KIT - Kalaignarkarunanidhi Institute of Technology

An Autonomous Institution

Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai
Accredited by NAAC with 'A' GRADE & NBA (AERO, CSE, ECE, EEE, MECH & MBA)
An ISO 9001 : 2015 Certified Institution, Coimbatore - 641 402.

Regulations, Curriculum & Syllabus - 2023

(For Students admitted from the Academic Year 2023-24 and onwards)

BACHELOR OF ENGINEERING DEGREE
IN
MECHANICAL ENGINEERING

Department of Mechanical Engineering

Vision and Mission of the Department

Vision	
◎	To enrich the students into a knowledgeable professionals and take a leading edge as a proficient Mechanical Engineers and Entrepreneurs to create a paradigm shift in their technical fields.

Mission	
◎	To provide quality education in the domain of Mechanical Engineering in a conductive environment for enabling the students to face challenging career in ethical manner.
◎	To inculcate technical knowledge to create a strong foundation for generating full–fledged professionals in the field of Mechanical Engineering.
◎	To foster the students with Entrepreneurship training through EDC, leadership qualities and communication skills to meet the global demands

Program Educational Objectives (PEO's)	
PEO 1	Graduates will have successful professional career in Mechanical Engineering or related disciplines.
PEO 2	Graduates will formulate, analyze and solve real – world problems in Mechanical engineering to meet global challenges.
PEO 3	Graduates will have awareness and commitment to lifelong learning and professional ethics in their professional practice.

Programme Outcomes (PO's)	
Students graduating from Mechanical Engineering should be able to:	
PO 1	**Engineering knowledge :** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis :** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design / development of solutions :** 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 environmentalconsiderations.

PO 4	**Conduct investigations of complex problems :** 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.
PO 5	**Modern tool usage :** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO 6	**The engineer and society :** 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.
PO 7	**Environment and sustainability :** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics :** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work :** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication :** 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.
PO 11	**Project management and finance :** 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.
PO 12	**Life–long learning :** 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.

Program Specific Outcome (PSO's)	
Graduates of a Mechanical Engineering Programme should be able to	
PSO 1	Apply the mechanical engineering principles to solve engineering problems utilizing advanced technology in the domain of design, thermal, fluid sciences and robotics.
PSO 2	Take part as an entrepreneur or professional in industries by applying manufacturing and management practices for the advancement of society and self.

BoS Chairman

Curriculum

Curriculum and Scheme of Assessment

(For Students admitted from the Academic Year 2023-24 and onwards)

Semester - I

Course Code	Course Name	CT	Instructional Hours					Assessment		
			CP	L	T	P	C	CIA	ESE	Total
B23IPT101	Induction Programme	HS	-	-	-	-	0	-	-	-
Theory / Theory with Practical										
B23ENT101	Professional English	HS	3	3	0	0	2	40	60	100
B23MAT101	Matrices and Differential Calculus	BS	4	3	1	0	4	40	60	100
B23MET101	Engineering Graphics	ES	5	3	2	0	4	40	60	100
B23HST101	தமிழர்மரபு / Heritage of Tamils	HS	1	1	0	0	1	40	60	100
B23CHI101	Engineering Chemistry	BS	4	2	0	2	4	50	50	100
B23CSI102	Problem Solving and Python Programming	ES	4	2	0	2	4	50	50	100
Practical										
B23MEP101	Engineering Practices Laboratory	ES	4	0	0	4	2	60	40	100
Total credits to be earned							21			

Semester - II

Course Code	Course Name	CT	Instructional Hours					Assessment		
			CP	L	T	P	C	CIA	ESE	Total
Theory / Theory with Practical										
B23MAT201	Integral Calculus and Complex Analysis	BS	4	3	1	0	4	40	60	100
B23HST201	தமிழரும் தொழில் நுட்பமும் / Tamils and Technology	HS	1	1	0	0	1	40	60	100
B23MET201	Engineering Mechanics	ES	4	3	1	0	4	40	60	100
B23CET201	Soft Skills	CEC	2	2	0	0	NC	100	-	100
B23ENI201	Professional Communication	HS	4	2	0	2	4	50	50	100
B23PHI101	Engineering Physics	BS	4	2	0	2	4	50	50	100
B23EEI202	Basics of Electrical and Electronics Engineering	ES	4	2	0	2	4	50	50	100
B23CEP202	Application Design and Development	CEP	1	1	0	0	NC	100	-	100
Total credits to be earned							21			

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Semester - III											
Course Code	Course Name	CT	Instructional Hours					Assessment		
			CP	L	T	P	C	CIA	ESE	Total
Theory / Theory with Practical										
B23MAT301	Transforms and Partial Differential Equation	**BS**	4	3	1	0	**4**	40	60	100
B23MET301	Engineering Thermodynamics	**PC**	4	3	1	0	**4**	40	60	100
B23MET302	Metal Cutting and Computer Aided Manufacturing	**PC**	3	3	0	0	**3**	40	60	100
B23MET303	Engineering Materials and Metallurgy	**PC**	3	3	0	0	**3**	40	60	100
B23MEI301	Fluid Mechanics and Machinery	**PC**	4	2	0	2	**4**	50	50	100
Practical										
B23MEP301	Manufacturing Technology Laboratory	**PC**	4	0	0	4	**2**	60	40	100
B23MEP302	Design Studio	**PC**	4	0	0	4	**2**	60	40	100
Total credits to be earned							**22**			

Semester - IV										
Course Code	Course Name	CT	Instructional Hours					Assessment		
			CP	L	T	P	C	CIA	ESE	Total
Theory / Theory with Practical										
B23MAT403	Numerical Methods	**BS**	4	3	1	0	**4**	40	60	100
B23MET401	Kinematics of Machinery	**PC**	3	2	1	0	**3**	40	60	100
B23MET402	Strength of Materials	**PC**	3	2	1	0	**3**	40	60	100
B23MET403	Thermal Engineering	**PC**	3	2	1	0	**3**	40	60	100
B23MET404	Manufacturing Processes	**PC**	3	3	0	0	**3**	40	60	100
B23MEI401	Mechanical Measurements and Metrology	**PC**	4	2	0	2	**4**	50	50	100
Practical										
B23MEP401	Strength of Materials Laboratory	**PC**	4	0	0	4	**2**	60	40	100
B23MEP402	Thermal Engineering Laboratory I	**PC**	4	0	0	4	**2**	60	40	100
B23CEP401	Professional Certificate Course	**CEC**	-	-	-	-	**1**	-	-	-
B23MCP401	Professional Development Course	**MC**	0	0	0	2	**1**	100	-	100
Total credits to be earned							**25**			
Summer Internship – THREE WEEKS (Review will be conducted in first week of Semester V and its credit will be included in Semester V)										

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Semester - V											
Course Code	Course Name	CT	Instructional Hours					Assessment		
			CP	L	T	P	C	CIA	ESE	Total
Theory / Theory with Practical											
B23MET501	Heat and Mass Transfer	**PC**	4	3	1	0	**4**	40	60	100
B23MET502	Design of Machine Elements	**PC**	4	3	1	0	**4**	40	60	100
B23MET503	Dynamics of Machines	**PC**	4	3	1	0	**4**	40	60	100
B23MET504	Digital Manufacturing and IoT	**PC**	3	3	0	0	**3**	40	60	100
	Professional Elective I	**PE**	3	3	0	0	**3**	40	60	100
	Open Elective I	**OE**	3	3	0	0	**3**	40	60	100
B23MCT50X	Mandatory Course I	**MC**	2	2	0	0	**NC**	100	-	100
B23MCT505	Holistic Insight into UN SDGs	**MC**	3	3	0	0	**NC**	100	-	100
Practical											
B23MEP501	Kinematics and Dynamics Laboratory	PC	4	0	0	4	2	60	40	100
B23MEP502	Thermal Engineering Laboratory II	PC	4	0	0	4	2	60	40	100
B23CEP501	Summer Internship	CEC	-	-	-	-	**1**	100	-	100
Total credits to be earned							**26**			

Semester - VI											
Course Code	Course Name	CT	Instructional Hours					Assessment		
			CP	L	T	P	C	CIA	ESE	Total
Theory / Theory with Practical											
B23MET601	Design of Transmission Systems	**PC**	4	3	1	0	**4**	40	60	100
B23MET602	Automation in Manufacturing	**PC**	3	3	0	0	**3**	40	60	100
B23MET603	Finite Element Analysis	**PC**	4	3	1	0	**4**	40	60	100
B23MET604	Artificial Intelligence in Manufacturing Systems	**PC**	3	3	0	0	**3**	40	60	100
	Professional Elective II	**PE**	3	3	0	0	**3**	40	60	100
	Open Elective II	**OE**	3	3	0	0	**3**	40	60	100
B23MCT60X	Mandatory Course II	**MC**	2	2	0	0	**NC**	100	-	100
B23MCT605	Cyber Safety Concepts	**MC**	3	3	0	0	**NC**	100	-	100
Practical											
B23MEP601	Simulation and Analysis Laboratory	**PC**	4	0	0	4	**2**	60	40	100
B23MEP602	Innovative Design Practices	**PW**	4	0	0	4	**2**	40	60	100
Total credits to be earned							**24**			

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Semester - VII										
Course Code	**Course Name**	**CT**	**Instructional Hours**					**Assessment**		
			CP	**L**	**T**	**P**	**C**	**CIA**	**ESE**	**Total**
Theory / Theory with Practical										
B23MGT701	Universal Human Values	**HS**	3	3	0	0	**2**	40	60	100
B23MET701	Total Quality Management	**PC**	3	3	0	0	**3**	40	60	100
B23MET702	Automobile Engineering	**PC**	3	3	0	0	**3**	40	60	100
	Professional Elective III	**PE**	3	3	0	0	**3**	40	60	100
	Professional Elective IV	**PE**	3	3	0	0	**3**	40	60	100
B23MEI701	Mechatronics and IoT	**PC**	4	2	0	2	**4**	40	60	100
Practical										
B23MEP701	Project work Phase I	**PW**	6	0	0	6	**4**	60	40	100
Total credits to be earned							**22**			

Semester - VIII										
Course Code	**Course Name**	**CT**	**Instructional Hours**					**Assessment**		
			CP	**L**	**T**	**P**	**C**	**CIA**	**ESE**	**Total**
Practical										
B23MEP801	Project Work Phase II	**PW**	16	0	0	16	**8**	60	40	100
Total credits to be earned							**8**			

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Vertical - 1	Vertical - 2	Vertical - 3	Vertical - 4	Vertical - 5	Vertical 6
Modern Mobility Systems	**Product and Process Development**	**Robotics and Automation**	**Process Equipment and Piping Design**	**Computational Engineering**	**Smart Cyber Physical Systems**
Automotive Materials, Components, Design & Testing	Value Engineering	Sensors and Instrumentation	Design of Pressure Vessels	Computational Solid Mechanics	Advanced Manufacturing Systems
Conventional and Futuristic Vehicle Technology	Additive Manufacturing	Electrical Drives and Actuators	Failure Analysis and NDT Techniques	Computational Fluid Dynamics and Heat transfer	Industrial IoT and Smart Sensors
Advanced Vehicle Engineering	CAD / CAM	Robots and Systems in Smart Manufacturing	Material Handling and solid processing Equipment	Theory on Computation and Visualization	Product Lifecycle Management and Digital Design
Vehicle Health Monitoring, Maintenance and Safety	Design For X	Robotics	Rotating Machinery Design	Computational Bio Mechanics	Robotics and Industrial Automation
CAE and CFD Approach in Future Mobility	Ergonomics in Design	Smart Mobility and Intelligent Vehicles	Thermal and Fired Equipment design	Advanced Statistics and Data Analytics	Smart Factory and Industry 4.0 Technologies
Hybrid and Electric Vehicle Technology	New Product Development	Haptics and Immersive Technologies	Industrial Layout Design and Safety	CAD and CAE	Manufacturing Data Analytics and AI
Thermal Management of Batteries and Fuel Cells	Product Life Cycle Management	Drone Technologies	Design Codes and Standards	Machine Learning for Intelligent Systems	Supply Chain Digitization and Smart Logistics
IoT for Electric Vehicles	Product Design and Optimization	Agricultural Robotics and Automation	Energy Conservation in HVAC System	Engineering Failure Analysis	Digital Twin and Simulation for Manufacturing

Registration of Professional Elective Courses from Verticals :

Professional Elective Courses will be registered in Semesters V and VI. These courses are listed in groups called verticals that represent a particular area of specialisation / diversified group. Students are permitted to choose all the Professional Electives from a particular vertical or from different verticals. Further, only one Professional Elective course shall be chosen in a semester horizontally (row wise). However, two courses are permitted from the same row, provided one course is enrolled in Semester V and another in semester VI.

The registration of courses for B.E. / B. Tech (Honours) or Minor degree shall be done from Semester V to VIII. The procedure for registration of courses explained above shall be followed for the courses.

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PROFESSIONAL ELECTIVE COURSES : VERTICALS

VERTICAL - 1 : MODERN MOBILITY SYSTEMS

Course Code	Course Name	CT	Instructional Hours					Assessment		
			CP	L	T	P	C	CIA	ESE	Total
B23MEE901	Automotive Materials, Components, Design and Testing	PE	3	3	0	0	3	40	60	100
B23MEE902	Conventional and Futuristic Vehicle Technology	PE	3	3	0	0	3	40	60	100
B23MEE903	Advanced Vehicle Engineering	PE	3	3	0	0	3	40	60	100
B23MEE904	Vehicle Health Monitoring, Maintenance and Safety	PE	3	3	0	0	3	40	60	100
B23MEE905	CAE and CFD Approach in Future Mobility	PE	3	3	0	0	3	40	60	100
B23MEE906	Hybrid and Electric Vehicle Technology	PE	3	3	0	0	3	40	60	100
B23MEE907	Thermal Management of Batteries and Fuel Cells	PE	3	3	0	0	3	40	60	100
B23MEE908	IoT for Electric Vehicles	PE	3	3	0	0	3	40	60	100

VERTICAL - 2 : PRODUCT AND PROCESS DEVELOPMENT

Course Code	Course Name	CT	Instructional Hours					Assessment		
			CP	L	T	P	C	CIA	ESE	Total
B23MEE909	Value Engineering	PE	3	3	0	0	3	40	60	100
B23MEE910	Additive Manufacturing	PE	3	3	0	0	3	40	60	100
B23MEE911	CAD/CAM	PE	3	3	0	0	3	40	60	100
B23MEE912	Design For X	PE	3	3	0	0	3	40	60	100
B23MEE913	Ergonomics in Design	PE	3	3	0	0	3	40	60	100
B23MEE914	New Product Development	PE	3	3	0	0	3	40	60	100
B23MEE915	Product Life Cycle Management	PE	3	3	0	0	3	40	60	100
B23MEE916	Product Design and Optimization	PE	3	3	0	0	3	40	60	100

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VERTICAL - 3 : ROBOTICS AND AUTOMATION										
Course Code	Course Name	CT	Instructional Hours					Assessment		
			CP	L	T	P	C	CIA	ESE	Total
B23MEE917	Sensors and Instrumentation	PE	3	3	0	0	3	40	60	100
B23MEE918	Electrical Drives and Actuators	PE	3	3	0	0	3	40	60	100
B23MEE919	Embedded Systems and Programming	PE	3	3	0	0	3	40	60	100
B23MEE920	Robotics	PE	3	3	0	0	3	40	60	100
B23MEE921	Smart Mobility and Intelligent Vehicles	PE	3	3	0	0	3	40	60	100
B23MEE922	Haptics and Immersive Technologies	PE	3	3	0	0	3	40	60	100
B23MEE923	Drone Technologies	PE	3	3	0	0	3	40	60	100
B23MEE924	Agricultural Robotics and Automation	PE	3	3	0	0	3	40	60	100

VERTICAL - 4 : PROCESS EQUIPMENT AND PIPING DESIGN										
Course Code	Course Name	CT	Instructional Hours					Assessment		
			CP	L	T	P	C	CIA	ESE	Total
B23MEE925	Design of Pressure Vessels	PE	3	3	0	0	3	40	60	100
B23MEE926	Failure Analysis and NDT Techniques	PE	3	3	0	0	3	40	60	100
B23MEE927	Material Handling and Solid Processing Equipment	PE	3	3	0	0	3	40	60	100
B23MEE928	Rotating Machinery Design	PE	3	3	0	0	3	40	60	100
B23MEE929	Industrial Layout Design and Safety	PE	3	3	0	0	3	40	60	100
B23MEE930	Design Codes and Standards	PE	3	3	0	0	3	40	60	100
B23MEE931	Thermal and Fired Equipment design	PE	3	3	0	0	3	40	60	100
B23MEE932	Energy Conservation in HVAC System	PE	3	3	0	0	3	40	60	100

