, - gear boxes, types, sliding mesh, construct mesh, synchro mesh gear boxes, epicyclic gear box, over drive torque converter. Propeller shaft - universal joint- differential- rear axles- types - wheels and tyres

Hardening of crank shaft.

12 Hours

Unit II

Steering system, Suspension and Braking system: Steering geometry - camber, castor, king pin rake, combined angle toe-in, center point steering. Types of steering mechanism - Ackerman steering mechanism, Davis steering mechanism, steering gears - types.

Suspension system: Objects of suspension systems - rigid axle suspension system, torsion bar, shock absorber, independent suspension system.

Braking system: Mechanical brake system, hydraulic brake system, master cylinder, wheel cylinder tandem master cylinder requirement of brake fluid, pneumatic and vacuum brakes.

Assembly of steering suspension and braking system in the assembly line of an automobile assembly unit

12 Hours

Unit III

Electrical systems and Charging system: Electrical system: Charging circuit, generator, current voltage regular - starting system, bendix drive mechanism solenoid switch, lighting systems, horn, wiper, fuel gauge - oil pressure gauge, engine temperature indicator etc.

Charging system: Introduction, Generator, Principle of D.C. generator, Constructional details, Generator output control, testing procedure for generator regulator system, generator faults and their diagnosis, generator maintenance, regulator service. Alternator- working principle, construction details. Alternator trouble shooting, comparison of alternator with D.C. generator.

Different types of Modern generators and alternators

12 Hours

Unit IV

Engine emission control and Engine Service: Engine emissions: Introduction - types of pollutants, mechanism of formation, concentration measurement, methods of controlling- engine modification, exhaust gas treatment-

thermal and catalytic converters - use of alternative fuels for emission control - National and International pollution standards.

Engine service: Introduction, service details of engine cylinder head, valves and valve mechanism, piston connecting rod assembly, cylinder block, crank shaft and main bearings, engine reassembly-precautions.

Study of National and International standards relating to Engine emissions

12 Hours
Total: 48 Hours

Textbook (s)

1. Kirpal Singh, Automobile Engineering Vol. I & Vol. 2, Standard publishers, 13th Edition, 2020.
2. William Crouse and Donald L Anglin, Automotive Mechanics, TMH Distributors, 10th Edition, 2017
3. Jack Erjavec, Automotive Technology: a system approach, Thomson/Delmar Learning, 7th Edition, 2019.

Reference (s)

1. P.S Gill, Text book of Automobile Engineering, S.K. Kataria & Sons New Delhi, 2nd Edition, 2012.
2. Joseph Heitner, Automotive mechanics: principles and practice, CBS Publishers New Delhi, 2nd Edition, 2004.
3. K.M. Moeed, Automobile Engineering, S. K. Kataria & Sons, 2nd Edition, 2017.

Sample Question (s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	25	15	-
Understand	55	55	-
Apply	20	25	50
Analyze	-	-	50
Evaluate	-	-	-
Create	-	-	-
Total (%)	**100**	**100**	**100**

Remember

1. Classify the components of an automobile.
2. State the main parts of an automobile engine.
3. Define supercharging.
4. State the objectives of lubrication.
5. List the three methods of decarbonizing.
6. What is main function of generator in an automobile?

Understand

1. Explain positive crankcase ventilation.
2. Explain the different processes for hardening of crankshafts.
3. Derive the expression for torque transmitted in a single plate clutch.
4. Classify the different types of oil pumps.
5. Explain the principle of a generator. Give its constructional details.
6. What type of generators are used in the modern cars?

Apply

1. In a situation in cold countries the water in the radiator freezes as the temperature fall below zero degrees centigrade. What measures would you suggest for encountering this situation?
2. A sliding mesh type of gear box with forward speeds only is to be designed. The gear box should have the following gear ratios available approximately: 1.0, 1.5, 2.5 and 3.9. The center distance between the lay shaft and the main shaft is 78 mm and the smallest gear is to have at least 16 teeth with a diametric pitch of 3.25 mm. Calculate the number of teeth of various gears and exact gear ratios thus available.
3. What do you do in case you find the cylinder head jammed over the block after you have removed all nuts for removing the head?

4. What is an HCCI engine? How does it compare with S.I. and C.I engines? Discuss in details its merits and demerits , describing also current scenario regarding its applications in automobile engines. **(For Open Book Examination and not for semester end examination)**

Analyze

1. Which Ackerman steering mechanism is suitable in the car technology?
2. Compare between turbocharging and supercharging.
3. Due to some accident, only one-cylinder bore has been damaged and it is found that it needs reboring to next oversize, whereas other cylinder bores are perfectly alright. Should only the affected cylinder be rebored and fitted with oversize piston or should all the cylinders be rebored oversize? Justify your answer.
4. Analyze the braking torque provided by each shoe in a drum brake with 380 mm diameter. The shoes are anchored together 150 mm away from the brake drum center. The free ends of the two shoes are pushed apart with a force of 320 N which may be considered acting at a distance of 320 mm from the anchor. Assume that the normal pressure on the brake shoes act at right angles to the line joining the anchor with the brake drum centre and the resultant frictional force acts at a distance of 200 mm from the brake drum centre. Take coefficient of friction between the shoes and the drum as 0.5.
   (For Open Book Examination and not for semester end examination)

21ME012 Design for Manufacturing

3 0 0 3

Course Outcome(s)

1. Understand the modern manufacturing operations and their capabilities.
2. Explain the process of design a criterion for material selection
3. Illustrate the process of analyzing products to improve their manufacturability with lower costs
4. Analyze the relationship between customer desires, functional requirements in product design and manufacturing
5. Develop the design guidelines for manufacturing of products using extrusion process
6. Outline the design guidelines for manufacturing of Plastics

COs – POs Mapping

COs	PO_1	PO_2	PO_7	PO_{12}	PSO_2
1	3	2	1	1	2
2	3	2	1	1	2
3	3	2	-	2	2
4	3	2	2	2	2
5	3	1	-	1	1
6	1	1	-	2	1

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit- I

Design Process- Creative steps in design and materials selection Design philosophy, steps in design process, general design rules for manufacturability basic principles of designing for economical production, creativity in design., Case Studies for Design Process.

Materials

Selection of materials for design, developments in material technology, criteria for material selection, material selection interrelationship with process selection, process selection charts, Case Studies for Material Selection.

Design process of any automobile component with its material selection

12 Hours

Unit- II

Machining processes- According to Design for manufacturing Overview of various machining processes, general design rules for machining dimensional clearance and surface roughness, Design for machining ease, redesigning of components for machining ease with suitable examples. General design recommendations for machined parts.

Metal casting: Appraisal of various casting processes, selection of casting process, general design considerations for casting, Gating design, casting tolerance-use of solidification, simulation in casting design, product design rules for sand casting.

Case Studies for Machining and Casting Process.

Design recommendations for special casting processes; centrifugal and investment casting processes

12 Hours

Unit- III

Metal joining- According to Design for joints, Design for forging Appraisal of various welding processes, factors in design of weldments, general design guidelines, pre and post treatment of welds, Under water welding, welding of dissimilar metals, Robotic welding, effects of thermal stresses in weld joints, design of brazed joints.

Forging

Design factors for forging, closed die forging design, parting lines of dies, drop forging die design, general design recommendations.

Case Studies for Metal Joining Process.

Design recommendations for special joining and forging processes

12 Hours

Unit- IV

Automatic Assembly Transfer Systems: Continuous transfer, intermittent transfer, indexing mechanisms, and operator - paced free – transfer machine.