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VERTICAL - 5 : COMPUTATIONAL ENGINEERING

Course Code	Course Name	CT	Instructional Hours					Assessment		
			CP	L	T	P	C	CIA	ESE	Total
B23MEE933	Computational Solid Mechanics	PE	3	3	0	0	3	40	60	100
B23MEE934	Computational Fluid Dynamics and Heat transfer	PE	3	3	0	0	3	40	60	100
B23MEE935	Theory on Computation and Visualization	PE	3	3	0	0	3	40	60	100
B23MEE936	Computational Bio-Mechanics	PE	3	3	0	0	3	40	60	100
B23MEE937	Advanced Statistics and Data Analytics	PE	3	3	0	0	3	40	60	100
B23MEE938	CAD and CAE	PE	3	3	0	0	3	40	60	100
B23MEE939	Machine Learning for Intelligent Systems	PE	3	3	0	0	3	40	60	100
B23MEE940	Engineering Failure Analysis	PE	3	3	0	0	3	40	60	100

VERTICAL - 6 : SMART CYBER PHYSICAL SYSTEMS

Course Code	Course Name	CT	Instructional Hours					Assessment		
			CP	L	T	P	C	CIA	ESE	Total
B23MEE941	Advanced Manufacturing Systems	PE	3	3	0	0	3	40	60	100
B23MEE942	Industrial IoT and Smart Sensors	PE	3	3	0	0	3	40	60	100
B23MEE943	Product Lifecycle Management (PLM) and Digital Design	PE	3	3	0	0	3	40	60	100
B23MEE944	Robotics and Industrial Automation	PE	3	3	0	0	3	40	60	100
B23MEE945	Smart Factory and Industry 4.0 Technologies	PE	3	3	0	0	3	40	60	100
B23MEE946	Manufacturing Data Analytics and AI	PE	3	3	0	0	3	40	60	100
B23MEE947	Supply Chain Digitization and Smart Logistics	PE	3	3	0	0	3	40	60	100
B23MEE948	Digital Twin and Simulation for Manufacturing	PE	3	3	0	0	3	40	60	100

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OPEN ELECTIVES (OE)											
SEMESTER - V											
ELECTIVE - I											
Course Code	Course Name	CT	Instructional Hours					Assessment		
			CP	L	T	P	C	CIA	ESE	Total
B23AEO501	Principles of Flight	OE	3	3	0	0	3	40	60	100
B23AGO501	Farm Automation	OE	3	3	0	0	3	40	60	100
B23ADO501	Gen AI With Open-Source Framework	OE	3	3	0	0	3	40	60	100
B23AMO501	Principles of Machine Learning	OE	3	3	0	0	3	40	60	100
B23BMO501	Principles of Biosensors	OE	3	3	0	0	3	40	60	100
B23BTO501	Biofertilizer Production and Mushroom Cultivation	OE	3	3	0	0	3	40	60	100
B23CSO501	Foundations of DBMS	OE	3	3	0	0	3	40	60	100
B23ECO501	Communication Engineering	OE	3	3	0	0	3	40	60	100
B23EEO501	Electric Vehicle Technology	OE	3	3	0	0	3	40	60	100
SEMESTER - V											
ELECTIVE - II											
Course Code	Course Name	CT	Instructional Hours					Assessment		
			CP	L	T	P	C	CIA	ESE	Total
B23AEO601	Unmanned Aircraft Systems Operation and MRO	OE	3	3	0	0	3	40	60	100
B23AGO501	Environmental Management in Agriculture	OE	3	3	0	0	3	40	60	100
B23ADO601	Human Computer Communication	OE	3	3	0	0	3	40	60	100
B23AMO601	AI for Smart Systems	OE	3	3	0	0	3	40	60	100
B23BMO601	Medical instrumentation	OE	3	3	0	0	3	40	60	100
B23BTO601	Bioinformatics	OE	3	3	0	0	3	40	60	100
B23CSO601	Foundations of Web Development	OE	3	3	0	0	3	40	60	100
B23ECO601	Foundations of Web Development	OE	3	3	0	0	3	40	60	100
B23EEO601	Green Electronics and Sustainable Technologies	OE	3	3	0	0	3	40	60	100

HUMANITIES AND SOCIAL SCIENCES (HS)										
Course Code	Course Name	CT	Instructional Hours					Assessment		
			CP	L	T	P	C	CIA	ESE	Total
B23IPT101	Induction Programme	HS	-	-	-	-	0	-	-	-
B23ENT101	Professional English	HS	3	3	0	0	2	40	60	100
B23HST101	தமிழர் மரபு / Heritage of Tamils	HS	1	1	0	0	1	40	60	100
B23HST201	தமிழரும் தொழில் நுட்பமும் / Tamils and Technology	HS	1	1	0	0	1	40	60	100
B23ENI201	Professional Communication	HS	4	2	0	2	4	50	50	100
B23MGT701	Universal Human Values	HS	3	3	0	0	2	40	60	100

BASIC SCIENCES (BS)										
Course Code	Course Name	CT	Instructional Hours					Assessment		
			CP	L	T	P	C	CIA	ESE	Total
B23MAT101	Matrices and Differential Calculus	BS	4	3	1	0	4	40	60	100
B23CHI101	Engineering Chemistry	BS	4	2	0	2	4	50	50	100
B23MAT201	Integral Calculus and Complex Analysis	BS	4	3	1	0	4	40	60	100
B23PHI101	Engineering Physics	BS	4	2	0	2	4	50	50	100
B23MAT301	Transforms And Partial Differential Equation	BS	4	3	1	0	4	40	60	100
B23MAT403	Numerical Methods	BS	4	3	1	0	4	40	60	100

ENGINEERING SCIENCES (ES)										
Course Code	Course Name	CT	Instructional Hours					Assessment		
			CP	L	T	P	C	CIA	ESE	Total
B23MET101	Engineering Graphics	ES	5	3	2	0	4	40	60	100
B23CSI102	Problem Solving and Python Programming	ES	4	2	0	2	4	50	50	100
B23MEP101	Engineering Practices Laboratory	ES	4	0	0	4	2	40	60	100
B23MET201	Engineering Mechanics	ES	4	3	1	0	4	40	60	100
B23EEI202	Basics of Electrical and Electronics Engineering	ES	4	2	0	2	4	50	50	100

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PROFESSIONAL CORE (PC)

Course Code	Course Name	CT	Instructional Hours				Assessment			
			CP	L	T	P	C	CIA	ESE	Total
B23MET301	Engineering Thermodynamics	PC	3	2	1	0	3	40	60	100
B23MET302	Manufacturing Processes	PC	3	3	0	0	3	40	60	100
B23MET303	Engineering Materials and Metallurgy	PC	3	3	0	0	3	40	60	100
B23MEI301	Fluid Mechanics & Machinery	PC	4	2	0	2	4	50	50	100
B23MEP301	Manufacturing Technology and CNC Laboratory	PC	4	0	0	4	2	60	40	100
B23MEP302	Design Studio	PC	4	0	0	4	2	60	40	100
B23MET401	Kinematics of Machinery	PC	4	3	1	0	4	40	60	100
B23MET402	Strength of Materials	PC	3	2	1	0	3	40	60	100
B23MET403	Thermal Engineering	PC	3	2	1	0	3	40	60	100
B23MET404	Metal Cutting and Computer Aided Manufacturing	PC	3	3	0	0	3	60	40	100
B23MEI401	Mechanical Measurements and Metrology	PC	4	2	0	2	4	50	50	100
B23MEP401	Strength of Materials Laboratory	PC	4	0	0	4	2	60	40	100
B23MEP402	Thermal Engineering Laboratory I	PC	4	0	0	4	2	60	40	100
B23MET501	Heat and Mass Transfer	PC	4	3	1	0	4	40	60	100
B23MET502	Design of Machine Elements	PC	3	2	1	0	3	40	60	100
B23MET503	Dynamics of Machines	PC	4	3	1	0	4	40	60	100
B23MET504	Digital Manufacturing and IoT	PC	3	3	0	0	3	40	60	100
B23MEP501	Kinematics and Dynamics Laboratory	PC	4	0	0	4	2	60	40	100
B23MEP502	Thermal Engineering Laboratory II	PC	4	0	0	4	2	60	40	100
B23MET601	Design of Transmission Systems	PC	4	3	1	0	4	40	60	100
B23MET602	Automation in Manufacturing	PC	3	3	0	0	3	40	60	100
B23MET603	Finite Element Analysis	PC	3	2	1	0	3	40	60	100
B23MET604	Artificial Intelligence in Manufacturing Systems	PC	3	3	0	0	3	40	60	100
B23MEP601	Simulation and Analysis Laboratory	PC	4	0	0	4	2	60	40	100
B23MET701	Total Quality Management	PC	3	3	0	0	3	40	60	100
B23MEI701	Mechatronics and IoT	PC	4	2	0	2	4	50	50	100
B23MET702	Automobile Engineering	PC	3	3	0	0	3	40	60	100

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PROJECT WORK (PW)										
Course Code	Course Name	CT	Instructional Hours					Assessment		
			CP	L	T	P	C	CIA	ESE	Total
B23MEP602	Innovative Design Practices	**PW**	4	0	0	4	**2**	60	40	100
B23MEP701	Project work Phase – I	**PW**	6	0	0	6	**2**	60	40	100
B23MEP801	Project Work Phase - II	**PW**	16	0	0	16	**8**	60	40	100

CAREER ENHANCEMENT COURSE (CEC)										
Course Code	Course Name	CT	Instructional Hours					Assessment		
			CP	L	T	P	C	CIA	ESE	Total
B23CET201	Soft Skills	**CEC**	2	2	0	0	**NC**	100	-	100
B23CEP202	Application Design and Development	**CEP**	1	1	0	0	**NC**	100	-	100
B23CEP401	Professional Certificate Course	**CEC**	-	-	-	-	**1**	-	-	-
B23CEP501	Summer Internship	**CEC**	-	-	-	-	**1**	-	-	-

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Syllabus

Semester – I

B.E. / B.Tech. (Except CSBS)	B23ENT101 PROFESSIONAL ENGLISH	L	T	P	C
		2	0	0	2

Course Objectives	
1.	To develop the listening and reading skills of first year engineering and technology students.
2.	To help learners' develop vocabulary through reading skills.
3.	To enhance learners' grammatical knowledge.
4.	To enhance the learners' ability of writing different complex texts.
5.	To develop the competency of learners through LSRW skills.

UNIT – I	6
Listening	Listening to voicemail & messages; Listening and contextualizing.
Speaking	Replying to polite requests and offers, understanding basic instructions.
Reading	Short comprehension passages, practice in skimming & scanning.
Writing	Writing Instructions.
Language development	Parts of Speech, Wh - Questions, yes or no questions, Question tags.
Vocabulary development	Prefixes - suffixes.

UNIT – II	6
Listening	Listening commentaries and announcements.
Speaking	Role Play exercises based on workplace contexts.
Reading	Comprehension questions including dialogues and conversations.
Writing	Writing different types of Paragraph.
Language development	Regular & Irregular Verbs, Tenses.
Vocabulary development	Understanding contextual meaning, Synonyms.

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UNIT – III	6
Listening	Listening to a product launch-sensitizing leaners to the nuances of persuasive communication.
Speaking	Debate - discussion on current issues.
Reading	Short texts and longer passages - note making.
Writing	Understanding text structure, use of reference words and discourse markers, jumbled sentences.
Language development	Idioms and Phrases, Degrees of comparison.
Vocabulary development	One word substitutes.

UNIT – IV	6
Listening	Listening to short academic videos.
Speaking	Making short presentation through short films.
Reading	Intensive and Extensive reading-reading different types of magazines.
Writing	Letter writing- formal and informal.
Language development	Direct / indirect questions.
Vocabulary development	Phrasal verbs

UNIT – V	6
Listening	Listening to talks/lectures by specialists on specific topics.
Speaking	Discussion on general and current topics.
Reading	Longer texts - cloze reading.
Writing	Writing short essays, developing outline, identifying main and subordinate ideas, Dialogue writing.
Language development	Spelling and Punctuations, Modal verbs.
Vocabulary development	Collocations
	Total Instructional hours : 30

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Course Outcomes : Students will be able to	
CO1	Develop listening and reading skills for effective communication
CO2	Develop vocabulary skills
CO3	Build grammatical understanding
CO4	Explain opinions efficiently in writing formal and informal contexts
CO5	Develop knowledge through LSRW skills

Text Books	
1.	Board of Editors Using English, “A Course book for Undergraduate Engineers and Technologists”, Orient Black Swan Limited, Hyderabad : 2015.
2.	Richards, C. Jack,“ Interchange Students Book - 2”, New Delhi, CUP, 2015.

Reference Books	
1.	Bailey, Stephen, “A practical guide for students”, New York Rutledge, 2011.
2.	Raman, Meenakshi and Sharma, Sangeetha “Technical Communication Principles and Practice” Oxford University Press: New Delhi, 2014.
3.	Dutt P. Kiranmai and Rajeevan Geeta, “Basic Communication Skills”, Foundation Books, 2013.

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B.E. / B.Tech.	B23MAT101 MATRICES AND DIFFERENTIAL CALCULUS (Common to all Branches)	L	T	P	C
		3	1	0	4

Course Objectives	
1.	To develop the use of matrices that is needed by engineers for practical applications.
2.	To understand the concept of functions of several variables.
3.	To recognize and classify ordinary differential equations.
4.	To apply the concept of ordinary differential equations in engineering disciplines.
5.	To learn the applications of Laplace transforms in engineering.

UNIT - I	MATRICES	12
Eigen values and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigen values and Eigenvectors – Cayley Hamilton theorem – Quadratic form: Nature, Reduction to canonical form by orthogonal transformation		

UNIT - II	FUNCTIONS OF SEVERAL VARIABLES	12
Partial differentiation –Total derivative – Jacobians – Taylor's series expansion for functions of two variables – Maxima and minima of functions of two variables – Lagrange's method of undetermined multipliers		

UNIT - III	ORDINARY DIFFERENTIAL EQUATIONS	12
Higher order linear ordinary differential equations with constant coefficients - Method of variation of parameters - Simultaneous differential equations		

UNIT - IV	APPLICATIONS OF ORDINARY DIFFERENTIAL EQUATIONS	12
Solution of specified differential equations connected with electric circuits - Law of Natural growth and decay - Simple harmonic motion (Differential equations and associated conditions need to be given)		

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UNIT - V	LAPLACE TRANSFORM	12
Existence conditions - Properties (excluding proofs) - Transform of standard functions -Transforms of derivatives and integrals - Inverse Laplace transform - Applications to solution of linear second order ordinary differential equations with constant coefficients		
		Total Instructional hours : 60

Course Outcomes : Students will be able to	
CO1	Make use of Eigen values and Eigen vectors to reduce the quadratic form into canonical form and to find the powers of a square matrix.
CO2	Construct maxima and minima problems.
CO3	Solve differential equations which existing in different engineering disciplines.
CO4	Develop the applications of differential equations in various engineering field.
CO5	Apply Laplace transform and inverse transform to solve differential equations with constant coefficients.

Text Books	
1.	Grewal B.S.,“Higher Engineering Mathematics”, Khanna Publishers, New Delhi, 43rd Edition, 2015.
2.	Bali N., Goyal M. and Watkins C., “Advanced Engineering Mathematics”, Firewall Media - An imprint of Lakshmi Publications Pvt., Ltd., New Delhi, 7th Edition, 2015.
3.	Kreyszig Erwin, "Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2015.
4.	George B. Thomas, Joel Hass, Christopher Heil, Maurice D. Weir, “Thomas' Calculus”, Pearson, 14th Edition, 2018.

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Reference Books	
1.	Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", Narosa Publications, New Delhi, 5th Edition, 2019.
2.	Srimantha Pal and Bhunia, S.C, "Engineering Mathematics" Oxford University Press, 2015.
3.	Ramana B V., "Higher Engineering Mathematics", Tata Mc Graw Hill Publishing Company, New Delhi, 2017.
4.	Veerarajan T., "Engineering Mathematics for Semester I and II", Tata Mc Graw Hill Publishing Company, New Delhi, 2019.
5.	Gean Duffy., "Advanced Engineering Mathematics with MATLAB", A CRC Press Company, Boca Raton London, New York Washington, D.C, 2nd edition 2009. (Free e-book downloaded from www.EasyEngineering.net.pdf).

Approved by BoS Chairman

B.E / B.Tech	B23MET101 ENGINEERING GRAPHICS (Common to All)	L	T	P	C
		2	2	0	4

Course Objectives	
1.	Understand the conventions and method of Engineering drawing.
2.	Construct and interpret the basic Engineering drawings.
3.	Improve their visualization skills so that they can apply these skills in new product development.
4.	Enhance their technical communication skill in the form of communicative drawings.
5.	Comprehend the theory of projection.

CONCEPTS AND CONVENTIONS (NOT FOR EXAMINATION)	2
Importance of graphics in Engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning	

UNIT - I	PLANE CURVES AND FREE HANDSKETCHING	14
Basic Geometrical constructions, Curves used in Engineering practices-Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of square and circle – Drawing of tangents and normal to the above curves. Visualization concepts and Free Hand sketching: Visualization principles – Representation of Three-Dimensional objects – Layout of views- Free hand sketching of multiple views from pictorial views of objects		

UNIT - II	PROJECTION OF POINTS, LINES AND PLANE SURFACE	14
Orthographic projection- principles-Principal planes-First angle projection-Projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes- Determination of true lengths and true inclinations by rotating line method and trapezoidal method and traces Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method		

UNIT - III	PROJECTION OF SOLIDS	14
Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to both the principal planes by rotating object method and auxiliary plane method		

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UNIT - IV	PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES	14
Sectioning of solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones		

UNIT - V	ISOMETRIC AND PERSPECTIVE PROJECTIONS	14
Principles of isometric projection – isometric scale –Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions and miscellaneous problems. Perspective projection of simple solids-prisms, pyramids and cylinders by visual ray method		

COMPUTER AIDED DRAFTING	3
Introduction to drafting packages and demonstration of their use Basic Geometrical constructions using AUTOCAD	
Total Instructional hours : 75	

Course Outcomes : Students will be able to	
CO1	Construct the basic Engineering curves and freehand sketching of basic geometrical constructions and multiple views of objects.
CO2	Draw problems related to projections of points, straight lines, planes and solids.
CO3	Build the projection of simple solids.
CO4	Apply the knowledge acquired on practical applications of sectioning and development of solids.
CO5	Construct simple solids and its sections in isometric view and projections and to draw its perspective views.

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Text Books	
1.	K.V.Natarajan, "A text book of Engineering Graphics", 28^{th} Edition, Dhana Lakshmi Publishers, Chennai, 2015.
2.	N.D. Bhatt and V.M. Panchal, "Engineering Drawing", Charotar Publishing House, 53^{rd} Edition, 2014.

Reference Books	
1.	K. Venugopal and V.Prabhu Raja, "Engineering Graphics", New Age International Publishers, 2017.
2.	K.R.Gopalakrishna., "Engineering Drawing" (Vol. I & II combined) Subhas Publications, Bangalore, 2018.
3.	N.S Parthasarathy and Vela Murali, "Engineering Drawing", Oxford University Press, 2015.

Approved by BoS Chairman

B.E. / B.Tech.	B23HST101 தமிழர் மரபு	L	T	P	C
		1	0	0	1

அலகு – I	மொழி மற்றும் இலக்கியம்	3

இந்திய மொழிக் குடும்பங்கள் - திராவிட மொழிகள் - தமிழ் ஒரு செம்மொழி - தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை - சங்க இலக்கியத்தில் பகிர்தல் அறம் - திருக்குறளில் மேலாண்மைக் கருத்துக்கள் - தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் - சிற்றிலக்கியங்கள் - தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி - தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு

அலகு – II	மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக்கலை	3

நடுகல் முதல் நவீன சிற்பங்கள் வரை - ஐம்பொன் சிலைகள் - பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் - தேர் செய்யும் கலை - சுடுமண் சிற்பங்கள் - நாட்டுப்புறத் தெய்வங்கள் - குமரிமுனையில் திருவள்ளுவர் சிலை - இசைக் கருவிகள் - மிருதங்கள், பறை, வீணை, யாழ், நாதஸ்வரம் - தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு

அலகு – III	நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்	3

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்

அலகு – IV	தமிழர்களின் திணைக் கோட்பாடுகள்	3

தமிழகத்தின் தாவரங்களும், விலங்குகளும் - தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் - தமிழர்கள் போற்றிய அறக்கோட்பாடு - சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் - சங்ககால நகரங்களும் துறை முகங்களும் - சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி - கடல் கடந்த நாடுகளில் சோழர்களின் வெற்றி

அலகு – V	இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு	3

இந்திய விடுதலைப் போரில் தமிழர்களின் பங்கு - இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டில் தாக்கம் - சுயமரியாதை இயக்கம் - இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு - கல்வெட்டுகள், கையெழுத்துப் படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு

மொத்தம் – 15 காலங்கள்

Approved by BoS Chairman

Text - Cum - Reference Books	
1.	தமிழக வரலாறு - மக்களும் பண்பாடும் - கே.கே. பிள்ளை (வெளியீடு - தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)
2.	கணினித் தமிழ் - முனைவர் இல.சுந்தரம் (விகடன் பிரசுரம்)
3.	கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4.	பொருநை - ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)
5.	Social Life of Tamils (Dr. K.K. Pillay) A joint publication of TNTB & ESC and RMRL - (in print)
6.	Social Life of the Tamils - The Classical Period (Dr. S. Singaravelu) (Published by : International Institute of Tamil Studies.
7.	Historical Heritage of the Tamils (Dr. S.V. Subatamanian, Dr. K.D. Thirunavukkarasu) (Published by : International Institute of Tamil Studies).
8.	The Contributions of the Tamils to Indian Culture (Dr. M. Valarmathi) (Published by : International Institute of Tamil Studies).
9.	Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by : Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10.	Studies in the Histroyb of India with Special Reference to Tamil Nadu (Dr. K.K. Pillay) (Published by : The Author)
11.	Porunai Civilization (Jointly Published by : Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12.	Journey of Civilization Indus to Vaigai (R. Balakrishnan) (Published by : RMRL) - Reference Book.

Approved by BoS Chairman

B.E. / B.Tech.	B23HST101 HERITAGE OF TAMILS (Common to all Branches)	L	T	P	C
		1	0	0	1

UNIT - I	LANGUAGE AND LITERATURE	3
Language Families in India - Dravidian Languages – Tamil as aClassical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan		
UNIT - II	**HERITAGE - ROCK ART PAINTINGS TO MODERN ART - SCULPTURE**	**3**
Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils		
UNIT - III	**FOLK AND MARTIAL ARTS**	**3**
Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leatherpuppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils		
UNIT - IV	**THINAI CONCEPT OF TAMILS**	**3**
Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas		
UNIT - V	**CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE**	**3**
Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books		
		Total Instructional hours : 15

Approved by BoS Chairman

Text - Cum - Reference Books	
1.	தமிழக வரலாறு - மக்களும் பண்பாடும் - கே.கே. பிள்ளை (வெளியீடு - தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)
2.	கணினித் தமிழ் - முனைவர் இல.சுந்தரம் (விகடன் பிரசுரம்)
3.	கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4.	பொருநை - ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)
5.	Social Life of Tamils (Dr. K.K. Pillay) A joint publication of TNTB & ESC and RMRL - (in print)
6.	Social Life of the Tamils - The Classical Period (Dr. S. Singaravelu) (Published by : International Institute of Tamil Studies.
7.	Historical Heritage of the Tamils (Dr. S.V. Subatamanian, Dr. K.D. Thirunavukkarasu) (Published by : International Institute of Tamil Studies).
8.	The Contributions of the Tamils to Indian Culture (Dr. M. Valarmathi) (Published by : International Institute of Tamil Studies).
9.	Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by : Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10.	Studies in the Histroyb of India with Special Reference to Tamil Nadu (Dr. K.K. Pillay) (Published by : The Author)
11.	Porunai Civilization (Jointly Published by : Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12.	Journey of Civilization Indus to Vaigai (R. Balakrishnan) (Published by : RMRL) - Reference Book.

Approved by BoS Chairman

B.E. / B.Tech.	B23CHI101 ENGINEERING CHEMISTRY (Common to all Branches)	L	T	P	C
		3	0	2	4

Course Objectives	
1.	To make the students conversant with boiler feed water requirements, related problems, water treatment and inculcate practical skills in the water quality analysis.
2.	To make the students conversant with basics of polymer chemistry.
3.	To make the students conversant with basic of electrochemical reactions, corrosion and induce experimental skills in the electro-analytical techniques.
4.	To make the student acquire sound knowledge of energy devices.
5.	To develop an understanding of the basic concepts of nano materials.

UNIT - I	WATER TECHNOLOGY	17

Hardness of water : Types, expression of hardness and their units, hardness problems, boiler troubles - scale and sludge, caustic embrittlement, boiler corrosion, priming and foaming
Treatment of Boiler feed water : Internal treatment (phosphate, colloidal, sodium aluminate and calgon conditioning)
External treatment : Ion exchange process, Zeolite process
Desalination of brackish water : Reverse osmosis - municipal water treatment, break point chlorination
Determination of alkalinity in water sample, Determination of total, temporary & permanent hardness of water by EDTA method. Estimation of iron content of the water sample using spectrophotometer

UNIT - II	POLYMERS	9

Polymers : Definition, polymerization, types - addition and condensation polymerization, free radical mechanism - tacticity – biodegradable polymer (PHBV) and conducting polymer (poly-aniline)
Plastics : Classification, preparation, properties and uses of PVC, teflon, nylon-6, 6 and epoxy resin
Rubber : Vulcanization of rubber, synthetic rubbers -n-butyl rubber and SBR
Moulding : Ingredients - compression and Injection

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UNIT - III	ELECTROCHEMISTRY AND CORROSION	16
Electrochemistry : Redox reaction, electrode potential - oxidation potential, reduction potential, Nernst equation (derivation) - measurement and applications - electrochemical series and its significance **Corrosion :** causes - types-chemical and electrochemical corrosion (galvanic and differential aeration), corrosion control - electrochemical protection (sacrificial anodic method and impressed current cathodic method) **Estimation of iron content of the given solution using potentiometer, Conductometric titration of strong acid vs strong base, Estimation of copper in brass**		

UNIT - IV	ENERGY DEVICES	9
Batteries : Types of batteries – primary (alkaline battery) and secondary battery (lead acid battery, lithium-ion-battery), Fuel Cells (H_2 - O_2 fuel cell) **Super Capacitors :** Principle, construction, working and applications **Photo voltaic cell :** Solar cells - principle, construction, working and applications		

UNIT - V	NANOCHEMISTRY	9
Basics : Distinction between molecules, nanoparticles and bulk materials- surface area to volume ratio **Synthesis :** Top-down process (ball milling) - Bottom-up process (chemical vapour deposition and sol-gel method) **Properties of nano materials -** Optical, electrical, thermal and mechanical **Applications of nano materials -** Medicine, Industries, electronics and biomaterials		
		Total Instructional hours : 60

Course Outcomes : Students will be able to	
CO1	Determine the characterization of water and quantitative analysis of alkalinity, hardness and Iron. (K5)
CO2	Develop the basics of polymer chemistry. (K3)
CO3	Interpret the principles of electrochemical reactions, corrosion and estimation of copper in Alloy. (K5)
CO4	Apply the concepts of energy devices and its engineering applications. (K3)
CO5	Organize the basics of Nano chemistry and its applications. (K3)

Approved by BoS Chairman

Text Books	
1.	Dara, S S and Umare, S S, “A Textbook of Engineering Chemistry”, Chand S & Company Ltd., New Delhi, 2015.
2.	Jain, P C and Monika Jain, “Engineering Chemistry” Dhanpat Rai Publishing Company Pvt. Ltd., New Delhi, 2015
3.	Vogel’s Textbook of Quantitative Chemical Analysis, 8th edition, 2014.

Reference Books	
1.	Friedrich Emich, “Engineering Chemistry”, Scientific International Pvt. Ltd., New Delhi, 2014.
2.	Prasanta Rath, “Engineering Chemistry”, Cengage Learning India Pvt. Ltd., Delhi, 2015.
3.	Shikha Agarwal, “Engineering Chemistry - Fundamentals and Applications”, Cambridge University Press, Delhi, 2015.
4.	Charles P. Poole and Frank J. Owens, "Introduction to nanotechnology", John Wiley Sons, New Jersey, 2003.

Equipment Needed for 30 Students

1. Conductivity Meter-10
2. Potentiometer-10
3. Spectrophotometer-02
4. Electronic Balance-01

Approved by BoS Chairman

B.E.	B23CSI102 PROBLEM SOLVING AND PYTHON PROGRAMMING (Common to AERO, AGRI, BT and MECH)	L	T	P	C
		3	0	2	4

Course Objectives	
1.	To develop python programs with conditional statements and loops.
2.	To learn how to use strings, functions and pass arguments in Python.
3.	To use python data structures such as lists, tuples, and dictionaries.
4.	To use file concepts and to build a package using Python modules for reusability.
5.	To learn the fundamentals of data manipulations with Python.

UNIT - I	INTRODUCTION TO PYTHON PROGRAMMING	9

Introduction : Python basics and its scripting modes – Variables, Operators - Control Structures : if, if - else, nested if, if – elif ladder statements - Iterative statements : while, for, Nested loops, else in loops, break, continue and pass statements

UNIT - II	STRINGS AND FUNCTIONS	9

Strings: Formatting, Comparison, Slicing, Splitting, Stripping, Negative indices, String functions. Regular expression: Matching the patterns, Search and replace. Functions: Types, parameters, arguments: positional arguments, keyword arguments, parameters with default values, functions with arbitrary arguments

UNIT - III	COLLECTIONS	9

List : Create, Access, Slicing, Negative Indices, List Methods, and comprehensions, Tuples : Create, Indexing and Slicing, Operations on tuples. Dictionary: Create, add, and replace values, operations on dictionaries

UNIT - IV	SETS AND FILE HANDLING	9

Sets : Create and operations on set, Files : Manipulating files and directories, text files : reading / writing text and numbers from / to a file; creating and reading a formatted file (csv or tab separated)

UNIT - V	MODULES AND PACKAGES	9

Modules: Importing module, standard modules, executing modules. Packages: Importing Packages, simple programs using built-in functions of packages like pandas, jumpy, matplotlib

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List of Experiments

Expt. No.		Description of the Experiments
1.		Programs Using Simple Statements
	a.	Exchange the values of two variables,
	b.	Circulate the values of n variables,
	c.	Distance between two points.
2.		Programs Using Conditionals and Iterative Statements
	a.	Number Series
	b.	Number Patterns
	c.	Pyramid Pattern
3.		Programs Using built-in and user defined Functions
	a.	Factorial of a Number
	b.	Largest Number in a list
	c.	Area of Shape
4.		Programs using Strings
	a.	Reversing a String
	b.	Checking Palindrome in a String
	c.	Counting Characters in a String
	d.	Replacing Characters in a String
5.		Operations of Lists
	a.	Basic Operations (Insertion, Updating, deletion, accessing, List Comprehensions)
	b.	Implement linear search and binary search using list.
	c.	Matrix operations using Nested List.
	d.	Implement Merge, Bubble and Insertion sort

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6.		Create a tuple and perform its operations for the following:
	a.	Basic Operations (Insertion, Updating, deletion, accessing)
	b.	Items present in a library
	c.	Components of a car
	d.	Materials required for construction of a laboratory
7.		Operations of Dictionaries
	a.	Python program to create a dictionary with integer keys, and print the keys, values & key-value pairs
	b.	Python program to randomize (shuffle) values of dictionary
8.		Operations of Sets
	a.	Basic operations of set (Membership, Operations and Modifications)
9.		Programs using File Handling
	a.	Copy from one file to another.
	b.	Word count
	c.	Longest word
10.		Python programs using Time and Calendar related functions
	a.	Print the current time using time module.
	b.	Display the calendar of given month of the year using calendar module.
11.		Implementing programs using written modules and Python Standard Libraries (pandas, numpy. Matplotlib, scipy)
		Total Instructional hours: (45+15) = 60

Course Outcomes : Students will be able to	
CO1	Construct Python programs using iterative and conditional statements.
CO2	Experiment with user-defined functions and Strings.