Design of Manual Assembly: Design for assembly fits in the design process, general design guidelines for manual assembly, development of the systematic DFA methodology, assembly efficiency, classification system for manual handling, classification system for manual insertion and fastening, effect of part symmetry on

handling time, effect of part thickness and size on handling time, effect of weight on handling time, parts requiring two hands for manipulation, effects of combinations of factors.
Case Studies for Design for Assembly Process.
Effect of symmetry effect of chamfer design on insertion operations, estimation of insertion time.

12 Hours
Total: 48 Hours

Textbook (s)

1. G. Boothroyd, Peter Dewhurst, Product design for manufacture and assembly, Taylor & Francis, 5th Edition, 2020.
2. G Dieter, Engineering Design - a materials and processing approach, McGraw Hill, NY, 3rd Edition, 2019.
3. M F Ashby, Material Selection in Mechanical Design, Butterworth-Heinemann, 2nd Edition, 2019.

Reference (s)

1. John Cobert, Design for manufacture, Adisson Wesley, 5th Edition, 2020.
2. M F Ashby and K Johnson, Materials and Design - the art and science of material selection in product design, Butterworth-Heinemann, 3rd Edition, 2019.
3. T H Courtney, Mechanical Behavior of Materials, McGraw Hill, NY, 3rd Edition, 2017.
4. K G Swift and J D Booker, Process selection: from design to manufacture, London: Arnold, 3rd Edition, 1999.
5. S S Rao, Engineering Optimization: theory and practice, John Wiley, NY, 4th Edition, 2010.
6. J G Bralla, Handbook for Product Design for Manufacture, McGraw Hill, NY, 1998.
7. Houldcroft, Which Process – an introduction to welding and related processes and guide to their selection, Cambridge, Abington Pub., 1990.
8. ASTM Design handbook.

Sample Question(s)
Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	15	15	**-**
Understand	15	15	**-**
Apply	55	55	50
Analyze	15	15	50
Evaluate	**-**	**-**	-
Create	**-**	**-**	-
Total (%)	**100**	**100**	**100**

Remember

1. Define about design for machining.
2. Recall the factors in design of weldments.
3. List any three guidelines for manufacturability
4. What are the guidelines to be followed while designing machining for plastics?
5. Define the "Design rules for machining are intended to improve machined part quality and reduce machining costs".
6. What do you understand from section size effect in casting?
7. What do you know about Keeler Goodman forging line diagram?
8. What are the good design practices for joining?
9. List out general design for machining rules.
10. Define the guidelines to be followed while designing injection molding.

Understand

1. Explain various materials used for forging dies with their advantages.
2. Classify between design for manufacturing and detailed design explaining the various terms involved.
3. Summarize the importance of solidification simulation in casting design
4. Explain the three criteria against which a part is examined in DFMA.
5. Derive the behavior of cast iron during solidification.
6. Discuss the economic and product design considerations in machining.

7. Briefly explain the effect of design guidelines on extruded sections.
8. Sketch and explain the design of parting line of dies.
9. Discuss the design considerations for punching and blanking operations.

Apply

1. Construct the design of closed die forging design and drop forging die design with a neat sketch.
2. Choose a suitable example and apply the steps in improving the design of a component from the point of view of machining.
3. Discuss briefly the basic principles of designing for economical production.
4. What are the general problems we come across while designing for machining operations? Explain how one can overcome those problems.
5. Illustrate the Keeler Goodman forging line diagram.
6. Discuss about the visco elastic and creep behavior in plastics.
7. What is the difference between drawing and deep drawing operation? And Give the applications of injection molding process.
8. Constract the assembly design parameters and how the following engineering design types are different from each other: lnnorathe design, adaptive design, variant design and industrial design.**(For Open Book Exam Question)**
9. Define Group Technology (GT) concept in manufacturing. Discuss the stages involved for adopting plan for for group technology. **(For Open Book Exam Question)**

Analyze

1. Analyze the factors which will be considered in the analysis of reduce part count and part types.
2. Examine how adjustments can be eliminated in the assembly design process?
3. Distinguish the factors which will be considered in handling part from the bulk no of parts
4. Justify the statement “Design rules for machining are intended to improve machined part quality and reduce machining costs”
5. Enumerate how the properties of casting get affected due to casting defects with neat sketches.
6. Analyze the design guide lines for plastic components.
7. Discuss about the visco elastic and creep behavior in plastics.
8. Recognize the briefly the basic principles of designing for economical production.
9. Describe the die casting process. Explain briefly the advantages and disadvantages of die casting process over sand casting process. **(For Open Book Exam Question)**

21ME013 Operations Research

3 0 0 3

Course Outcomes

1. Formulate a mathematical model and solve using linear programming techniques.
2. Solve real time problems using Non-linear programming techniques.
3. Perform optimum problem-solving process in transportation and work assignment
4. Assign a right job to a right person using job sequencing.
5. Make right decisions in operations management using game theory, queuing theory and replacement analysis.
6. Distinguish the process of waiting lines and its applications.

COs – POs Mapping

COs	PO_1	PO_2	PO_3	PO_5
1	3	2	2	1
2	1	2	3	2
3	1	3	3	2
4	3	2	2	3
5	2	1	3	2
6	3	2	1	3

3 Strongly linked | 2 Moderately linked | 1 Weakly linked

Unit I

Linear Programming – Characteristics and Methods

Development, definition, characteristics and phases, types of models, operation research models, applications. Allocation Linear programming problem formulation, graphical solution, simplex method, artificial variables techniques, two phase methods, big m method, duality principle.

Nonlinear Programming

One Dimensional Minimization: Unimodal function, Elimination methods, Unrestricted search, Exhaustive search, Dichotomous search and Fibonacci method,

Evaluation of a linear problem using advanced linear programming methods

12 Hours

Unit- II

Transportation Problem- Solution methodology with examples

Formulation, optimal solution, unbalanced transportation problem, degeneracy, assignment problem formulation, optimal solution, variants of assignment problem travelling salesman problem.

Solving a given transportation problem using soft computing techniques

12 Hours

Unit-III

Sequencing- Scheduling techniques: Solution methodology with examples

Introduction, flow, shop sequencing, n jobs through two machines, n jobs through three machines, job shop sequencing, two jobs through „m" machines.

Replacement Analysis: Solution methodology

Introduction, replacement of items that deteriorate with time, dominance principle, m x counted, replacement of items that fail completely, group replacement.

Development of a replacement policy of the components for an enterprise.

12 Hours

Unit IV

Theory of Games-Various types of games

Introduction, mini. Max(max. mini) criterion and optimal strategy, solution of games with saddle points2 & 2 x n games, graphical method.

Waiting Lines

Introduction, single channel, poison arrivals, exponential service times, with infinite population and finite population models, multichannel, poison arrivals, exponential service times with infinite population single channel poison arrivals.

Implementing the principles of waiting lines for a given case study.

12 Hours

Total: 48 Hours

Textbook (s)

1. S.D Sharma, Operations Research: Theory method and Applications, Kedarnath, Ram Nath & Co, Meerut Publications, 16th Edition, 2012.
2. FredErick S Hiller & Gerald J Liberman, Introduction to Operations Research, TMH Publications, 7th Edition, 2002.
3. Operations Research: An Introduction, Hamdy A. Taha,10th edition,2017

Reference (s)

1. Handy A Taha, Operations Research: An Introduction, Prentice Hall of India Publications, 6th Edition, 1997.
2. R. Pannerselvam, Operation Research, PHI Publications, 1st Edition, 2002. 3. J. K Sharma, Operation Research: Problems and Solutions, McMillan, 1st Edition, 2002.
3. Operations Research, Theory and Applications,Lakshmi Publications,2017

Sample Question(s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	15	15	**-**
Understand	15	15	**-**
Apply	55	55	50
Analyze	15	15	50
Evaluate	**-**	**-**	-
Create	**-**	**-**	-
Total (%)	**100**	**100**	**100**

Remember

1. Define Operations research for engineers.
2. Racall the factors to be consider in Simplex procedure.
3. List any three assumptions in Game theory strategies.
4. What is Saddle Point?
5. Spell about Constraints?