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CO3	Build python programs with list, tuples, dictionaries and set.
CO4	Develop Python application using file operations and modules.
CO5	Apply data manipulation concepts using libraries.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS		
Sl. No.	**Description of the Equipment**	**Quantity required (Nos.)**
1.	HP Make, Core i5, 11th Generation, 16GB RAM PCs, Operating systems: Windows* 10 or later, macOS, and Linux. Python* version: 3.10.X	30

Text Books	
1.	Allen B. Downey, “Think Python: How to Think Like a Computer Scientist”, 2nd Edition, Updated for Python 3, Shroff / O ‘Reilly Publishers, 2016
2.	Reema Thereja, “Python Programming using Problem Solving Approach”, 4th Impression, Oxford University Press, 2019.
3.	Python Course Data Analysis with Python by Bernd Klein, 2021.

Reference Books	
1.	John V Guttag, “Introduction to Computation and Programming Using Python”, Revised and expanded Edition, MIT Press, 2013.
2.	Robert Sedgewick, Kevin Wayne, Robert Dondero, “Introduction to Programming in Python : An Inter-disciplinary Approach”, Pearson India Education Services Pvt. Ltd, 2016.
3.	Timothy A. Budd, “Exploring Python”, Mc-Graw Hill Education (India) Private Ltd, 2015.
4.	Kenneth A. Lambert, “Fundamentals of Python: First Programs”, CENGAGE Learning, 2012.

Approved by BoS Chairman

B.E. / B.Tech	B23MEP101 ENGINEERING PRACTICES LABORATORY	L	T	P	C
		0	0	4	2

Course Objectives	
1.	Drawing pipe line plan; laying and connecting various pipe fittings used in common household plumbing work, sawing, planning, making joints in wood materials used in common household wood work.
2.	Welding various joints in steel plates using arc welding work; machining various simple processes like turning, drilling, tapping in parts; assembling simple mechanical assembly of common household equipments, making a tray out of metal sheet using sheet metal work.
3.	To provide exposure to the students with hands on experience on various basic Engineering practices in Electrical Engineering.
4.	To provide exposure to the students with hands on experience on various basic Engineering practices in Electronics Engineering.

GROUP – A (CIVIL & MECHANICAL)

I	Civil Engineering Practices	12

Plumbing Works

Making basic pipe connections involving the fittings like valves, taps, coupling, unions, reducers, elbows and other components used in household fittings

Carpentry

Preparation of wooden joints by sawing, planning and cutting

1.	Planning & Polishing operation
2.	Half lap joint
3.	Cross lap joint

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II	**Mechanical Engineering Practices**	**18**
Welding Workshop Study of welding tools and equipment's - Study of various welding methods - Instruction of BI standards and reading of welding drawings.		
Exercise in arc welding for making		
1.	Lap joint	
2.	Butt joint	
3.	Demonstration of gas welding and cutting.	
Machine Shop		
1.	Drilling and Tapping	
2.	Lathe Exercise – Facing operation	
3.	Lathe Exercise – Straight turning and Chamfering	
Sheet metal		
Making of small parts using sheet metal		
1.	Making of Square Tray	

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GROUP – B (ELECTRICAL & ELECTRONICS)	30

Expt. No.	Description of the Experiments
1.	Residential house wiring using switches, fuse, indicator, lamp and energy meter.
2.	Fluorescent lamp and Stair case wiring.
3.	Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit.
4.	Measurement of energy using single phase energy meter.
5.	Measurement of resistance to earth of an electrical equipment.
6.	Study of Electronic components and equipment's – Resistor color coding
7.	Measurement of AC signal parameter (peak-peak, rms period, frequency) using CRO.
8.	Study of logic gates AND, OR, EX-OR and NOT.
9.	Soldering & desoldering practices.
10.	Study of Fan, Iron Box, Emergency Lamp, Telephone and FM Radio.
	Total Instructional hours : 60

Course Outcomes : Students will be able to	
CO1	Explain the pipe connections and identify the various components used in plumbing.
CO2	Develop simple wooden joints using wood working tools and simple components using lathe and drilling machine.
CO3	Construct simple lap, butt and tee joints using arc welding equipment and simple parts using sheet metal.
CO4	Construct Residential house wiring, Fluorescent lamp wiring and Stair case wiring.
CO5	Measure electrical quantities such as voltage, current, power & power factor in RLC Circuit, resistance to earth, AC signal parameter (peak-peak, RMS period, frequency) and ripple factor.
CO6	Examine logic gates (AND, OR, EX-OR and NOT), Electronic components and equipment's.

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LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS		
GROUP – A (CIVIL & MECHANICAL)		
Sl. No.	**Description of Equipment**	**Quantity required**
1.	Assorted components for plumbing, Consisting of metallic pipes, plastic pipes, flexible pipes, couplings, unions, elbows, plugs and other fittings.	15
2.	Carpentry vice (fitted to work bench)	15
3.	Standard woodworking tools	15
4.	Models of industrial trusses, door joints, furniture joints	5
5.	Power Tools:	
	(a) Rotary Hammer	2
	(b) Demolition Hammer	2
	(c) Circular Saw	2
	(d) Planer	2
	(e) Hand Drilling Machine	2
	(f) Jigsaw	2
6.	Arc welding transformer with cables and holders	5
7.	Welding booth with exhaust facility	5
8.	Welding accessories like welding shield, chipping hammer, wire brush, etc.	5
9.	Oxygen and acetylene gas cylinders, blow pipe and other welding outfit.	2
10.	Centre lathe	2
11.	Hearth furnace, anvil and smithy tools	2
12.	Moulding table, foundry tools	2
13.	Power Tool: Angle Grinder	2
14.	Study-purpose items: Centrifugal pump, Airconditioner	1

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GROUP – B (ELECTRICAL & ELECTRONICS)		
Sl. No.	Description of Equipment	Quantity required
1.	Assorted Electrical Components for House Wiring	15 sets
2.	Electrical Measuring Instruments	10 sets
3.	Iron Box	1
4.	Fan and Regulator	1
5.	Emergency Lamp	1
6.	Megger	1
7.	Digital Live Wire Detector	2
8.	Soldering Guns	10
9.	Assorted Electronic Components for Making Circuits	50
10.	Multipurpose PCBs	10
11.	Multi Meters	10
12.	Telephone	2
13.	FM radio	2
14.	Regulated Power Supply	2
15.	CRO (30MHz)	2
16.	Bread board	10
17.	Digital IC types (IC 7432, IC 7408, IC 7400, IC 7404, IC 7402, IC 7486)	Each 10

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Semester – II

B.E. / B.Tech.	B23MAT201 INTEGRAL CALCULUS AND COMPLEX ANALYSIS (Common to all Branches)	L	T	P	C
		3	1	0	4

Course Objectives	
1.	To recognize various techniques of integration.
2.	To apply integration techniques in evaluating area and volume of solids.
3.	To develop the use of Vector calculus in two and three dimensional spaces.
4.	To demonstrate understanding of the basic concepts of complex differentiation.
5.	To understand Cauchy theorem and Cauchy integral formulae and apply these to evaluate complex contour integrals.

UNIT - I	INTEGRAL CALCULUS	12
Riemann sum – Definite and Indefinite integrals - Substitution rule (Exponential, logarithmic, Trigonometric functions) – Integration by parts – Integration of Rational functions by Partial fraction		

UNIT - II	MULTIPLE INTEGRALS	12
Double integrals : Double integrals in Cartesian coordinates - Double integrals in Polar coordinates – Area enclosed by plane curves – Triple integrals: Evaluation of triple integrals - Volume as triple integral (Simple problems)		

UNIT - III	VECTOR CALCULUS	12
Gradient and directional derivative - Divergence and curl - Solenoidal and Irrotational vector fields - Green's theorem in a plane, Gauss divergence theorem and Stoke's theorem (excluding proofs) – Verification of theorem and applications (for cubes and rectangular parallellopipeds)		

UNIT - IV	COMPLEX DIFFERENTIATION	12
Analytic functions - Cauchy - Riemann equations (excluding proof) – Properties of analytic function – Harmonic conjugate - Construction of analytic function by Milne Thomson method – Bilinear transformation		

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UNIT - V	COMPLEX INTEGRATION	12
Cauchy‘s integral theorem – Cauchy‘s integral formula – residues - Cauchy‘s Residue theorem – Evaluation of real integrals – Stereographic projection – Use of circular contour and semicircular contour (excluding poles on real axis)		
		Total Instructional hours : 60

Course Outcomes : Students will be able to	
CO1	Develop Fundamental Theorem of Calculus, techniques of Integration such as substitution, partial fractions and integration by parts.
CO2	Make use of integration to compute area and volume.
CO3	Apply the line, surface and volume integrals for verification of Green‘s, Gauss and Stokes theorems.
CO4	Develop an understanding of the standard techniques of complex variable theory in particular analytic function
CO5	Classify and compare the different types of Crystals, their structures and its defects.

Text Books	
1.	Grewal B.S.,”Higher Engineering Mathematics”, Khanna Publishers, New Delhi, 43rd Edition, 2014.
2.	Kreyszig Erwin, "Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2015.
3.	George B. Thomas , Joel Hass , Christopher Heil , Maurice D. Weir, “Thomas' Calculus”, Pearson, 14th Edition, 2018.

Reference Books	
1.	Bali N., Goyal M. and Watkins C., “Advanced Engineering Mathematics”, Firewall Media - An imprint of Lakshmi Publications Pvt., Ltd., New Delhi, 7th Edition, 2015.
2.	Jain R.K. and Iyengar S.R.K., “Advanced Engineering Mathematics”, Narosa Publications, New Delhi, 5th Edition 2019.

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3.	O'Neil, P.V.,"Advanced Engineering Mathematics", Cengage Learning India Pvt. Ltd, New Delhi, 7th Edition 2017.
4.	Sastry, S.S, "Engineering Mathematics", Vol. I & II, PHI Learning Pvt. Ltd, 4th Edition, New Delhi, 2014.
5.	Wylie, R.C. and Barrett, L.C., "Advanced Engineering Mathematics", (Tata McGraw Hill Education Pvt. Ltd), 6th Edition, New Delhi, 2012.
6.	Gean Duffy., "Advanced Engineering Mathematics with MATLAB", A CRC Press Company, Boca Raton London, New York Washington, D.C, 2nd edition 2009. (Free e-book downloaded from www.EasyEngineering.net.pdf)

Approved by BoS Chairman

B.E. / B.Tech.	B23HST201 தமிழரும் தொழில்நுட்பமும்	L	T	P	C
		1	0	0	1

அலகு – I	நெசவு மற்றும் பானைத் தொழில்நுட்பம்	3
சங்க காலத்தில் நெசவுத் தொழில் - பானைத் தொழில்நுட்பம் - கருப்பு சிவப்பு பாண்டங்கள் - பாண்டங்களில் கீறல் குறியீடுகள்		

அலகு – II	வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்	3
சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு - சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் - சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் - மாமல்லபுரச் சிற்பங்களும், கோவில்களும் - சோழா் காலத்துப் பெருங்கோவில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் - நாயக்கா் காலக் கோவில்கள் - மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கா் மஹால் - செட்டிநாட்டு வீடுகள் - பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ - சாரோசெனிக் கட்டிடக்கலை		

அலகு – III	உற்பத்தித் தொழில் நுட்பம்	3
கப்பல் கட்டும் கலை - உலோகவியல் - இரும்புத் தொழிற்சாலை - இரும்பை உருவாக்குதல், எ.்.கு - வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் - நாணயங்கள் அச்சடித்தல் - மணி உருவாக்கும் தொழிற்சாலைகள் - கல்மணிகள், கண்ணாடி மணிகள் - சுடுமண் மணிகள் - சங்கு மணிகள் - எலும்புத் துண்டுகள் - தொல்லியல் சான்றுகள் - சிலப்பதிகாரத்தில் மணிகளின் வகைகள்		

அலகு – IV	வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்	3
அணை, ஏரி, குளங்கள், மதகு - சோழா்காலக் குமிழித் தூம்பின் முக்கியத்துவம் - கால்நடை பராமரிப்பு - கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் - வேளாண்மை மற்றும் வேளாண்மைச் சாா்ந்த செயல்பாடுகள் - கடல்சாா் அறிவு - மீன் வளம் - முத்து மற்றும் முத்துக் குளித்தல் - பெருங்கடல் குறித்த பண்டைய அறிவு - அறிவுசாா் சமூகம்		

அலகு – V	அறிவியல் தமிழ் மற்றும் கணித்தமிழ்	3
அறிவியல் தமிழின் வளா்ச்சி - கணித்தமிழ் வளா்ச்சி - தமிழ் நூல்களை மின் பதிப்பு செய்தல் - தமிழ் மென்பொருட்கள் உருவாக்கம் - தமிழ் இணையக் கல்விக் கழகம் - தமிழ் மின் நூலகம் - இணையத்தில் தமிழ் அகராதிகள் - சொற்குவைத் திட்டம்		
		மொத்தம் – 15 காலங்கள்

Approved by BoS Chairman

Text - Cum - Reference Books	
1.	தமிழக வரலாறு - மக்களும் பண்பாடும் - கே.கே. பிள்ளை (வெளியீடு - தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)
2.	கணினித் தமிழ் - முனைவர் இல.சுந்தரம் (விகடன் பிரசுரம்)
3.	கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4.	பொருநை - ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)
5.	Social Life of Tamils (Dr. K.K. Pillay) A joint publication of TNTB & ESC and RMRL
6.	Social Life of the Tamils - The Classical Period (Dr. S. Singaravelu) (Published by : International Institute of Tamil Studies.
7.	Historical Heritage of the Tamils (Dr. S.V. Subatamanian, Dr. K.D. Thirunavukkarasu) (Published by : International Institute of Tamil Studies).
8.	The Contributions of the Tamils to Indian Culture (Dr. M. Valarmathi) (Published by : International Institute of Tamil Studies).
9.	Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by : Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10.	Studies in the Histroy of India with Special Reference to Tamil Nadu (Dr. K.K. Pillay) (Published by : The Author)
11.	Porunai Civilization (Jointly Published by : Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12.	Journey of Civilization Indus to Vaigai (R. Balakrishnan) (Published by : RMRL) - Reference Book.

Approved by BoS Chairman

B.E. / B.Tech.	B23HST201 TAMILS AND TECHNOLOGY	L	T	P	C
		1	0	0	1

UNIT - I	WEAVING AND CERAMIC TECHNOLOGY	3

Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries

UNIT - II	DESIGN AND CONSTRUCTION TECHNOLOGY	3

Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period

UNIT - III	MANUFACTURING TECHNOLOGY	3

Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting,steel - Copper and goldCoins as source of history - Minting of Coins – Beads making-industries Stone beads - Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram

UNIT - IV	AGRICULTURE AND IRRIGATION TECHNOLOGY	3

Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society

UNIT - V	SCIENTIFIC TAMIL & TAMIL COMPUTING	3

Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project

Total Instructional hours : 15

Approved by BoS Chairman

Text - Cum - Reference Books	
1.	தமிழக வரலாறு - மக்களும் பண்பாடும் - கே.கே. பிள்ளை (வெளியீடு - தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)
2.	கணினித் தமிழ் - முனைவர் இல.சுந்தரம் (விகடன் பிரசுரம்)
3.	கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4.	பொருநை - ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)
5.	Social Life of Tamils (Dr. K.K. Pillay) A joint publication of TNTB & ESC and RMRL - (in print)
6.	Social Life of the Tamils - The Classical Period (Dr. S. Singaravelu) (Published by : International Institute of Tamil Studies.
7.	Historical Heritage of the Tamils (Dr. S.V. Subatamanian, Dr. K.D. Thirunavukkarasu) (Published by : International Institute of Tamil Studies).
8.	The Contributions of the Tamils to Indian Culture (Dr. M. Valarmathi) (Published by : International Institute of Tamil Studies).
9.	Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by : Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10.	Studies in the Histroyb of India with Special Reference to Tamil Nadu (Dr. K.K. Pillay) (Published by : The Author)
11.	Porunai Civilization (Jointly Published by : Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12.	Journey of Civilization Indus to Vaigai (R. Balakrishnan) (Published by : RMRL) - Reference Book.

Approved by BoS Chairman

B.E.	B23MET201 ENGINEERING MECHANICS (Common to Mech, Aero, Agri)	L	T	P	C
		3	1	0	4

Course Objectives	
1.	To make the students understand the vector and scalar representation of forces and the static equilibrium of particles.
2.	To understand the moment and the equilibrium of rigid bodies in two dimensions and three dimensions.
3.	To make the students understand the properties of surfaces and solids in relation to moment of inertia.
4.	To understand laws of motion, kinetics of particles and their interrelationship.
5.	To make the students understand effect of friction on equilibrium in rigid bodies.

UNIT - I	STATICS OF PARTICLES	12

Introduction – Units and Dimensions – Laws of Mechanics – Principle of transmissibility – Lami's theorem, Parallelogram and triangular Law of forces – Coplanar Forces – rectangular components – Equivalent systems of forces – Equilibrium of a particle – Forces in space – Equilibrium of a particle in space using vector representation

UNIT - II	EQUILIBRIUM OF RIGID BODIES	12

Free body diagram – Types of supports – Action and reaction forces – stable equilibrium – Moments and Couples – Varignon's theorem - Moment of a force about a point and about an axis – Scalar components of a moment – Single equivalent force - Couple - Moment of a Couple, Equivalent Couples, Addition of Couples, Resolution of a Given Force into a Force - Couple system – Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in three dimensions

UNIT - III	PROPERTIES OF SURFACES AND SOLIDS	12

Centroids and centre of mass – Centroids of lines and areas – T section, I section, Angle section and Hollow section by using standard formula – Theorems of Pappus - Area moments of inertia of plane areas – T section, I section, Angle section and Hollow section by using standard formula – Parallel axis theorem and perpendicular axis theorem – Principal moments of inertia of plane areas – Principal axes of inertia – Mass moment of inertia – Mass moment of inertia for cylindrical and spherical solids from first principle

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UNIT - IV	DYNAMICS OF PARTICLES	15
Kinematics - Rectilinear Motion and Curvilinear Motion of Particles. Kinetics - Newton's Second Law of Motion - Equations of Motions, Dynamic Equilibrium, Energy and Momentum Methods - Work of a Force, Kinetic Energy of a Particle, Principle of Work and Energy, Principle of Impulse and Momentum, Impact of bodies		

UNIT - V	FRICTION	9
The Laws of Dry Friction, Coefficients of Friction, Angles of Friction, Wedge friction, Wheel Friction, Rolling Resistance, Ladder friction		
		Total Instructional hours : 60

Course Outcomes : Students will be able to	
CO1	Explain the basics and state of particles and understand the vectorial and scalar representation of forces and moments.
CO2	Interpret static equilibrium of particles and rigid bodies in two and three dimensions.
CO3	Identify the properties of surfaces & solids in relation to moment of inertia.
CO4	Illustrate the laws of motion, kinematics and kinetics of particles and their interrelationship.
CO5	Determine the friction and the effects by the laws of friction

Text Books	
1.	Vela Murali, "Engineering Mechanics", Oxford University Press, 2018.
2.	Beer Ferdinand P, Russel Johnston Jr., David F Mazurek, Philip J Cornwell, Sanjeev Sanghi, Vector Mechanics for Engineers: Statics and Dynamics, McGraw Higher Education., 12th Edition, 2019.

Reference Books	
1.	Hibbeller, R.C., Engineering Mechanics: Statics and Dynamics, 13th Edition, Prentice Hall, 2013.
2.	Timoshenko S, Young D H, Rao J V and SukumarPati, Engineering Mechanics, 5th Edition, McGraw Hill Higher Education, 2013.
3.	Meriam J L and Kraige L G, Engineering Mechanics: Statics and Engineering Mechanics: Dynamics, 7th edition, Wiley student edition, 2013.

Approved by BoS Chairman

B.E. / B.Tech.	B23CEP201 SOFT SKILLS (Common to all Branches)	L	T	P	C
		2	0	0	0

Course Objectives	
1.	To identify personality using evaluation method.
2.	To encourage creative thinking by practice.
3.	To enrich interpersonal skills through integrated activities.
4.	To develop social and professional etiquette.
5.	To identify and apply employability skills for professional success.

UNIT - I	SELF EVALUATION	6
Introduction to soft skills, Familiarize oneself, Self-understanding, SWOT analysis, Goal Setting		

UNIT - II	INNOVATIVE THINKING	6
Divergent thinking, Encourage curiosity, Writing a story, Poster making		

UNIT - III	INTERPERSONAL SKILLS	6
Interpersonal skills - Need & Components – Understanding Intercultural Competence - Team Work-Problem Solving Skills - Conflict Management & Resolutions in Workplace, Leadership skills, Managerial skills		

UNIT - IV	BUSINESS ETIQUETTE	6
Define Etiquette -Types and Importance of Workplace Etiquette - Basic Corporate Etiquette - Telephone Etiquette - Meeting & E-mail Etiquette - Customer Service Etiquette		

UNIT - V	CORPORATE SKILLS	6
Work Ethics - Adaptability - Analytical Reasoning - Lateral Thinking - Stress & Time Management		
Total Instructional hours : 30		

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Course Outcomes : Students will be able to	
CO1	Identify different personalities.
CO2	Show creative skill in different aspects.
CO3	Utilize leadership skills with ability to work in a team.
CO4	Analyze work place etiquette.
CO5	Develop adequate soft skills required for the workplace.

Reference Books	
1.	Butterfield, Jeff “Soft Skills for Everyone” Cengage Learning, New Delhi, 2015.
2.	S.Hariharanetal ”Soft Skills” MJP Publishers : Chennai, 2010.
3.	Peter, Francis “Soft Skills and Professional Communication” New Delhi : Tata McGraw Hill, 2012. Print.
4.	Meenakshi Raman, Shalini Upadhyay, ’Soft Skills’, Cengage Learning India Pvt. Ltd, Delhi, 2018.
5.	M.S. Rao, ‘Soft Skills Enhancing Employability’, I. K. International Publishing House Pvt. Ltd, New Delhi, 2010
6.	Sabina Pillai, Agna Fernandez, ‘Soft Skills and Employability Skills’, Cambridge University Press, 2018.
7.	John Peter.A, ‘Self – Development and Professional Excellence’, Cengage Learning India Pvt. Ltd, Delhi, 2019.

Approved by BoS Chairman

B.E. / B.Tech. (Except CSBS)	B23ENI101 PROFESSIONAL COMMUNICATION	L	T	P	C
		3	0	2	4

Course Objectives	
1.	To enhance listening and reading ability of learners to comprehend various forms of speech or conversations.
2.	To develop learners' verbal ability through complex texts and speak effectively in real life and workplace context.
3.	To make use of grammatical knowledge to enhance fluency.
4.	To foster learners' ability to write convincing job applications and effective reports.
5.	To develop learners language proficiency through LSRW skills.

UNIT – I	9
Listening	Listening for general information - specific details - conversation - Audio / video (formal & informal); Telephone conversation
Speaking	Self-Introduction; Introducing a friend; - politeness strategies - making polite requests & polite offers
Reading	Introduction to technical texts, scientific texts
Writing	Extended definitions, Writing checklists, Recommendation
Language development	Gerunds, Infinitives
Vocabulary development	Technical vocabulary, abbreviations, British & American spelling

UNIT – II	9
Listening	Listening to podcasts, anecdotes / stories / event narration; documentaries and interviews with celebrities
Speaking	Narrating personal experiences / Talking about events and situations
Reading	Reading longer technical texts, Summarizing

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Writing	Interpreting graphical representations, Writing dialogues about formal and informal contexts
Language development	Use of conjunctions and prepositions
Vocabulary development	Numerical adjectives, Transitional device

UNIT – III	**9**
Listening	Listen to a classroom lecture; listening to advertisements about products
Speaking	Picture description - describing locations in workplace, Presenting product, describing shape, size and weight - talking about quantities - talking about precautions, discussing advantages and disadvantages - making comparisons
Reading	Cause & effect texts, practice in speed reading
Writing	Process writing, Use of sequence words, Analytical and issue based essays
Language development	Subject verb agreement, Pronoun concord / pronoun antecedent
Vocabulary development	Sequence words, Misspelled words, Content v/s Function words

UNIT – IV	**9**
Listening	Listening to TED Talks, Educational videos and completing exercises based on them
Speaking	Short speech (Just A Minute) - Extempore and persuasive speech, discussing and making plans-talking about tasks-talking about progress
Reading	Reading for details in personal and professional emails
Writing	Drafting personal and professional emails, job application - cover letter, résumé preparation, Internship letter
Language development	Clauses, if conditionals
Vocabulary development	Finding suitable synonyms, Paraphrasing

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UNIT – V		9
Listening	Listening to debates/ discussions and panel discussions, listening to interviews	
Speaking	Making predictions - talking about a given topic, giving opinions & facts, describing a process, discussing safety issues (making recommendations)	
Reading	Reading and understanding technical articles	
Writing	Writing reports, Minutes of meeting, Writing feasibility, survey and industrial reports	
Language development	Reported speech, Active and Passive voice, Impersonal passive, Idioms	
Vocabulary development	Verbal analogies, Purpose statements	
	Total Theory Instructional hours : 45 **Total Lab Instructional hours : 30**	

Course Outcomes : Students will be able to	
CO1	Develop listening skills to respond appropriately in general and academic purposes.
CO2	Develop strategies and skills to enhance their ability to read and comprehend.
CO3	Apply vocabulary skills to improve their language skills.
CO4	Build the writing skills with specific reference to technical writing.
CO5	Demonstrate language proficiency through LSRW skills.

Text Books	
1.	Board of Editors. Fluency in English A Course book for Engineering and Technology. Orient Blackswan, Hyderabad : 2016
2.	Sudharshana.N.P and Saveetha. C. English for Technical Communication. Cambridge University Press: New Delhi, 2016.

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Reference Books	
1.	Raman, Meenakshi and Sharma, Sangeetha “Technical Communication Principles and Practice” Oxford University Press: New Delhi, 2014.
2.	Kumar, Suresh. E. “Engineering English” Orient Blackswan: Hyderabad, 2015.
3.	Booth-L. Diana, Project Work, Oxford University Press, Oxford: 2014.
4.	Davis, Jason and Rhonda LIss. Effective Academic Writing (Level 3) Oxford University Press: Oxford, 2006.
5.	Communicative English for Engineers and Professionals- Nitin Bhatnagar & Mamta Bhatnagar.
6.	Skills for Success. Listening and Speaking. Level 4- Margret Brooks.
7.	Grammar F. Margot and Colin S. Ward Reading and Writing (Level 3) Oxford University Press : Oxford, 2011.

Exercises for Batch of 30 Students

1. Listening Comprehension
2. Self- introduction
3. Short presentation
4. Group Discussion

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B.E. / B.Tech.	B23PHI101 ENGINEERING PHYSICS (Common to all Branches)	L	T	P	C
		3	0	2	4

Course Objectives	
1.	To gain knowledge on the basics of properties of matter, its applications and inculcate practical skills in the determination of elastic property of the materials.
2.	To acquire knowledge & experimental skills on the concepts of Photonics and their applications in fiber optics.
3.	To have adequate knowledge on the concepts of electrical, magnetic properties of materials and enhance the practical skills in determination of electrical properties of the materials.
4.	To get knowledge on advanced physics concepts of quantum theory and its applications in SEM, TEM and induce practical skills in microscope.
5.	To enhance the fundamental knowledge of students in Crystal Physics and its Applications relevant to various streams of Engineering and Technology.

UNIT - I	PROPERTIES OF MATTER	14

Elasticity - Modulus, types of moduli of elasticity, Stress - strain diagram and its uses - factors affecting elastic modulus and Twisting couple, torsion pendulum; theory and experiment

Bending of beams - Bending moment - uniform and non- uniform bending; theory and experiment - I - shaped girders and its applications

Determination of rigidity modulus - Torsion pendulum - Determination of Young's modulus by non-uniform bending method - Determination of Young's modulus by uniform bending method

UNIT - II	PHOTONICS AND FIBER OPTICS	12

Lasers ; properties of laser-spontaneous and stimulated emission-amplification of light by population inversion - Einstein's A and B coefficients - derivation – Types of laser; Nd. - YAG Laser, Semiconductor lasers; homojunction and heterojunction, Industrial and Medical Applications

Fiber Optics ; Principle, Numerical Aperture and Acceptance Angle - Types of optical fibres - Fiber optic communication System - Block diagram - Medical Applications - Endoscopy

Determination of wavelength of the Laser using grating- Determination of particle size using Laser - Determination of Numerical aperture and acceptance angle of an optical fiber

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UNIT - III	ELECTRICAL AND MAGNETIC PROPERTIES OF MATERIALS	12
Classical free electron theory – Relaxation time and collision time - Expression for electrical conductivity – Thermal conductivity – Wiedemann - Franz law – Lorentz number - Drawbacks of classical theory - Quantum theory - Fermi - Dirac statistics – variation of Fermi level with temperature **Introduction to magnetic materials –** Comparision of Dia, Para and Ferro magnetic materials – Domain theory of ferromagnetism - Hysteresis - Soft and Hard magnetic materials - Ferrites and its applications. **Determination of specific resistance of the wire using Carey Foster's Bridge**		

UNIT - IV	QUANTUM PHYSICS	12
Black body radiation; Planck's theory (derivation) - wave particle duality- debroglie's wavelength -concept of wave function and its physical significance **Wave equation;** Schroedinger's time independent and time dependent equations, particle in a one-dimensional rigid box. **Applications;** Scanning Electron Microscope (SEM) and Transmission Electron Microscope (TEM) **Determination of thickness of a thin wire by using travelling microscope**		

UNIT - V	CRYSTAL PHYSICS	10
Crystal Structures; Single crystalline, polycrystalline and amorphous materials - unit cell - space lattice - crystal systems - Bravais lattices - Miller indices- inter - planar distances – coordination number and packing factor for SC, BCC, FCC and HCP structures **Crystal imperfections;** Point and Line defects - Burger vector		
Total Instructional hours : 60		

Course Outcomes : Students will be able to	
CO1	Categorize the basics of properties of matter and its applications, classify the elastic properties of materials by using uniform, non-uniform bending method and torsional pendulum apparatus.
CO2	Explain the basics of Laser, Fiber Optics and their applications, determination of Particle size, Wavelength of laser and acceptance angle, numerical aperture of optical fiber.
CO3	Justify the concepts of electrical, magnetic properties of materials, determination of Specific resistance of the material.

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CO4	Interpret the basic knowledge of quantum theory that could be helpful in understanding the wave functions of the particle and determination of thickness of thin sheet by using travelling microscope.
CO5	Classify and compare the different types of Crystals, their structures and its defects.

Text Books	
1.	Bhattacharya, D.K. & Poonam, T, "Engineering Physics", Oxford University Press, 2015.
2.	Gaur, R.K. & Gupta, S.L. "Engineering Physics", Dhanpat Rai Publishers, 2012.
3.	Pandey, B.K. & Chaturvedi, S. "Engineering Physics", Cengage Learning India, 2012.
4.	Rajendran V, "Engineering Physics", Tata McGraw Hill, Publishing Company, New Delhi, 2011.
5.	Wahab, M.A. - Solid State Physics: Structure and Properties of Materials, Narosa Publishing House, 2009.

Reference Books	
1.	Halliday, D., Resnick, R. & Walker, J. "Principles of Physics"", Wiley, 2015.
2.	Serway, R.A. & Jewett, J.W. "Physics for Scientists and Engineers", Cengage Learning, 2010.
3.	Tipler, P.A. & Mosca, G. "Physics for Scientists and Engineers with Modern Physics", W.H. Freeman, 2007.
4.	Avadhanulu M.N, "Engineering Physics - Volume 1", S.Chand & Company Ltd., New Delhi, 2010.
5.	Garcia, N. & Damask, A. - Physics for Computer Science Students. Springer - Verlag, 2012.
6.	Senthil Kumar, G. Physics Laboratory I & II, VRB publishers Pvt. Ltd., Chennai (2016).

Equipment Needed for 30 Students

1.	Diode Laser (2 mS power) , He – Ne Laser source (2mW), Optical Fibre Kit	-	06
2.	Travelling Microscope ,Knife edge, Slotted weights	-	19
3.	Carey Foster Bridge	-	06
4.	Air Wedge Apparatus with Travelling Microscope	-	06
5.	Torsional Pendulum	-	06

Approved by BoS Chairman

B.E.	B23EEI202 BASIC ELECTRICAL AND ELECTRONICS ENGINEERING (Common to AERO, AGRI and MECH)	L	T	P	C
		3	0	2	4

Course Objectives	
1.	To analyse the electric circuit laws and theorems.
2.	To analyse the single and three phase circuits with different types of load.
3.	To understand the working principles and characteristics of electrical machines.
4.	To understand the working principle of various electronic devices.
5.	To understand the concept of electrical wiring and safety.