Understand

1. Explain about the procedural steps involved in two phase methods?
2. Classify different types of queuing systems?
3. Explain the role of computers in Operations research?
4. Summarize about Assignment Algorithm?
5. Illustrate the objectives of Operations Research?

Apply

1. Seven jobs are to be processed on two machines A and B in the order A→B. Each machine can process
1. one job at a time. The processing times (in hours) are as follows. Develop the optimum sequence.
2. Identify the initial basic feasible solution of the transportation problem?
3. Apply the minimax method for game theory applications?
4. Organize the Travelling Salesman Problem to find out the least path in a business model.
5. Develop the optimum criteria for queuing for a service management area?

Analyze

1. ABC company is engaged in manufacturing 5 brands of packed snacks. It is having five manufacturing setups, each capable of manufacturing any of its brands, one at a time. The cost to make a brand on these setups vary according to the following table. Analyze the optimum assignment of products on these setups resulting in the minimum cost.
2. Discover the route cause analysis in delay in production scheduling.
3. Examine the feasible solutions for optimum production scheduling.
4. Inspect the failure conditions in replacement theory

Evaluate

1. Fleet cars have increased their costs as they continue in service due to increased direct operating cost and increased maintenance. The initial cost is Rs. 3,500 and the trade in value drops as time passes until it reaches a constant value of Rs.500. Given the cost of operating, maintaining and the trade in value, evaluate the proper length of service before cars should be replaced?
2. Determine the decision criteria for selecting the facility layout?
3. Estimate the optimal criteria for production sequencing?
4. Assess the failure conditions for bulb replacement?
5. Explain the optimum criteria for Transpotation Probelems?
6. A harbor has a single dock to unload the containers from the incoming ships. The arrival rate of ships at the harbor follows Poisson distribution and the unloading time for the ships follow exponential distribution and hence, the service rate also follows Poisson distribution. The arrival rate and service rate are 8 ships per week and 14 ships per week, respectively. Determine the following.
    a. Utilization factor of the dock
    b. Average number of waiting ships in the queue
    c. Average number of waiting ships in the system
    d. Average waiting time per ship in the queue
    e. Average waiting time per ship in the system

21ME014 Refrigeration and Air Conditioning

3 0 0 3

Course Outcome(s)

1. Apply the concept of refrigeration cycle to various systems
2. Choose the exact methods to improve performance of vapor compression systems
3. Explain the steam jet, vapor absorption, thermoelectric and vortex tube systems
4. Select the eco-friendly refrigerants based on the performance and environmental impact
5. Explain the principles of psychometry and air conditioning processes
6. Analyze cooling and heating loads in an air conditioning system

COs – POs Mapping

COs	PO_1	PO_2	PO_3	PO_7
1	3	3	2	2
2	3	3	2	1
3	3	1	2	2
4	3	1	2	3
5	3	3	2	2
6	3	3	3	2

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

Unit I

Air refrigeration cycle and systems - Vapor absorption system- Introduction - Necessity and applications – Unit of refrigeration and C.O.P. Types of Ideal cycles of refrigeration-Reversed Carnot cycle and Bell Coleman cycle. Open and dense air systems – Air refrigeration system– Refrigeration needs of Air crafts. Working principle and essential components of the plant – different methods- numerical problems.

Vapor Absorption System – Calculation of max COP – description and working of NH3 – water system and Li Br – water (Two shell) System.

Three Fluid absorption system, salient features.

12 Hours

Unit II

Vapor compression system – Nonconventional refrigeration system- Simple vapor compression refrigeration cycle – Classification and working principles of compressors, condensers, Evaporators and Expansion devices. COP – Representation of cycle on T-S and p-h charts – effect of sub cooling and super heating – cycle analysis – Actual cycle Influence of various parameters on system performance – numerical Problems.

Working principle and basic components of Steam Jet Refrigeration System. Principle and operation of thermoelectric refrigerator and Vortex tube or Hilsch tube.

Use of p-h charts

12 Hours

Unit III

Refrigerants - Introduction to air conditioning- Classification, thermodynamic, physical, and chemical properties – classification of refrigerants – Nomenclature – Ozone Depletion – Global Warming. Psychometric Properties & Processes – Psychometric chart - Characterization of Sensible and latent heat loads – Problems. Classification of air conditioning -Load concepts of RSHF and ADP

GSHF and ERSHF

12 Hours

Unit IV

Human comfort conditions- Air conditioning load calculations - Requirements of human comfort and concept of effective temperature- Comfort chart. Air conditioning Load Calculations – Application to real time problems like class room, office room etc. Air Conditioning Systems-Classification of equipment, cooling, heating, humidification, dehumidification and Filters.

Fans and blowers

12 Hours

Total: 48 Hours

Textbook(s)

1. R.S. Khurmi & J. K Gupta, Textbook of Refrigeration and Air Conditioning, S Chand, 5th Edition, 2015.
2. C. P. Arora, Refrigeration and Air Conditioning, McGraw Hill Education (India) Private Limited, 4th Edition, 2020.

3. R.K. Rajput, A Textbook of Refrigeration & Air Conditioning, S.K. Kataria & Sons, 3rd Edition, 2015 reprint 2019.

Reference(s)

1. P. L. Bellaney, Refrigeration and Air Conditioning, Khanna Publishers, 16th Edition, 2016.
2. Ananthanarayanan, Basic Refrigeration and Air-Conditioning, TMH, 4th Edition, 2013.
3. SC Arora & Domkundwar, A Course in Refrigeration and Air conditioning, Dhanpat Rai & Sons, 7th Edition, 2003.

Sample Question(s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	30	30	--
Understand	30	30	--
Apply	40	40	50
Analyze	--	--	50
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Remember

1. List the desirable properties of ideal refrigerant
2. What are the advantages and disadvantages of steam jet refrigeration system over other types of refrigeration system
3. Define Specific humidity.
4. Name the factors that determine human comfort.
5. Define the term "ton of refrigeration".
6. What is meant by psychometry?

Understand

1. Classify the condensers based on cooling medium used and compare them
2. Explain the working of Li-Br absorption refrigeration system
3. Illustrate the simple vapour compression refrigeration system
4. Outline Ozone depleting potential and global warming potential
5. Explain with the help of a neat sketch, the working of a steam jet refrigeration system.
6. Compare the comfort and industrial air conditioning system.