UNIT - I	ELECTRICAL CIRCUITS	9

Basic circuit components - Ohms Law - Kirchoff‘s Law – Instantaneous Power – Inductors - Capacitors – Independent and Dependent Sources. Steady state solution of DC circuits - Nodal analysis, Mesh analysis. Network Theorems -Thevenin‘s theorem, Norton‘s theorem, Maximum Power transfer theorem - Superposition theorem

UNIT - II	AC CIRCUITS	9

Introduction to AC circuits – waveforms and RMS value – power and power factor, single phase and three - phase balanced circuits – Three phase loads

UNIT - III	ELECTRICAL MACHINES	9

Construction, working and characteristics of DC machines, single phase transformers, single phase and three phase induction motors, Introduction to special electrical machines (BLDC, PMSM)

UNIT - IV	ELECTRONIC DEVICES AND CIRCUITS	9

Types of Materials – Silicon and Germanium- N type and P type materials – PN Junction - Forward and Reverse Bias – Semiconductor Diodes. Bipolar Junction Transistor - Characteristics – Field Effect Transistors – Transistor Biasing. Introduction to operational Amplifier – Inverting Amplifier – Non Inverting Amplifier

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UNIT - V	ELECTRICAL WIRING AND SAFETY	9
Housing wiring, industrial wiring, materials of wiring – Hazards of electricity - Electrical safety equipment – safety procedures and methods – Grounding – safety requirements and standards - Human factors in electrical safety		
		Total Instructional hours : 45

Expt. No.	Description of the Experiments
1.	Verification of Circuit Laws.
2.	Verification of Circuit Theorems.
3.	Measurement of three phase power.
4.	Load test on DC shunt motor.
5.	Speed control of DC shunt motor.
6.	Load test on Single phase Transformer.
7.	Load test on single phase Induction motor.
8.	VI characteristics of Diode.
9.	Characteristics of Common Emitter Configuration in NPN transistor.
	Total Practical hours : 30
	Total Instructional hours : 45 + 30 = 75

Course Outcomes : Students will be able to	
CO1	Apply basic circuit laws and Theorems to analyze the electrical circuits.
CO2	Analyze the single and three phase circuit with different types of load.
CO3	Examine the performance of DC machines, transformers, induction motors and explain the construction and operation of special machines.
CO4	Analyze the characteristics of various semiconductor devices.
CO5	Outline the basic wiring materials, types of wiring and Safety practices

Approved by BoS Chairman

Text Books	
1.	Leonard S Bobrow, Foundations of Electrical Engineering, Oxford University Press, 2013.
2.	Kothari.D.P and Nagarath.I.J,Electrical Machines - Basic Electrical and Electronics Engineering, McGraw Hill Education (India) Private Limited, Third Reprint, 2016.
3.	S.Salivahanan , N.Suresh Kumar, Electronic Devices and Circuits, McGraw Hill Education (India) Private Limited, 4th edition, 2017.
4.	E.G. Janardanan, “Special electrical machines”, PHI learning Private Limited, Delhi, 2014.
5.	John Cadick, P.E, “Electrical Safety Handbook”, 4th edition, McGraw Hill, 2012.

Reference Books	
1.	N K De, DipuSarkar, Basic Electrical Engineering, Universities Press (India) Pvt. Ltd, 2016.
2.	Vincent Del Toro, Electrical Engineering Fundamentals, Pearson Education, Second Edition New Delhi, 2015.
3.	John Bird, Electrical Circuit Theory and Technology, Elsevier, Fifth Edition, 2014.

Approved by BoS Chairman

Semester – III

B.E.	B23MET301 ENGINEERING THERMODYNAMICS	L	T	P	C
		3	1	0	4

(Use of Standard and approved Steam Table, Mollier Chart, Compressibility Chart and Psychometric Chart permitted)

Course Objectives	
1.	To understand the fundamentals of thermodynamics.
2.	To apply the laws of thermodynamics into an energy system.
3.	To understand the thermodynamic behavior of steam and its applications.
4.	To Understand the behavior of Gas mixture and real gases
5.	To apply psychometric process in various energy system.

UNIT - I	BASIC CONCEPTS AND FIRST LAWOF THERMODYNAMICS	12
Basic concepts properties. System. process. Quasi-static, reversible and irreversible processes. Heat and work transfer, P-V diagram. Zeroth and first law of thermodynamics. First law of thermodynamics – application to closed and open systems – steady and unsteady flow processes		

UNIT - II	SECOND LAW OF THERMODYNAMICS AND AVAILABILITY ANALYSIS	12
Heat Reservoir, source and sink. Heat Reservoir, source and sink. Heat Engine, Refrigerator, and Heat pump. Statements of second law and its corollaries. Carnot cycle, Characteristics of entropy, Clausius Theorem, Principle of increase of entropy, Applications of entropy principle, , Entropy Changes For a Closed System T-s diagram		

UNIT - III	PROPERTIES OF PURE SUBSTANCES	12
Steam - formation and its thermodynamic properties - p-v, p-T, T-v, T-s, h-s diagrams. PVT surface. Determination of dryness fraction. Calculation of work done and heat transfer in non-flow and flow processes using Steam Table and Mollier Chart		

Approved by BoS Chairman

UNIT - IV	GAS MIXTURES AND THERMODYNAMIC RELATIONS	12
Properties of Ideal gas, real gas - comparison. Equations of state for ideal and real gases. Vander Waal's relation - Compressibility factor Generalized Compressibility Chart. Maxwell relations - TdS Equations - heat capacities relations - Energy equation, Joule - Thomson experiment - Clausius - Clapeyron equation		

UNIT - V	PSYCHROMETRIES	12
Psychometric properties, Psychometric charts. Property calculations of air vapor mixtures by using chart and expressions. Psychometric process – adiabatic saturation, adiabatic mixing, evaporative cooling and. Simple Applications		
		Total Instructional hours : 60

Course Outcomes : Students will be able to	
CO1	Apply the first law of thermodynamics-to-thermodynamics systems.
CO2	Apply second law of thermodynamics and analyzing the performance of thermal systems.
CO3	Develop sound knowledge of techniques in solving ordinary differential equations that model Engineering problems.
CO4	Utilize the mathematical model for thermodynamic properties and Real Gas.
CO5	Calculate the properties of air and process with the help of psychometric chart.

Text Books	
1.	Rajput. R.K, "Engineering Thermodynamics", 5^{th} Edition, Lakshmi Publications, New Delhi, 2016.
2.	Nag. P.K., "Engineering Thermodynamics", 6^{th} Edition, Tata McGraw-Hill, New Delhi, 2017.

Reference Books	
1.	Cengel. Y and M. Boles, "Thermodynamics - An Engineering Approach", 9^{th} Edition, Tata McGraw Hill, 2019.
2.	Arora C.P., Engineering Thermodynamics, McGraw Hill Education, 2012.
3.	Chattopadhyay, P, "Engineering Thermodynamics", Oxford University Press, 2010.
4.	https://archive.nptel.ac.in/courses/112/106/112106310/.

Approved by BoS Chairman

B.E. / B.Tech.	B23MET302 METAL CUTTING AND COMPUTER AIDED MANUFACTURING	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the concept and basic mechanics of metal cutting.
2.	To understand the basic concepts of machining operation.
3.	To gain a preliminary understanding of NC and CNC machining processes.
4.	To understand the application of computers in Manufacturing.
5.	To provide students an exposure to cellular manufacturing.

UNIT - I	METAL CUTTING THEORY	9

Introduction to Metal Cutting Methods – Mechanics of Metal Cutting – Orthogonal – Oblique – Merchants' Circle Diagram – Details of Derivation – Chip Details – Heat Generation – Cutting Tool Life – Cutting Tool Nomenclature - Economics of tool life – Optimal cutting speed for productivity - Cutting tool Materials - Cutting fluids – Recent Developments and Applications - Dry Machining and High-Speed Machining

UNIT - II	MECHANISMS OF OPERATION	9

Introduction to Lathe – Shaper – Planning – Milling – Drilling – Boring – Grinding – Honing – Working Principles – Operations – Working Holding Devices. - Grinding Machines – Grinding wheel Specifications – Honing – Lapping –Burnishing – Super Finishing- Gear Manufacturing Processes – Gear cutting – Gear Hobbing- Types of Gears

UNIT - III	FUNDAMENTALS OF NC AND CNC	9

Numerical control - classifications – point-to-point, straight cut and contouring – positioning – incremental and absolute systems – driving devices – feedback devices – NC part programming – manual programming for simple components – computer aided part programming- Introduction to Automatically Programmed Tools (APT) programming – programming with interactive graphics – computer automated part programming

Approved by BoS Chairman

UNIT - IV	INTRODUCTION TO COMPUTER INTEGRATED MANUFACTURING	9
The meaning and origin of CIM- the changing manufacturing and management scene - External communication - islands of automation and software-dedicated and open systems- product related activities of a company- marketing engineering - production planning - plant operations - physical distribution- business and financial management		

UNIT - V	CELLULAR MANUFACTURING AND FLEXIBLE MANUFACTURING SYSTEM (FMS)	9
Role of Group Technology in CAD/CAM integration, Part Families – Parts Classification and coding – Simple Problems in Opitz Part Coding system – Production flow Analysis – Cellular Manufacturing – Composite part concept –Types of Flexibility – FMS – FMS Components – FMS Application & Benefits – FMS Planning and Control Quantitative analysis in FMS		
Total Instructional hours : 45		

Course Outcomes : Students will be able to	
CO1	Outline the theory of metal cutting with recent trends.
CO2	Choose the different types of operations based on the required process.
CO3	Classify the NC and CNC Machining processes.
CO4	Apply the manufacturing activities inter relation with computers for plant operations.
CO5	Develop the concepts related to cellular manufacturing and FMS.

Text Books	
1.	Serope Kalpakjian, Steven R. Schmid “Manufacturing Engineering and Technology” eighth edition by Pearson Publication, 2020.
2.	Mikell.P.Groover “Automation, Production Systems and Computer Integrated Manufacturing”, Prentice Hall of India, 2016.
3.	Radhakrishnan P, Subramanyan S. and Raju V., “CAD/CAM/CIM”, New Age International Publishers, Fourth Edition, 2018.

Approved by BoS Chairman

Reference Books	
1.	Sharma P.C., “A Text Book of Production Technology”, S.Chand& Company Ltd., New Delhi,2010.
2.	Foley, Van Dam, Feiner, “Computer Graphics: Principles and Practice”’. Pearson Education India, Third Edition, 2013.
3.	P.M. Agrawl, V.J. Patel “CNC Fundamentals and programming”, V.J Patel Edition, 2nd Edition, 2017.

Approved by BoS Chairman

B.E. / B.Tech	B23MET303 ENGINEERING MATERIALS AND METALLURGY	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To outline the constitutions of alloys, phase diagrams and different types of ferrous alloys.
2.	To identify and select suitable heat treatment processes of steel with the aid of transformation diagrams and to understand the powder metallurgy.
3.	To summarize the non–ferrous metal alloys and modern engineering materials employed for various engineering applications.
4.	To explain the properties and applications of non-metallic materials.
5.	To demonstrate various destructive and non-destructive testing methods and common failure mechanisms of materials.

UNIT - I	CONSTITUTION OF ALLOYS AND PHASE DIAGRAMS	9

Constitution of alloys – Solid solutions, substitutional and interstitial – phase diagrams, Isomorphous, eutectic, eutectoid, peritectic, and peritectoid reactions, Iron – Iron carbide equilibrium diagram. Classification of steel and cast-Iron microstructure, properties and application

UNIT - II	HEAT TREATMENT	9

Definition – Full annealing, stress relief, recrystallisation and spheroidising – normalizing, hardening and tempering of steel. Isothermal transformation diagrams – cooling curves superimposed on I.T. diagram – continuous cooling Transformation (CCT) diagram – Austempering, Martempering – Hardenability, Jominy end quench test -case hardening, carburizing, Nitriding, cyaniding, carbonitriding – Flame and Induction hardening – Vacuum and Plasma hardening – Thermo-mechanical treatments- elementary ideas on sintering

UNIT - III	FERROUS AND NON-FERROUS METALS	9

Effect of alloying additions on steel (Mn, Si, Cr, Mo, Ni, V,Ti& W) – stainless and tool steels – HSLA - Maraging steels – Grey, white, malleable, spheroidal – alloy cast irons, Copper and its alloys – Brass, Bronze and Cupronickel – Aluminium and its alloys; Al-Cu – precipitation strengthening treatment – Titanium alloys, Mg-alloys, Ni-based super alloys – shape memory alloys- Properties and Applications

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UNIT - IV	NON-METALLIC MATERIALS	9
Polymers – types of polymers, commodity and engineering polymers – Properties and applications of PE, PP, PS, PVC, PMMA, PET, PC, PA, ABS, PAI, PPO, PPS, PEEK, PTFE, Thermoset polymers – Urea and Phenol formaldehydes –Nylon, Engineering Ceramics – Properties and applications of Al2O3, SiC, Si3N4, PSZ and SIALON – Composites- Matrix and reinforcement Materials- applications of Composites - Nano composites		

UNIT - V	MECHANICAL PROPERTIES AND DEFORMATION MECHANISMS	9
Mechanisms of plastic deformation, slip and twinning – Types of fracture – fracture mechanics - Griffith's theory- Testing of materials under tension, compression and shear loads – Hardness tests (Brinell, Vickers and Rockwell), Micro and nano-hardness tests, Impact test Izod and charpy, fatigue and creep failure mechanisms		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Explain alloys and phase diagram, Iron-Iron carbon diagram and steel classification.
CO2	Outline isothermal transformation, continuous cooling diagrams and different heat treatment processes.
CO3	Clarify the effect of alloying elements on ferrous and non-ferrous metals.
CO4	Summarize the properties and applications of non-metallic materials.
CO5	Explain the testing of mechanical properties.

Text Books	
1.	Williams D Callister, "Material Science and Engineering" Wiley India Pvt Ltd, Revised Indian Edition, 2014.
2.	O.P. Khanna "Material Science and Metallurgy", Dhanpat Rai Publication, 2011.

Approved by BoS Chairman

Reference Books	
1.	Kenneth G.Budinski and Michael K. Budinski, “Engineering Materials”, Prentice Hall of India Private Limited, 9th edition, 2018.
2.	Raghavan.V, “Materials Science and Engineering”, Prentice Hall of India Pvt.Ltd. 6th edition, 2019.
3.	G.S. Upadhyay and Anish Upadhyay, “Materials Science and Engineering”, Viva Books Pvt. Ltd, New Delhi, 2020.
4.	U.C. Jindal : Material Science and Metallurgy, “Engineering Materials and Metallurgy”, First Edition, Dorling Kindersley, 2012.
5.	https://archive.nptel.ac.in/courses/113/102/113102080/

Approved by BoS Chairman

B.E. / B.Tech.	B23MEI301 FLUID MECHANICS AND MACHINERY	L	T	P	C
		3	0	2	4

Course Objectives	
1.	The properties of fluids and concept of control volume are studied.
2.	The applications of the conservation laws to flow through pipes are studied.
3.	To understand the importance of dimensional analysis.
4.	To understand the importance of various types of flow in pumps.
5.	To understand the importance of various types of flow in turbines.

UNIT - I	FLUID PROPERTIES AND FLOW CHARACTERISTICS	9

Units and dimensions- Properties of fluids - mass density, specific weight, specific volume, specific gravity, viscosity, compressibility, vapor pressure, capillarity and surface tension. Flow characteristics – concept of control volume - application of control volume to continuity equation, energy equation and momentum equation

UNIT - II	BOUNDARY LAYER AND FLOW THROUGH PIPES	9

Hydraulic and energy gradient - Laminar flow through circular conduits and circular Boundary layer concepts – types of boundary layer thickness – Darcy Weisbach equation – friction factor - Moody diagram - commercial pipes - minor losses– Flow through pipes in series and parallel

UNIT - III	DIMENSIONAL ANALYSIS	9

Need for dimensional analysis – methods of dimensional analysis – Rayleigh method and Buckingham π theorems. Similitude – types of similitude – Dimensionless parameters- application of dimensionless parameters – Model analysis

UNIT - IV	HYDRAULIC PUMPS	9

Impact of jets - Euler’s equation - Theory of rotodynamic machines – various efficiencies – velocity components at entry and exit of the rotor- velocity triangles - Centrifugal pumps – working principle - work done by the impeller – performance curves - Reciprocating pump working principle – indicator diagram – work saved by fitting air vessels – Rotary pumps – classification – comparison of working principle with other pumps – advantages

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UNIT - V	HYDRAULIC TURBINES	9
Classification of turbines – heads and efficiencies – velocity triangles – axial, radial and mixed flow turbines – Pelton wheel and Francis turbine - working principles – work done by water on the runner – draft tube - specific speed - unit quantities – performance curves for turbines – governing of turbines		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Apply mathematical knowledge to predict the properties and characteristics of a fluid.
CO2	Analyse and calculate major and minor losses associated with pipe flow in piping networks.
CO3	Solve problems in mass, momentum and energy balance equations in fluid dynamics
CO4	Analyse the performance of pumps.
CO5	Analyse the performance of turbines.

LIST OF EXPERIMETS	
1.	Determination of the Coefficient of discharge of given Orifice meter.
2.	Determination of the Coefficient of discharge of given Venturi meter.
3.	Calculation of the rate of flow using Rota meter.
4.	Performance characteristics of a Centrifugal pump.
5.	Performance characteristics of a Reciprocating pump.
6.	Performance characteristics of a Gear pump.
7.	Determination of co-efficient of friction in a pipe flow.
8.	Performance characteristics of a Pelton wheel.
9.	Performance characteristics of a Francis turbine.
10.	Performance characteristics of a Kaplan turbine.
Total Instructional hours : Lecture Hours = 45 . Practical Hours = 30.	

J.P.

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Text Books	
1.	R. K. Bansal, “Fluid Mechanics and Hydraulic machines”,11th Edition, Laxmi Publications, 2023.
2.	Modi P.N. and Seth, S.M., "Hydraulics and Fluid Mechanics", 22nd Edition Standard Book House, New Delhi 2019.

Reference Books	
1.	Rajput.R.K., “A Textbook of Fluid Mechanics and Hydraulic Machines” March 2021.
2.	White.F.M., “Fluid Mechanics”, 9th Edition, Tata McGraw Hill, New Delhi 2022.
3.	https://nptel.ac.in/courses/112104118.

Approved by BoS Chairman

B.E. / B.Tech.	B23MEP301 MANUFACTURING TECHNOLOGY LABORATORY	L	T	P	C
		0	0	4	2

Course Objectives	
1.	Using moulding pattern and prepare sand moulds.
2.	Make the workpiece by performing various lathe operations.
3.	Perform milling , shaping and grinding operations.
4.	Manufacture the gears and to manufacture the tools using tool cutter grinder.
5.	Develop CNC part program for performing machine operations in CNC.

Expt. No.	Description of the Experiments
1.	Preparation of Green sand mould using Solid patterns.
2.	Preparation of Green sand mould using Split patterns.
3.	Taper turning operation using lathe.
4.	Knurling operation using lathe.
5.	External and Internal thread cutting operations using lathe.
6.	Eccentric turning operation using lathe.
7.	Contour milling and shaping operation.
8.	Plain surface grinding operation.
9.	Gear generation in hobbing machine.
10.	Tool angle grinding with Tool and Cutter Grinder.
11.	Taper turning and Threading using CNC lathe.
12.	Drilling and Tapping using CNC milling machine.
	Total Instructional hours : 45

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Course Outcomes : Students will be able to	
CO1	Preparing Sand moulds using moulding tools and patterns.
CO2	Obtain Required shape and size through Lathe operations.
CO3	Ability to use different machine tools for finishing operations.
CO4	Use different machine tools to manufacturing gears.
CO5	Develop CNC part programming.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S. No.	Name of the Equipment	Qty.
1.	Moulding table, Moulding equipments	2 sets
2.	Centre Lathe	7
3.	Milling machine	1
4.	Shaper	1
5.	Surface Grinding machine	1
6.	Gear hobbing machine	1
7.	Tool and cutter grinder	1
8.	CNC Lathe	1

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B.E. / B.Tech.	B23MEP302 DESIGN STUDIO	L	T	P	C
		0	0	4	2

Course Objectives	
1.	To learn the drawing standards, fits and tolerances.
2.	To draw part drawings, sectional views and assembly drawings as per standards and parts.
3.	To understand the orthographic projections of simple machine parts.
4.	To understand the various functions of 3D modeling software.
5.	To make students to appreciate the functions of various machine assemblies.

PART - A	DRAWING STANDARDS, FITS AND TOLERANCES	9

Code of practice for Engineering Drawing, BIS specifications – Welding symbols, riveted joints, keys, fasteners – Reference to hand book for the selection of standard components like bolts, nuts, screws, keys etc. - Limits, Fits – Tolerancing of individual dimensions – Specification of Fits – Preparation of production drawings and reading of part and assembly drawings, basic principles of geometric dimensioning & tolerance

PART - B	INTRODUCTION TO 2D DRAFTING	15

- Drawing, Editing, Dimensioning, Layering, Hatching, Block, Array & Detailed drawing
- Orthographic Projections of simple machine parts

PART - C	3D GEOMETRIC MODELING AND ASSEMBLY	21

- Sketcher - Datum planes – Protrusion – Holes - Part modeling – Extrusion – Revolve – Sweep – Loft – Blend – Fillet - Pattern – Chamfer - Round - Mirror – Section – Assembly
- Couplings – Flange and Universal couplings
- Joints – Knuckle joint, sleeve & cotter joints
- Engine parts – Piston, connecting rod

Total Instructional Hours : 45

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Course Outcomes : Students will be able to	
CO1	Understand and interpret drawing standards, fits and tolerances.
CO2	Develop part drawings, sectional views and assembly drawings as per standards and parts.
CO3	Make use of Indian Standards on drawing practices and standard components.
CO4	Make use of CAD packages to prepare assembly drawings.
CO5	Develop knowledge in handling 2D drafting and 3D modeling software systems.

Reference Books	
1.	N.D. Bhatt and V.M. Panchal, “Machine Drawing”, 48^{th} Edition, Charotar Publishers, 2013.
2.	N.D. Junnarkar, “Machine Drawing”, 1^{st} Edition, Pearson Education, 2004.
3.	N. Siddeshwar, P. Kanniah, V.V.S. Sastri,” Machine Drawing”, published by Tata Mc Graw Hill, 2006.
4.	S. Trymbaka Murthy, “A Text Book of Computer Aided Machine Drawing”, CBS Publishers, New Delhi, 2007.
5.	SP- 46 - 2003 - Bureau of Indian Standards.

Total 20% of classes for theory and 80% of classes for practice.

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Semester – IV

B.E.	B23MET401 KINEMATICS OF MACHINERY	L	T	P	C
		3	1	0	4

Course Objectives	
1.	To understand the basic components and layout of linkages in the assembly of a system machine.
2.	To understand the principles in analyzing the assembly with respect to the displacement, velocity, and acceleration at any point in a link of a mechanism.
3.	To understand the motion resulting from a specified set of linkages, design few linkage mechanisms and cam mechanisms for specified output motions.
4.	To understand the basic concepts of toothed gearing and kinematics of gear trains.
5.	To understand the basic of the effects of friction in motion transmission and in machine components.

UNIT - I	BASICS OF MECHANISMS	12

Classification of mechanisms – Basic kinematic concepts and definitions – Degree of freedom, Mobility – Kutzbach criterion, Gruebler's criterion – Grashof's Law – Kinematic inversions of four-bar chain and slider crank chains – Limit positions – Mechanical advantage – Transmission Angle – Description of some common mechanisms – Quick return mechanisms, Straight line generators, Universal Joint – rocker mechanisms

UNIT - II	KINEMATICS OF LINKAGE MECHANISMS	12

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 – Introduction to linkage synthesis problem

UNIT - III	KINEMATICS OF CAM MECHANISMS	12

Classification of cams and followers – Terminology and definitions – Displacement diagrams –Uniform velocity, parabolic, simple harmonic and cycloidal motions – Derivatives of follower motions – Layout of plate cam profiles – Specified contour cams – Circular arc and tangent cams – Pressure angle and undercutting – sizing of cams

J.P.

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UNIT - IV	GEARS AND GEAR TRAINS	12
Law of toothed gearing – Involutes and cycloidal tooth profiles –Spur Gear terminology and definitions – Gear tooth action – contact ratio – Interference and undercutting. Helical, Bevel, Worm, Rack and Pinion gears [Basics only]. Gear trains – Speed ratio, train value – Parallel axis gear trains – Epicyclic Gear Trains		

UNIT - V	FRICTION IN MACHINE ELEMENTS	12
Surface contacts – Sliding and Rolling friction – Friction drives – Friction in screw threads – Bearings and lubrication – Friction clutches – Belt and rope drives – Friction in brakes - Band and Block brakes		
		Total Instructional hours : 60

Course Outcomes : Students will be able to	
CO1	Discuss the basics of mechanism.
CO2	Calculate velocity and acceleration in simple mechanisms.
CO3	Develop CAM profiles.
CO4	Solve problems on gears and gear trains.
CO5	Examine friction in machine elements.

Text Books	
1.	RS Khurmi, JK Gupta, "Theory of Machines", 14th Edition, S.Chand, 2017.
2.	Rattan, S.S, "Theory of Machines", 5th Edition, Tata McGraw-Hill, 2017.
3.	J.Uicker, Gordon R. Pennock & Joseph E. Shigley, "Theory Of Machine And Mechanisms", 6th Edition, Cambridge University Press, 2023.

Approved by BoS Chairman

Reference Books	
1.	Robert William Angus, “ The Theory of Machines “, Maxwell press, 2022.
2.	RL Norton, “Kinematics & Dynamics of Machinery”, 13th Edition, McGraw Hill Education Pvt. Ltd. 2017.
3.	Sadhu Singh, “Theory of Machines: Kinematics and Dynamics", 3rd Edition, Pearson Education, 2011.
4.	R.K. Bansal, "A Textbook of Theory of Machines", 5th Edition, Laxmi Publications, 2016.
5.	Thomas Bevan, “Theory of Machines”, 3rd Edition, Pearson Education, 2010.
6.	Talpasanu I, “Mechanics of Mechanisms and Machines”, Taylor & Francis, 2018. John
7.	https://archive.nptel.ac.in/courses/112/104/112104121/.

Approved by BoS Chairman

B.E.	B23MET402 STRENGTH OF MATERIALS	L	T	P	C
		2	1	0	3

Course Objectives	
1.	To impart the concepts of stress, strain, principal stresses and principal planes.
2.	To study the concept of shearing force and bending moment due to external loads in determinate beams and their effect on stresses.
3.	To determine stresses and deformation in circular shafts and helical spring due to torsion.
4.	To compute slopes and deflections in determinate beams by various methods.
5.	To determine the stresses and deformations induced in thin and thick shells.

UNIT - I	STRESS, STRAIN AND DEFORMATION OF SOLIDS	9

Rigid bodies and deformable solids – Tension, Compression and Shear Stresses – Deformation of simple and compound bars – Thermal stresses – Elastic constants – Volumetric strains – Stresses on inclined planes – principal stresses and principal planes – Mohr's circle of stress

UNIT - II	TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM	9

Beams – types transverse loading on beams – Shear force and bending moment in beams-Cantilevers and Simply supported beams. Theory of simple bending– bending stress distribution – Load carrying capacity – Proportioning of sections – Flitched beams – Shear stress distribution

UNIT - III	TORSION	9

Torsion formulation stresses and deformation in circular and hollows shafts – Stepped shafts– Deflection in shafts fixed at the both ends – Stresses in helical springs – Deflection of helical springs, carriage springs

UNIT - IV	DEFLECTION OF BEAMS	9

Double Integration method – Macaulay's method – Area moment method for computation of slopes and deflections in beams - Conjugate beam and strain energy – Maxwell's reciprocal theorems

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UNIT - V	THIN CYLINDERS AND THICK CYLINDERS	9
Stresses in thin cylindrical shell due to internal pressure circumferential and longitudinal stresses and deformation in thin and thick cylinders – Lame's theorem		
Total Instructional hours : 45		

Course Outcomes : Students will be able to	
CO1	Understand the concepts of stress, strain and fundamentals of principal stresses and principal planes.
CO2	Construct Shear force and Bending moment diagram and Bending stress.
CO3	Apply basic equation of simple torsion in designing of shafts and helical spring.
CO4	Choose a suitable method of solving for slope and deflection of beams under transverse loading.
CO5	Apply theories to design thin and thick shells.

Text Books	
1.	Bansal, R.K., "Strength of Materials", 6th Edition Laxmi Publications (P) Ltd., 2018.
2.	Rattan S S, "Strength of Materials", 3rd Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2016.

Reference Books	
1.	Subramanian R., "Strength of Materials", Oxford University Press, Oxford Higher Education Series, 2010.
2.	Ferdinand Pierre Beer, Elwood Russell Johnston, John T DeWolf, David Francis Mazurek, Sanjeev Sanghi, 7th Edition, McGraw-Hill India, 2016.
3.	Allan F. Bower, Applied Mechanics of Solids, Taylor & Francis Group, 2018.
4.	https://archive.nptel.ac.in/courses/112/107/112107147/

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B.E.	B23MET403 THERMAL ENGINEERING	L	T	P	C
		3	1	0	4

(Use of Standard and approved Steam Table, Mollier Chart, and Psychometric Chart permitted)

Course Objectives	
1.	Understand the internal combustion engine and apply thermodynamic concept to gas power cycle.
2.	Understand the internal combustion engine auxiliary systems with performance calculations.
3.	To apply thermodynamic concept to Boilers and analysis of Vapor Power cycles.
4.	Examine the importance of the for nozzles and turbine.
5.	Examine the importance of the various Compressor.

UNIT - I	IC ENGINES AND GAS POWER CYCLES	12

Classification and comparison of engines, working principle of four stroke and two stroke petrol and diesel engines with P-V and T-S diagrams. Air standard assumptions, cycles and efficiencies; Carnot, Otto, Diesel and Dual cycles, Brayton Cycle and comparison of gas power cycles

UNIT - II	ENGINE AUXILIARY SYSTEMS AND PERFORMANCE	12

Working principles and types of carburetors, fuel pumps and injectors, ignition systems MPFI, CRDI, lubricating and cooling systems; Super and turbo charging. Engine testing: Constant speed and variable speed tests, Engines powers, volumetric efficiency Morse test and heat balance test

UNIT - III	STEAM BOILER AND VAPOUR POWER CYCLE	12

Requirements of boiler; Types of boilers, Boilers Mountings and Accessories, Boiler performance: Ideal and actual Rankine cycles, Cycle Improvement methods Reheat and Regenerative cycles, and binary cycles

UNIT - IV	STEAM NOZZLES AND TURBINES	12

Types and Shapes of nozzles, Flow of steam through nozzles, Critical pressure ratio, Variation of mass flow rate with pressure ratio. Effect of friction. Metastable flow, Types, Impulse and reaction principles, Velocity diagrams, Work done and efficiency – optimal operating conditions. and governing

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UNIT - V	COMPRESSORS	12
Classification, working principle of air and gas reciprocating compressors, equations for shaft work and efficiencies, effect of clearance on volumetric efficiency, multi-stage compression, inter-cooler and optimum intermediate pressure. Rotary compressors working principle and performance		
		Total Instructional hours : 60

Course Outcomes : Students will be able to	
CO1	Apply thermodynamic concepts to IC Engine and analyse the performance of various gas standard cycles.
CO2	Apply thermodynamic concepts to engines auxiliaries and identify the performance parameters.
CO3	Determine the performance of Boilers and Vapor power cycles.
CO4	Determine the performance of Steam Nozzle and steam turbines.
CO5	Identify the various type of compressor and solve problems.

Text Books	
1.	Rudramoorthy R, "Thermal Engineering", 3rd Edition, Tata McGraw Hill Publishers Co. Ltd, India, 2017.
2.	Rajput. R.K., “Thermal Engineering” S.Chand Publishers, 2017.

Reference Books	
1.	Ananthanarayanan P.N, “Basic Refrigeration and Air – Conditioning”, 4th Edition, Tata McGraw Hill, 2013.
2.	Arora, “Refrigeration and Air – Conditioning”, 2nd Edition, Prentice Hall of India, 2010.
3.	Mathur M.L and Mehta F.S., “Thermal Science and Engineering”, 3rd Edition, Jain Brothers, Pvt. Ltd, 2017.
4.	Ganesan V, "Internal Combustion Engine", 4th Edition, McGraw Hill Publishers, India, 2012.
5.	Ballaney. P.L. “Thermal Engineering”, Khanna publishers, 24th Edition 2012.
6.	https://nptel.ac.in/courses/112103316.