Apply

1. In an aircraft cooling system, air enters the compressor at 1 bar and 4^{o} C. It is compressed to 3 bar with an isentropic efficiency of 72%. After being cooled to 55^{o} C at constant pressure in a heat exchanger, the air expands in a turbine to 1 bar with an isentropic efficiency of 78%. The low temperature air absorbs a cooling load of 3 tons of refrigeration at a constant pressure before re-entering compressor which is driven by turbine. Assuming air to be an ideal gas, determine the C.O.P of refrigerator, the driving power required and air mass flow rate.
2. The atmospheric conditions of air are 25 ^{o}C dry bulb temperature and specific humidity of air 0.01kg per kg of dry air. Find: 1. Partial pressure; 2. Relative Humidity.
3. An R-12 vapour compression system has saturated suction temperature of -5°C and saturated discharge temperature of 40°C. The refrigerant vapour is dry-saturated at the suction of compressor and becomes superheated after compression. For one ton of refrigeration capacity, Calculate i)Refrigerating effect ii)mass flow rate iii)Power and iv)COP of the system
4. A simple air-cooled system is used for an aero plane to take the load of 20 tons. Atmospheric temperature and pressure conditions are 23^{o}C and 0.9 bar respectively. The pressure of air is increased due to isentropic ramming from 0.9 bar to 1 bar. The pressure of air leaving the main compressor is 3.5 bar and its 60% heat is removed in the air-cooled heat exchanger and then it is passed through an evaporator for further cooling. The temperature of air is reduced by 7^{0}C in the evaporator. Lastly the air is passed through cooling turbine

and then it is supplied to the cooling cabin where the pressure is maintained at 1.03 bar. Assuming isentropic efficiencies of the compressor and turbine are 80% and 75%, determine, i) kW capacity required to take the load in the cooling cabin. ii) C.O.P. of the system. The temperature of the air leaving the cabin should not exceed 25°C. **(For Open Book Examination and not for semester end examination)**

5. An inventor claims to have developed a refrigerator that takes in 1.5 kW per ton of refrigeration and maintains at a temperature of -40°C. Comment on the validity of this claim. **(For Open Book Examination and not for semester end examination)**
6. From time to time people suggest using the difference in the temperature of water at the surface of the ocean and that near the bottom of the ocean for operating a heat engine. Using 20°C as the high temperature and 4°C as the low temperature. What is the efficiency of such a device? **(For Open Book Examination and not for semester end examination)**

Analyze

1. Throttle valve is used in vapour compression refrigerator rather than an expansion cylinder to reduce the pressure between the condenser and evaporator. Why?
2. Analyse the effect of evaporator pressure and condenser pressure on the performance of vapour compression refrigeration system using P-h diagram.
3. Examine effect of sub-cooling on the performance of vapour compression refrigeration system.
4. "A completely odourless refrigerant is not desirable", analyse the statement. **(For Open Book Examination and not for semester end examination)**
5. The amount of air supplied to an air-conditioned hall is 300 m3/min. The atmospheric conditions are 35°C DBT and 55% RH. The required conditions are 20°C DBT and 60% RH. Find out the sensible heat and latent heat removed from the air per minute, sensible heat factor for the system. Also analyse the effect of suction pressure and delivery pressure on the performance of a vapour compression system. Suggest the suitable refrigerant to the air-conditioning system and justify the selection. If the system is running based on the principle of steam jet refrigeration system then list out the advantages and disadvantages of steam jet refrigeration system. **(For Open Book Examination and not for semester end examination)**
6. A food storage locker requires a refrigeration system of 2400 kJ/min. capacity at an evaporator temperature of 263 K and a condenser temperature of 303 K. The refrigerant used is freon-12 and is subcooled by 6°C before entering the expansion valve and vapour is superheated by 7°C before leaving the evaporator coil. The compression of refrigerant is reversible adiabatic. The refrigeration compressor is two-cylinder single-acting with stroke equal to 1.25 times the bore and operates at 1000 r.p.m.

Properties of freon-12

Saturation temp, K	*Absolute pressure, bar*	*Specific volume of vapour, m^3/kg*	*Enthalpy, kJ/kg*		*Entropy, kJ/kg K*	
			Liquid	*Vapour*	*Liquid*	*Vapour*
263	*2.19*	*0.0767*	*26.9*	*183.2*	*0.1080*	*0.7020*
303	*7.45*	*0.0235*	*64.6*	*199.6*	*0.2399*	*0.6854*

Take : Liquid specific heat = 1.235 kJ/kg K ; Vapour specific heat = 0.733 kJ/kg K.

7. Analyze the refrigerating effect per kg and theoretical power required to run the compressor, in kW. Also compare between sub-cooling and superheating with the help of p-h and T-S diagram. Superheating considered to be good in certain cases, Justify it. **(For Open Book Examination and not for semester end examination)**

21ME015 Industrial IOT for Manufacturing

3 0 0 3

Course Outcome(s)

1. Explain the basic concept of IoT System.
2. Implement the M2M Communication protocols in a prototype
3. Understand the basic concepts of the main sensors used in electromechanical systems
4. Implement computer models of common engineering information types.
5. Illustrate the concept of Privacy, Security and Governance of IoT
6. Analysis algorithms for data management in distributed & data intensive applications.

COs – POs Mapping

COs	PO_1	PO_2	PSO_1	PSO_2
1	2	-	2	2
2	2	-	2	2
3	2	-	2	2
4	3	2	3	3
5	3	2	3	3
6	3	3	3	3

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit 1

IoT & Automatic Storage Management- Introduction, Physical design of IoT, Logical design of IoT, IoT enabling technologies, Domain specific IoTs ,IoT design methodology, logical design ,IoT physical devices (such as Raspberry Pi, pcDuino, Beaglebone black, Cubieboard) , Introduction to cloud computing: cloud models, Relational Databases in the Cloud, Automatic Storage Management in the Cloud ,cloud based services & applications, Introduction to M2M, Description of M2M Market, Segments/Applications – Automotive, Smart Telemetry, Surveillance and Security, M2M Industrial Automation.

M2M Terminals and Modules

12 hours

Unit 2

Mechatronic Systems Design & Information Systems in Manufacturing- Introduction: Mechatronics, history, applications, and trends, Sensors and transducers, Signal conditioning, Mechanical components, Software development, Pneumatic and hydraulic actuators, Manufacturing organizations, management, and the networked enterprises, Globalization challenges and opportunities, Dimensions of Information systems, Approaches to study information system, Technical and behavioural approach

12 hours

Unit 3

Internet of Things Privacy, Security and Governance- Introduction, Overview of Governance, Privacy and Security Issues, Contribution from FP7 Projects, Security, Privacy and Trust in IoT-Data-Platforms for Smart Cities, First Steps Towards a Secure Platform, Smartie Approach. Data Aggregation for the IoT in Smart Cities, Security, Online Predictive Modelling, Monitoring and Intelligent Control of Machining/Manufacturing and Logistics/Supply Chain Processes

Smart Energy Management of manufacturing processes and facilities

12 hours

Unit 4

Analytics & Systems of Big Data**-** Mapreduce abstraction, Google paper, Google systems, GFS, BigTable, Cluster and Data center network, Distributed Storage, Facebook photo storage, Azure storage systems. Data deduplication storage systems, Venti and DDFS, Data pre-processing, predictive techniques, association rules, classification, clustering, supervised v/s unsupervised learning, algorithms, domain specific feature extraction, similarity measures, Shingles and minhashing, locality sensitive hashing, Dimensionality reduction techniques, Clustering in high dimensional space

Web link analysis

12 hours

Total: 48 Hours

Textbook(s)

1. A. McEwen and H. Cassimally, Designing the Internet of Things, 1st edition, Wiley, 2013, ISBN-10: 111843062X

2. 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
3. M. Kuniavsky, Smart Things: Ubiquitous Computing User Experience Design, 1st edition, Morgan Kaufmann, 2010, ISBN-10: 0123748992
4. Bahga and V. Madisetti, Internet of Things, A hands-on approach, CreateSpace Independent Publishing Platform, 1st edition, 2014, ISBN: 978-0996025515

Reference(s)

1. D. Boswarthick, O. Elloumi, and O. Hersent, M2M communications: A systems approach, Wiley, 1st edition, 2012, ISBN: 978-1119994756
2. J. Edward Carryer, et al., Introduction to Mechatronic Design, Prentice Hall, 1st edition, 2010, ISBN: 978-8131788257
3. K. Laudon and J. Laudon, Management Information Systems, 14th edition, Pearson Higher Education,2016, ISBN: 9780136093688
4. A Rajaraman, J. Leskovec, J. Ullmann, Mining of Massive Data sets, Cambridge University Press, 2011, ISBN: 1107015359

Sample Question(s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember			--
Understand	40	20	--
Apply	60	40	50
Analyze	--	40	50
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Remember

1. Define IETF. And OGC
2. List out the major objectives of high level ETSI architecture.
3. Summarize the layers of IETF architecture of IoT
4. Classify the perception layer in IoT

Understand

1. Write a detailed note on IETF architecture for IoT.
2. Explain the OGC architecture in detail.
3. Explain the OGC sensor things API
4. Describe in detail about the IoT reference model
5. Examine the Domain model in IoT.

Apply

1. Construct the Design of Smart home with Raspberry Pi and other hardware devices with neat sketch
2. Explain the implementation of IoT technology in following areas: (i) Smart Parking (ii)Smart Lightening (iii) Emergency response (iv) smart roads in smart cities
3. Describe how the IoT technology can be implemented in smart appliances and smoke/gas detection systems.

Analyse

1. Analyze the OGC requirements baseline for geospatial interoperability
2. Describe the following steps involved in IoT system design methodology: (i) Information model Specification (ii) Service Specifications
3. Describe the following steps involved in IoT system design methodology: (i) Purpose & Requirements Specification (ii) Process Specification

Open Book Exam

1. Describe the implementation of IoT technology into distributed energy systems to optimize the efficiency of energy infrastructure and reduce wastage in the following categories: (i) Smart grids (ii) Renewable energy systems (iii) Prognostics.
2. With the help of following sectors explain how IoT technology is impacting on the end-to-end value chain in the logistics sector : (i)Route generation & scheduling (ii) Fleet tracking (iii) Shipment monitoring (iv) Remote vehicle diagnostics

3. Describe how the environment can be more protected with the help of IoT technology in the following categories: (i) Air pollution monitoring (ii) Noise pollution monitoring (iii) Forest fire detection (iv) River flood detection

21ME016 Quality Engineering

3 0 0 3

Course Outcome(s)

1. Apply the quality engineering tools and techniques for improving quality
2. Demonstrate the philosophy and approach of TQM
3. Apply benchmarking, BPR and FMEA processes for effective quality management
4. Apply the contemporary trends in Quality Engineering & Management for productivity improvement
5. Use six sigma approach for various industrial applications
6. Explain standards for total quality management in various service sectors

COs- POs Mapping

COs	PO_1	PO_5	PO_{10}	PO_{11}	PO_{12}
1	3	2	3	3	3
2	3	1	3	3	3
3	3	2	3	3	3
4	3	2	3	3	3
5	3	2	3	3	3
6	3	2	3	3	3

3 Strongly linked | 2 Moderately linked | 1 Weakly linked

Unit 1

Quality Engineering and Management Tools and Techniques- 7 QC tools, 7 New Quality Management Tools, 5S Technique, Kaizen, Poka-Yoke, Quality Circle, Cost of Quality Technique. KANO Quality model. Quality measurement systems (QMS) Developing and implementing QMS non-conformance database, inspection, nonconformity reports, QC, QA, quality costs, tools of quality

12 Hours

Unit 2

Total Quality Management- Basic Philosophy, Approach, Implementation Requirements & Barriers for TQM.
Designing for Quality- Introduction to Concurrent Engineering, Problem solving Methods, problem solving process, Taguchi approach, Achieving robust design, Quality Function Deployment (QFD)

12 Hours

Unit 3

Contemporary Trends in Quality Engineering & Management- Just in time (JIT) Concept, Lean Manufacturing, Agile Manufacturing, Total Productive Maintenance, Bench Marking, Business Process Re- engineering (BPR). Failure Mode and Effect Analysis (FMEA). Quality circles organization, focus team approach and Continuous improvement

12 Hours

Unit 4

Six Sigma Approach- Basic Concept, Principle, Methodology, Implementation, Scope, Advantages and Limitation. Application of six sigma approach to various industrial situations
Quality in Service Sectors- Characteristics of Service Sectors, Value engineering, supplier teaming, vendor appraisal and analysis, Quality Dimensions in Service Sectors, Measuring Quality in different Service Sectors

12 Hours

Total: 48 Hours

Textbook(s)

1. Dale H. Besterfiled, Total Quality Management, Pearson Education, 3rd Revised Edition, 2011
2. Subbaraj Ramasamy, Total Quality Management, Tata McGraw Hills, New Delhi, 4th Edition, 2012

Reference(s)

1. James R. Evans and William M. Lindsay, The Management and Control of Quality, 8th Edition, First Indian Edition, Cengage Learning, 2012.
2. K. C. Jain and A. K. Chitale, Quality Assurance and Total Quality Management, Khanna Publication, 3rd Edition, 2003
3. Suganthi, L and Anand Samuel, Total Quality Management, Prentice Hall (India) Pvt. Ltd., 3rd Edition, 2006
4. Douglas C. Montgomery, Design and Analysis of Experiments Minitab manual, John Wiley & Sons, 7th Edition, 2010
5. Narayana V. and Sreenivasan N.S., Quality Management Concepts and Tasks, New Age International, 1996.
6. Logothetis W, Management Total Quality, Prentice Hall of India, New Delhi, 1999.
7. Feigenbaum A.V., Total Quality Management, McGraw-Hill, 1991.

8. Vincent K. Omachonu and Joel E. Ross, Principles of Total Quality, 3rd Edition,Taylor & Francis, 2005.

Sample Question(s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	25	25	-
Understand	35	35	-
Apply	40	40	30
Analyze	-	-	70
Evaluate	-	-	-
Create	-	-	-
Total (%)	100	100	100

Remember

1. Examine the definitions of quality by the quality gurus
2. List out the basic concepts of TQM
3. Define quality policies and its objectives
4. Explain the five distinct dimensions of quality
5. Explain the purpose of different quality statements

Understand

1. Explain concepts of continuous improvement
2. Briefly explain the eight pillars of TPM
3. Contrast and compare Six Sigma with total quality management
4. Explain mutually beneficial supplier relationships

Apply

1. Discuss in detail about the various tasks of employee involvement
2. Point out the needed criteria's to be considered while developing performance measures in an organization
3. Enumerate the seven magnificent quality tools which form a significant part of the six-sigma tool kit
4. Discuss the eight quality principles of management on which ISO9000 is based

Analyze

1. List out essential steps for the quality planning in an organization.
2. Enumerate the 4 absolutes of quality management given by Crosby and also mention 14 steps to quality management.
3. Explain the three components of zero quality control.
4. In the manufacture of armatures for electric motors, inspection results pf 20 sample of each having 100 units of armatures in given in the following table. Calculate the average fraction defective and control limit. Construct a "p-chart" and comment about the process.

Sample No.	No of Defectives	Sample No.	No of Defectives
1	8	11	12
2	4	12	14
3	7	13	6
4	9	14	9
5	11	15	5
6	4	16	8
7	5	17	4
8	3	18	10
9	8	19	7
10	9	20	11

21ME003 Industrial Engineering & Management

3 0 0 3

Course Outcome(s)

1. Design organization structure and implement management principles in real time business environment
2. Establish layouts for different types of industries, manufacturing, process and service sectors
3. Elaborate productivity and profitability by implementing work study and SQC
4. Select and maintain skilled and sufficient manpower for various business proposals
5. Find total production time and cost by using networking techniques
6. Enunciate a best method of making a product in the production process

COs- POs Mapping

COs	PO_1	PO_{11}
1	3	2
2	3	2
3	3	1
4	3	2
5	2	1
6	3	1

3 Strongly linked | 2 Moderately linked | 1 Weakly linked

Unit I

Evolution of Management Thought-Organizational Structures - Douglas McGregor's Theory X and Theory Y, Maslow's Hierarchy of Human Needs, Systems Approach to Management. Designing. Basic concepts related to Organization, Depart mentation and Decentralization, Types of mechanistic and organic structures of organization (Line organization, Line and staff organization, functional organization, Committee organization, matrix organization, Virtual Organization) and their merits, demerits and suitability. Cellular Organization and team structure

12 Hours

Unit II

Facilities location- Work study - Plant location, definition, factors affecting the plant location, comparison of rural and urban sites methods for selection of plant, Matrix approach, Plant Layout; definition, objectives, types of production, types of plant layout, various data analyzing forms, travel chart. Definition, objectives, method study; definition, objectives, steps involved, various types of associated charts. Work measurement- definition, time study, steps involved, equipment, different methods of performance rating, allowances, standard time calculation. Work Sampling, definition, steps involved. Standard time calculations and differences with time study

12 Hours

Unit III

Materials Management-Quality Control- Objectives, Inventory, functions, types, associated costs, inventory classification techniques, EOQ, ABC and VED analysis. Inspection and quality control, types of inspections, Statistical Quality Control; techniques, variables and attributes, assignable and non assignable causes, variable control charts, and R charts, attributes control charts, p charts and c charts. sampling plans. Introduction to TQM, Quality Circles, ISO 9000 series procedures

12 Hours

Unit IV

Introduction to PERT / CPM-Introduction to Human Resource Management - Project management, network modelling: PERT/CPM Time and cost estimations. Functions of HRM, Job Evaluation, different types of evaluation methods, Job description, Merit Rating, difference with job evaluation. Different methods of merit ratings, wage incentives.

12 Hours
Total: 48 Hours

Textbook(s)

1. O.P. Khanna, Industrial Engineering and Management, S Chand & Co Publications, 3rd Edition, 2013
2. Teslang Martand, Industrial Engineering and Production Management, S Chand & Co Publications, 1st Edition, 2002
3. Phillip E Hicks, Industrial Engineering and Management; a new perspective, TMH publications, 2nd Edition, 1994
4. H.T. Amrine, J. A. Ritchey and O.S. Hulley, Manufacturing Organization and Management, Prentice-Hall, 2nd Edition, 1966

5. P.C. Tripathi and P.N. Reddy, Principles of Management, TMH Publications, 4th Edition, 2012

Reference(s)

1. H. Koontz & H. Weihrich, Essentials of Management, Tata McGraw Hill, 8th Edition, 2010
2. Paneer Selvam, Production and Operations Management, PHI, 3rd Edition, 2012

Sample Question (s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	35	35	-
Understand	45	35	20
Apply	20	30	80
Analyze	-	-	-
Evaluate	-	-	-
Create	-	-	-
Total (%)	100	100	100

Remember

1. List the five objectives of work study
2. List any four merits and demerits of committee organization
3. Define Mc-Gregor‟s theory X and theory Y
4. List the three types of plant layout
5. List any four functions of HRM
6. List the three functions of material management?

Understand

1. Explain the factors effecting plant locations
2. Explain about purchase management
3. Write about Statistical Quality Control-techniques
4. Compare the Mc-Gregor‟s Theory X and Theory Y

Apply

1. Explain the attribute charts
2. Compare the PERT and CPM
3. Explain about stores management and stores records
4. What are the different types of evaluation methods and explain them?
5. Identify duties of purchase manager

21ME017 Power Plant Engineering

0 0 0 3

Course Outcome(s)

1. Explain the construction, working principles of steam and hydroelectric power plants.
2. Describe the working principles of diesel and gas turbine power plants.
3. Explain the concepts of non-conventional energy sources.
4. Distinguish different technologies adopted in nuclear power plants.
5. Outline the pollution effects of different types of power plants.
6. Analyze the economics of power plants.

COs – POs Mapping

COs	PO_1	PO_2	PO_3	PO_6	PO_7
1	3	1	1	-	-
2	3	1	1	1	2
3	3	1	3	1	1
4	3	1	2	1	1
5	2	1	1	1	3
6	3	1	1	1	2

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

Unit I

Steam Power Plant- Overview of plant Layout, Working of different Circuits, coal handling, choice of handling equipment, Ash handling systems. Combustion Process overfeed and underfeed fuel beds, traveling grate stokers, spreader stokers, retort stokers, pulverized fuel burning system, cyclone furnace, FBC and Dust collectors.
Advanced resources and development of power.

12 Hours

Unit II

Diesel Power Plant- Introduction –Plant layout with auxiliaries – fuel supply system, air starting equipment – super charging

Gas Turbine Plant- Overview of gas turbine plant – classification - construction – Layout with auxiliaries – Principlesof working of closed and open cycle gas turbines. Combined Cycle Power Plants and comparison.
Design considerations of gas power plant.

12 Hours

Unit III

Hydro Electric Power Plant- Water power – Hydrological cycle flow measurement – Hydrographs – storage and Pondage – surge tanks.
Classification of hydroelectric power plants – Typical layouts – plant auxiliaries – plant operation pumped storage plants.
Power from Non-Conventional Sources- Utilization of Solar- Collectors- Principle of Working, Wind Energy – types – HAWT, VAWT -Tidal Energy. Direct Energy Conversion. Fuel cells and MHD generation.
Drainage area characteristics.

12 Hours

Unit IV

Nuclear Power plant- Nuclear fuel – fertile materials – Nuclear reactor – reactor operation. Types of reactors: Pressurized water reactor, Boiling water reactor, fast Breeder Reactor, Gas cooled Reactor.
Power plant economics and pollution - Capital cost, investment of fixed charges, operating costs, Load curves, load duration curve. Definitions of connected load, Maximum demand, demand factor, average load, load factor, diversity factor – related exercises.
Pollution - Introduction- pollution from thermal power plants-pollution from nuclear power plants-pollution from hydroelectric power plants.

12 Hours
Total: 48 Hours

Textbook(s)

1. R. K. Rajput, Power Plant Engineering, Lakshmi publications, 5th Edition, 2016.
2. P.C. Sharma, Power plant Engineering, S. K. Kataria & Sons, 4th Edition, 2013.
3. PK Nag, Power Plant Engineering, McGraw Hill Education, 4th Edition, 2017.

Reference(s)

1. K.K. Ramalingam, Power Plant Engineering, Scitech Publications, 1st Edition, 2010.
2. Subhash C. Arora, S. Domkundwar, Power Plant Engineering, Dhanpat Rai, 8th Edition, 2016
3. M.M. EL-Wakil, Power Plant Technology, McGraw-Hill Science, 1st Edition, 2002.
4. G. D. Rai, An Introduction to Power Plant Technology, Khanna Publications,3rd Edition, 1987.
5. C. Elanchezhian, B. Vijaya Ramnath & L. Saravana Kumar, Power Plant Engineering, I.K. International Publications, 1st Edition, 2011.

Sample Question(s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	50	40	--
Understand	40	50	--
Apply	10	10	50
Analyze	--	--	50
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Remember

1. Define load curve, average load, load factor.
2. State different cycles involved in steam power generation.
3. Define Rankin cycle.
4. State the construction and working of open and closed gas power plant.
5. Define solar constant.
6. List any three types of pollutants produced from power plants.

Understand

1. Explain the working principle of steam power plant.
2. Explain the working principle of gas power plant.
3. Derive load factor.
4. Classify different types of reactors and explain any one of them with neat sketch.
5. Explain the working of FBC with neat sketch.

Apply

1. In an open cycle regenerative gas turbine plant, the air enters the compressor at 1 bar abs 32°C and leaves at 6.9 bar abs. The temperature at the end of combustion chamber is 816°C. The isentropic efficiencies of compressor and turbine are resp 0.84 and 0.85. Combustion efficiency is 90% and the regenerator effectiveness is 60 percent, determine: (a) Thermal efficiency, (b) Air rate, (c) Work ratio.
2. A power station has to supply load as follows: The peak load on a power station is 30MW.the load having maximum demands of 5MW,10MW,5MW and 7MW are connected to the power station. The capacity of the power station is 40MW and annual load factor is 50%. Find: Average load on power station, Energy supplied per year, Demand factor.
3. A particular area can be supplied either by hydro station or steam station. The following data are available:

	Hydro	Steam
Capital cost /kW	Rs 2100	Rs 1200
Running cost /kWh	3.2 Paise	5 Paise
Interest and depreciation	7.5%	9%
Reserve capacity	33%	25%

   a. At what load factor the overall cost be the same in both cases?
   b. What would be the cost of generating 40 x 10^6 units at this load factor? **(for open book examination and not for semester end examination)**

21ME018 Supply Chain Management

0 0 0 3

Course Outcome(s)

1. Explain the strategies and models of Supply Chain Management
2. Apply the forecasting techniques to assess the demand requirements
3. Choose the criteria for Supply Chain Management decisions
4. Explain the transportation techniques and network modeling
5. Explain the production planning and scheduling techniques
6. Apply the appropriate Information Technology in Supply Chain Management requirements and decisions

COs POs Mapping

COs	PO_1	PO_2	PO_5	PO_{10}	PO_{11}	PO_{12}
1	3	-	-	1	2	-
2	3	3	-	1	2	-
3	3	3	-	2	2	-
4	3	3	-	1	2	1
5	3	3	-	1	2	1
6	3	-	3	2	2	1

3 Strongly linked | 2 Moderately linked | 1 Weakly linked

Unit 1

Introduction to Supply Chain Management: Supply Chain Management Introduction, Basics of Supply Chain Management, Supply Chain Decisions, Views of SCM, Supply Chain Management Metrics, Factors influencing the distribution networks. The role of material management in SCM, SCM Models, Strategies of SCM, Drivers of SCM, Procurement, Transportation and Inventory Strategies for Optimal Criteria, Inbound Logistics, Operations, Outbound Logistics.

Supply chain management applications

12 Hours

Unit 2

Designing and Managing the Supply Chain: Supply chain design, Network design and operation models. Sourcing and Transportation, Role of sourcing, Supplier selection and contracts, Procurement process, Role of transportation, Design options for transportation network. Planning and Managing Inventories,Introduction, cycle/safety/seasonal stock.

Qualitative methods and quantitative methods

12 Hours

Unit 3

Inventory Management in Supply Chains: Cycle inventory, economies of scale to exploit fixed costs, quantity discounts, example problems, multi echelon inventory, safety inventory in supply chain, safety level estimation, supply uncertainty, data aggregation, replenishment policies, managing safety inventory in practice, product availability, optimal level, affecting factors, supply chain contracts , Bull whip effect.

Advanced Inventory models

12 Hours

Unit 4

Information Technology in SCM: Information Technology in SCM, Role of IT, Infrastructure, Interface devices, System architecture, Electronic commerce, IT for supply chain excellence , Service oriented architecture ,Radio Frequency Identification (RFID) , Impact of internet. E business and future trends. Supply chain innovations, Introduction, Supply chain integration, Restructuring, Agile supply chains.

Working knowledge of SAP software

12 Hours

Total: 48 Hours

Textbook(s)

1. Sunil Chopra & Peter Meindl: Supply Chain Management: Strategy, Planning and Operation, Pearson, Education, 3rd Edition 2007.
2. Chopra Sunil, Meindl Peter and Kalara D.V., Supply Chain Management, Strategy, Planning and Operation" Pearson Education Inc, 6th Edition, 2016
3. Simchi Levi Davi, Kaminsky Philip and Simchi-Levi Edith, "Designing and Managing the Supply Chain", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2012.

Reference(s)

1. Donal J. Bowersox, David J. Closs, M. Bixby Cooper, Supply Chain Logistics Management, Tata McGraw Hill, 2nd Edition. 2007.
2. Ronald H. Ballou, Business Logistics and Supply Chain Management, Pearson Education, 5th Edition, 2004

Sample Question(s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	30	20	-
Understand	40	50	-
Apply	30	30	50
Analyze	-	-	50
Evaluate	-	-	-
Create	-	-	-
Total (%)	100	100	100

Remember

1. What are the differences between Pull and Push type of models?
2. Define Supply Chain Management.
3. List any two forecasting techniques.
4. List any four software packages for SCM.

Understand

1. Explain the views of SCM.
2. Explain the steps involved in SCM process.

Apply

1. Apply the information technology tools and packages for SCM process.

Analyze

1. Analyze the issues in traditional SCM process.

Evaluate

1. Evaluate the optimal criteria for Supply Chain Management decisions
2. Take any industrial organization and explain its supply chain management system with all strategies as a case study**(for open book examination and not for semester end examination)**

21ME019 Industrial Tribology

0 0 0 3

Course Outcome(s)

1. Explain fundamentals of the tribology and its applications
2. Identify the materials used for bearings and types of bearing oil pads
3. Apply hydrostatic and hydrodynamic theory of lubrication in tribology
4. Analyze the friction and power losses in journal bearings
5. Explain the air lubricated bearings
6. Explain the concepts of boundary friction and dry friction

Co-Po Mapping

COs	PO_1	PO_2	PO_3	PO_{12}
1	3	1	1	1
2	3	2	1	2
3	3	3	2	2
4	3	3	2	2
5	3	1	1	1
6	3	1	1	1

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit I

Introduction: Study of various parameters: Viscosity, flow of fluids, viscosity and its variation -absolute and kinematic viscosity, temperature variation, viscosity index determination of viscosity, different viscometers used Bearing materials: General requirements of bearing materials, types of bearing materials Types of bearing oil pads: Hydrostatic bearing wick oiled bearings, oil rings, pressure feed bearing, partial bearings
Externally pressurized bearings

12 Hours

Unit II

Hydrostatic and Hydrodynamic theory of lubrication: Hydrostatic lubrication: Hydrostatic step bearing, application to pivoted pad thrust bearing and other applications, hydrostatic lifts, hydrostatic squeeze films and its application to journal bearing. Hydrodynamic theory of lubrication: Various theories of lubrication, petroffs equation, Reynold's equation in two dimensions
Minimum oil film thickness

12 Hours

Unit III

Friction and power losses in journal bearings: Calibration of friction loss friction in concentric bearings, bearing modulus, Sommerfeld number, heat balance Practical consideration of journal bearing design considerations

12 Hours

Unit IV

Air Lubricated bearings: Applications of Hydrodynamic journal bearings, hydrodynamic thrust bearings. Hydrostatic thrust bearings. Hydrostatic bearing Analysis including compressibility effect. Study of current concepts of boundary friction and dry friction
Advantages and disadvantages of hydrodynamic journal bearing

12 Hours
Total: 48 hours

Textbook(s)

1. Fundamentals of Tribology, Basu, SenGupta and Ahuja, , PHI,1st Edition, 2011
2. Tribology in Industry, Sushil Kumar Srivatsava, , S. Chand & Co, 1st Edition, 2011

Reference(s)

1. Introduction to Tribology of Bearings, B.C. Majumdar, S Chand and Company, 2nd Edition, 2008
2. Prasanta Sahoo, Engineering Tribology, PHI India,1st Edition, 2005Web Reference (s)

Sample Question(s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	35	25	-
Understand	45	45	-

Apply	20	30	50
Analyze	-	-	50
Evaluate	**-**	**-**	-
Create	**-**	**-**	-
Total (%)	**100**	**100**	**100**

Remember

1. Define tribology
2. State adhesion theory
3. Define viscosity
4. State stick-slip theory
5. Define flash point
6. List the factors that affect viscosity

Understand

1. Explain Petroffs equation
2. Explain flow through a capillary tube
3. Derive the equation for flow of viscous liquid through a wide rectangular slot
4. Classify the different types of viscometers

Apply

1. Following data is given for a hydrostatic, flat, foot-step bearing

   Shaft diameter = 60 mm
   Step diameter = 40 mm
   Thrust load = 5000 N
   Minimum oil-film thickness = 150 microns
   Viscosity of oil = 20 MPa
   Shaft speed = 1500 r.p.m

   Calculate, Quantity of oil supplied to the bearing and total power lost in the bearing
2. Following data is given for a hydrostatic thrust bearing:
   Shaft diameter = 450 mm; Recess diameter = 250 mm; Shaft speed = 750 r.p.m; Thrust load = 900 kN Viscosity of lubricant = 3cp ; Calculate (i) The optimum film thickness for minimum energy losses (ii) The total power loss (iii) Temperature rise
3. A step bearing supports the vertical shaft of a turbo-generator. The recess diameter to shaft diameter ratio is 0.6 and supply pressure is 5 MPa. The thrust load is 400 kN. The shaft rotates at 800 r.p.m. If the viscosity of oil is 30 cP. Calculate optimum oil-film thickness to be maintained so that the total power loss in the bearing is minimum.

Analyze

1. A circular hydrostatic bearing with an outside diameter of 140 mm, recess diameter of 50 mm and rotating at 600 rpm supports a load of 50 kN. The bearing is lubricated by a mineral oil of density 700 kg/m^3 delivered to the bearing by a constant flow rate delivery pump operating at 30x10-9 m3/s. The operating temperature of the bearing is 30 deg.C. Calculate and analyse the recess pressure. Select an SAE oil such that the film thickness will never be less than 10 micro meters.
   2. Show that the generalized Reynolds equation is

$$\frac{\partial}{\partial x}\left(\frac{\rho h^3}{12\eta}\frac{\partial p}{\partial x}\right)+\frac{\partial}{\partial z}\left(\frac{\rho h^3}{12\eta}\frac{\partial p}{\partial z}\right)=\frac{\partial}{\partial x}\left[\frac{\rho(u_a+u_b)h}{2}\right]+\frac{\partial}{\partial z}\left[\frac{\rho(w_a+w_b)h}{2}\right]+\frac{\partial(\rho h)}{\partial t}$$

2. Compare between hydrostatic and hydrodynamic mode of lubrication and its application areas
3. Justify the statement with proper reasoning whirl instability influences the performance of air lubricated bearings.

21ME004 Total Quality Management

0 0 0 3

Course Outcome(s)

1. Demonstrate the demining philosophy as a frame work for TQM
2. Identify customer needs to enhance the quality management
3. Appraise the employee's involvement critically for effective team work requirements
4. Describe several techniques of quality management tools
5. Apply benchmarking and FMEA processes for effective quality management.
6. Apply ISO standards for design and development of products and services.

COs-POs Mapping

COs	PO_1	PO_{11}
1	2	3
2	1	3
3	2	1
4	3	2
5	2	1
6	3	1

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit I

Introduction- Definition and principles of quality Evolution of Quality Quality Planning Quality policies and objectives. Dimensions of product and service quality. Contributions of Demeing, Juran and Crosby Customer focus. Customer stratification, Customers complaints and Customer retention.

Basic concepts of TQM, Barriers to TQM, customer feedback.

Unit II

TQM Principles-Employee's- Motivation, Empowerment, Team & Team work, Recognition and Reward, Performance appraisal Benefitsof employee's involvement, performance measure, balance score card, Continuous Process Improvement, PDCA cycle, Kaizen 5s, Reengineering Supplier relationship Partnering, Supplier selection, Supplier rating.

Unit III

TQM Techniques- New management tools, New and old 7 QC tools, an affinity diagram, tree diagram, matrix diagram, Six sigma methodology, infrastructure, implementation, Bench marking, process, Taguchi philosophy of quality control.

TPM concepts, improvement needs

Unit IV

Quality System- Need for ISO 9000 system, Advantages, Clauses of ISO 9000, Implementation of ISO 9000, Quality costs, Quality auditing, Case studies of TQM implementation in manufacturing and service sectors including IT industry.

Need for quality system, Principles, Revision standards.

Total: 48 Hours

Textbook(s)

1. Dale H. Besterfiled, Total Quality Management, Pearson, 3rd Revised Edition, 2011
2. Subbaraj Ramasamy, Total Quality Management, Tata McGraw Hills, New Delhi, 4th Edition, 2012

Reference(s)

1. James R. Evans and William M. Lindsay, The Management and Control of Quality, 8th Edition, Fist Indian Edition, Cengage Learning, 2012
2. K. C. Jain and A. K. Chitale, Quality Assurance and Total Quality Management, Khanna Publication, 3rd Edition, 2003
3. Suganthi, L and Anand Samuel, Total Quality Management, Prentice Hall (India) Pvt. Ltd., 3rd Edition, 2006
4. Douglas C. Montgomery, Design and Analysis of Experiments Minitab manual, JWS, 7th Edition, 2010

Web Reference(s)

1. https://archive.nptel.ac.in/courses/110/101/110101010/
2. https://archive.nptel.ac.in/courses/112/107/112107259/

Video Reference(s)

1. https://archive.nptel.ac.in/courses/112/106/112106249/
2. https://archive.nptel.ac.in/courses/112/106/112106253/

Sample Question(s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	25	35	-
Understand	35	25	20
Apply	40	40	80
Analyze	-	-	-
Evaluate	-	-	-
Create	-	-	-
Total (%)	100	100	100

Remember

1. Examine the definitions of quality by the quality gurus
2. List out the basic concepts of TQM
3. Define quality policies and its objectives
4. Explain the five distinct dimensions of quality
5. Explain the purpose of different quality statements

Understand

1. Explain concepts of continuous improvement
2. Briefly explain the eight pillars of TPM
3. Contrast and compare Six Sigma with total quality management
4. Explain mutually beneficial supplier relationships

Apply

1. Discuss in detail about the various tasks of employee involvement.
2. Enumerate the seven magnificent quality tools which form a significant part of the six-sigma tool kit.
3. Discuss the eight quality principles of management on which ISO9000 is based.