Approved by BoS Chairman

B.E / B.Tech	B23MET404 MANUFACTURING PROCESSES	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To Design core, pattern, gating system and different types of metal casting processes.
2.	To Examine weld joints fabricated through solid state and fusion joining, brazing and soldering techniques.
3.	To Develop process-maps for metal forming processes using plasticity principles.
4.	To Demonstrate an understanding of sheet metal processes, press tools and high energy rate forming processes.
5.	To know the basic concepts of various methods of manufacturing plastic components and polymer composites.

UNIT - I	METAL CASTING PROCESSES	9

Sand Casting : Sand Mould – Type of patterns – Pattern Materials – Pattern allowances, Moulding sand Properties and testing – Cores – Types and applications – Moulding machines – Types and applications; gating system, sprue, gate, riser; Melting furnaces: Blast and Cupola Furnaces; Principle of special casting processes: Shell – investment – Ceramic mould – Pressure die casting Centrifugal Casting – CO_2 process – Stir casting; Defects in Sandcasting

UNIT - II	JOINING PROCESSES	9

Operating principle, basic equipment, merits and applications of : Fusion welding processes : Gas welding – Types – Flame characteristics; Manual metal arc welding – Gas Tungsten arc welding – Gas metal arc welding – Submerged arc welding – Electro slag welding; Operating principle and applications of: Resistance welding – Plasma arc welding ,Thermit welding – Electron beam welding – Friction welding and Friction Stir Welding; Brazing and soldering; Weld defects: types, causes and cure. Microstructural Evolution – Different Zones of Weld Region and their Microstructural Evolution

Approved by BoS Chairman

UNIT - III	METAL FORMING PROCESSES	9
Hot working and cold working of metals – Forging processes – Open, impression and closed die forging – forging operations. Rolling of metals – Types of Rolling – Flat strip rolling – shape rolling operations – Defects in rolled parts. Principle of Wire and tube drawing, Extrusion and Deep Drawing, Defects – Types – Hot and Cold extrusion		

UNIT - IV	SHEET METAL PROCESSES	9
Sheet metal processes – Principle of shearing, Sheet metal operations: Blanking, punching, bending, drawing, spinning – Stretch forming operations – Formability of sheet metal – Test methods – special forming processes – Working principle and applications – Hydro forming – Rubber pad forming, Metal spinning – Introduction of Explosive forming, magnetic pulse forming, peen forming, Super plastic forming – Microforming. High energy rate forming processes: Explosive forming, electromagnetic forming, electro hydraulic forming		

UNIT - V	MANUFACTURE OF PLASTIC COMPONENTS AND INTRODUCTION TO POLYMER COMPOSITES	9
Types and characteristics of plastics – Moulding of thermoplastics – working principles and typical applications – injection moulding – Plunger and screw machines – Compression moulding, Transfer moulding – Typical industrial applications – introduction to blow moulding Rotational moulding – Film blowing – Extrusion – Thermoforming – Bonding of Thermoplastics. Polymer Composite: matrix materials, reinforcement, different manufacturing methods		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Recognize the different types of casting and select a suitable casting process based on the product to be developed.
CO2	Establish knowledge on basic welding processes, defects in welding and modern welding processes.
CO3	Describe the concept of forging, rolling process and drawing.

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CO4	Explain an understanding of sheet metal processes, press tools and high energy rate forming processes.
CO5	Construct various methods of manufacturing plastic components and polymer composite.

Text Books	
1.	Hajra Chouldhary S.K and Hajra Choudhury. AK., "Elements of workshop Technology", Volume I and II, Media promoters and Publishers Private Limited, Mumbai, 2010.
2.	Serope Kalpakjian and Stephen Schmid "Manufacturing, Engineering and Technology", Pearson Education., 2018.
3.	Rao P N "Manufacturing Technology", Tata McGraw Hill Education Private Limited., New Delhi, 2013.

Reference Books	
1.	Gowri P. Hariharan, A. Suresh Babu, “Manufacturing Technology I”, Pearson Education, 2010.
2.	Rao, P.N. “Manufacturing Technology Foundry, Forming and Welding”, 4th Edition, TMH–2013.
3.	Sharma, P.C., “A Text book of Production Technology”, S. Chand and Co. Ltd, 2014.
4.	R.K. Rajput, “A textbook of Manufacturing Technology (Manufacturing Processes)”, Laxmi Publications (p) ltd, 2015.
5.	Manufacturing Science. Amitabha Ghosh and Mallick A.K, Affiliated East-West Press Pvt. Ltd. 2010.
6.	https://archive.nptel.ac.in/courses/112/107/112107219/

Approved by BoS Chairman

B.E.	B23MEI401 MECHANICAL MEASUREMENTS AND METROLOGY	L	T	P	C
		3	0	2	4

Course Objectives	
1.	The types of errors, design of limit gauges, and various Comparative measurements.
2.	To deliver knowledge on various linear and angular metrological instruments available to measure the sizes.
3.	To convey the ideas on advanced laser metrology for various industrial applications.
4.	To educate the proper procedure to be adopted in measuring the dimensions of the components.
5.	To impart the skill on different kind of traditional and latest computer-aided measuring instruments with appropriate parameters of measuring components.

UNIT - I	GENERAL CONCEPTS OF MEASUREMENT	9

Definition - standards of measurement - accuracy and precision-errors in measurement limits, fits and tolerance analysis in manufacturing and assembly - calibration of instruments. Principles of light interference - measurements and calibrations - interchangeability and selective assembly

UNIT - II	LINEAR AND ANGULAR MEASUREMENTS	9

Linear measuring instruments : Vernier instruments, micrometers, height gauge, dial indicators, bore gauges and slip gauges, comparators. Angle measuring instruments : bevel protractors, sprit level, sine bar, autocollimator, and angle dekkor and clinometers interferometry

UNIT - III	ADVANCES IN METROLOGY INSTRUMENTS AND ITS APPLICATIONS	9

Laser in engineering metrology - methods of laser metrology - precision instruments based on laser - laser interferometer - applications of laser in industry - coordinate measuring machine (CMM) - need, construction, types, applications - computer aided inspection

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UNIT - IV	FORM MEASURING INSTRUMENTS AND ITS APPLICATIONS	9
Screw thread terminology - Measurement of effective diameter by two wire and three wire methods - errors in threads - Measurement of pitch, profile errors and total composite errors, Gear tooth terminology - Methods of measurements of runout, pitch, profile, lead, backlash, tooth thickness composite method of inspection - Measurement of surface finish - Stylus probe instruments - profilometer - Tomlinson and Talysurf Instrument - Straightness, Flatness and Roundness measurement		

UNIT - V	COMPUTER AIDED INSPECTION	9
Automated inspection - online and offline inspection, sensor technology for manufacturing process monitoring and inspection - flexible inspection system-non contact inspection methods - automatic gauging and size control system - coordinate measuring machine - non-contact sensors for surface finish measurements - machine vision systems and its applications		
		Total Instructional hours : 45

LIST OF EXPERIMENTS	
1.	Calibration and use of measuring instruments – Vernier caliper, micrometer, Vernier height gauge – using gauge blocks.
2.	Calibration and use of measuring instruments – depth micrometer, bore gauge, telescopic gauge.
3.	Measurement of linear dimensions using Comparators.
4.	Measurement of angles using bevel protractor and sine bar.
5.	Measurement of gear parameters – disc micrometers, gear tooth vernier caliper.
6.	Non-contact (Optical) measurement using Toolmaker’s microscope / Profile projector and Video measurement system.
7.	Machine tool metrology – Level tests using precision level; Testing of straightness of a machine tool guide way using Autocollimator, spindle tests.
8.	Measurement of force, torque and temperature.

Contact periods :		
Lecture hours : 45	**Practical hours : 30**	**Total hours : 75**

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Course Outcomes : Students will be able to	
CO1	Describe the concepts of measurements to apply in various metrological instruments.
CO2	Outline the principles of linear and angular measurement tools used for industrial applications.
CO3	Express the various measurement concepts involved in laser metrology.
CO4	Demonstrate the techniques of form measurement used for industrial components.
CO5	Explain the basic concepts of computer-aided inspection.

Text Books	
1.	Anand K. Bewoor, Vinay A. Kulkarani, Metrology and Measurement, 1st Edition, McGraw Hill Publishing Co. Ltd., 2014.
2.	Mark Curtis, Francis T. Farago, “Handbook of Dimensional Measurement”, Industrial Press, Fifth edition, 2013.

Reference Books	
1.	Amm arGrous, J “Applied Metrology for Manufacturing Engineering”, Wiley-ISTE, 2011.
2.	Galy er, J.F.W. Charles Reginald Shotbolt, “Metrology for Engineers”, Cengage Learning EMEA; 5th revised edition, 1990.
3.	National Physical Laboratory Guide No. 40, No. 41, No. 42, No. 43, No. 80, No. 118, No. 130, No. 131. http://www.npl.co.uk.
4.	Raghavendra N.V. and Krishnamurthy. L., Engineering Metrology and Measurements, Oxford University Press, 2013.
5.	https://archive.nptel.ac.in/courses/112/106/112106139/

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B.E.	B23MEP401 STRENGTH OF MATERIALS LABORATORY	L	T	P	C
		0	0	4	2

Course Objectives	
1.	Perform Tension, shear and torsion test on solid materials.
2.	Determine the Toughness of the material using CHARPY and IZOD Test.
3.	Determine the Brinnell and Rockwell hardness number of the given specimen.
4.	Estimate the elastic constants through compression test on springs and deflection test on beams.
5.	Compare the structures and hardness of Unhardened and Hardened specimen through microscopic examinations.

LIST OF EXPERIMENTS		
1.	Tension test on a mild steel rod.	
2.	Double shear test on Mild steel and Aluminium rods	
3.	Torsion test on mild steel rod	
4.	Impact test on metal specimen	
5.	Hardness test on metals – Brinnell and Rockwell Hardness Number	
6.	Deflection test on beams	
7.	Compression test on helical springs	
8.	Effect of hardening– Improvement in hardness and impact resistance of steels.	
9.	Tempering– Improvement Mechanical properties Comparison	
	i.	Unhardened specimen
	ii.	Quenched Specimen and
	iii.	Quenched and tempered specimen.
10.	Microscopic Examination of	
	i.	Hardened samples and
	ii.	Hardened and tempered samples.
	Total Instructional hours : 45	

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Course Outcomes : Students will be able to	
CO1	Determine the mechanical properties like tensile and compressive strength, hardness, impact strength and flexural rigidity of materials.
CO2	Identify the materials for best practices based on mechanical properties.
CO3	Analyze the deformation behavior of materials for different loading conditions.
CO4	Utilize appropriate materials in design considering their properties, sustainability, Cost and weight.
CO5	Examine and distinguish different destructive testing methods.
CO6	Analyze the different hardened samples using various harnesses testing Machine.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S. No.	Name of the Equipment	Qty.
1.	Universal Tensile Testing machine with double 1 shear attachment – 40 Ton Capacity	1
2.	Torsion Testing Machine (60 NM Capacity)	1
3.	Impact Testing Machine (300 J Capacity)	1
4.	Brinnell Hardness Testing Machine	1
5.	Rockwell Hardness Testing Machine	1
6.	Spring Testing Machine for tensile and compressive loads (2500 N)	1
7.	Metallurgical Microscopes	1
8.	Muffle Furnace (800 C)	1

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B.E.	B23MEP402 THERMAL ENGINEERING LABORATORY	L	T	P	C
		0	0	4	2

Course Objectives	
1.	Analyzing the performance characteristics of various engines.
2.	Analyzing for proper valve and port timing in IC engines.
3.	Analyzing boiler and steam turbine operation.
4.	Experiment with two stage Reciprocating Air compressor.
5.	Analyzing characteristics of fuels/Lubricates used in IC Engines.

LIST OF EXPERIMENTS	
1.	Valve Timing diagrams.
2.	Port Timing diagrams.
3.	Performance Test on four – stroke Diesel Engine
4.	Heat Balance Test on 4 – stroke Diesel Engine.
5.	Retardation Test on a Diesel Engine.
6.	Determination of Flash Point and Fire Point of various fuels / lubricants
7.	Performance test on a two stage Reciprocating Air compressor.
8.	Study of Steam Generators.
9.	Study of Steam Turbines.
	Total Instructional hours : 45

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Course Outcomes : Students will be able to	
CO1	Infer the concepts, laws and methodologies from the first course in thermo dynamics into analysis of cyclic processes.
CO2	Apply the thermodynamic concepts into various thermal applications like IC engines, Steam Turbines, Compressors and Refrigeration and Air conditioning systems.
CO3	Apply the thermodynamic concepts to solve a variety of problems.
CO4	Estimate the performance of different thermal equipment's like air blower, reciprocating compressors, Boilers.
CO5	Experiment with variety of experiments in internal combustion engines.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S. No.	Name of the Equipment	Qty.
1.	I.C Engine – 2 stroke and 4 stroke model	1
2.	Apparatus for Flash and Fire Point	1
3.	4-stroke Diesel Engine with mechanical loading.	1
4.	4-stroke Diesel Engine with hydraulic loading.	1
5.	4-stroke Diesel Engine with electrical loading.	1
6.	Multi-cylinder Petrol Engine	1
7.	Single cylinder Diesel Engine	1
8.	Two stage Reciprocating Air compressor	1

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B.E.	B23CEP401 PROFESSIONAL CERTIFICATE COURSE	L	T	P	C
		0	0	2	1

Course Objectives	
1.	To understand and learn the software tools.
2.	To make the different types of parametric and feature based modeling.
3.	To gain the knowledge about assembly
4.	To create the 2D modeling for various component.
5.	To create the 3D modeling for different shapes.

UNIT - I	COMPLEX 2D SKETCH / PROFILE CREATION	4

Operation Toolbar - Re-limitations (Corner, Chamfer, Trim, Break, Quick Trim, Close arc, Complement), Transformation (Mirror, Symmetry, Translate, Rotate, Scale, Offset). Constraint - Important of Dimensional Constraints, Geometrical Constrains and its

UNIT - II	PART CREATION & MODIFICATION	6

Introduction to Part Design, Introduction to Parametric and Feature Based Modeling. Sketch-Based Features - Pads, Pockets, Shaft, Groove, Hole, Rib, Slot, Solid combine Stiffener, Multi-section Solid, and Multi-Section Remove. Dress-Up Features - Fillets, Chamfer, Drafts, Shell, Thickness, Thread / Tap, Remove & Replace face. Transformation Features - Translation, Rotation, Symmetry, Axis to Axis, Rectangular, Circular & User - defined Pattern, Scale, and Affinity. Reference Elements - Point, Lines, Planes

UNIT - III	BUILD, CONTROL AND ANALYZE ASSEMBLIES	7

Introduction to Assembly Design, Types of Approaches – Top down & Bottom-up Assembly. Product Structure Tools, Constraints - Coincidence, Contact, Offset, Angle, Fix Component, Fix Together, Change constraint, Reus

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UNIT - IV	CREATING MANUFACTURING READY 2D DRAWINGS	7
Inserting New Sheet, Views, etc., Views - Projections (Front View, Unfolded View, View from 3D, Projection View, Auxiliary view, Isometric view, Advanced front view), Sections, Details view, Clipping view, Broken view, Breakout view, 3D clipping, View creation wizard. Dimensioning, Annotations		

UNIT - V	CREATING COMPLEX COMPONENTS	6
Introduction to Wireframe & Surface Design, Wireframe - Point, Line, Plane, Projection, Intersection, Circle, Corner, Connect Curve, Spline, Helix. Surfaces - Extrude, Revolve, Sphere, Cylinder, Offset, Sweep, Fill, Multi-Section Surface, Blend. Operations - Join, Healing, Disassemble, Split, Tri		
		Total Instructional hours : 30

Course Outcomes : Students will be able to	
CO1	Summarize with the Engineering graphics fundamentals, Industrial Standards.
CO2	Apply the special features for part creation.
CO3	Create complex 2D models of Engineering components
CO4	Create complex 3D models of Engineering components.
CO5	Create complex Mechanical Components.

Text Books	
1.	Gopalakrishna K.R., “Machine Drawing”, 22nd Edition, Subhas Stores Books Corner, Bangalore, 2013.
2.	Sham Tickoo, “CATIA V5-6R2015 for Engineers and Designers”, 13th Edition, 2016.

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Semester – V

B.E.	B23MET501 HEAT AND MASS TRANSFER	L	T	P	C
		3	1	0	4
(Use of standard HMT data book permitted)					

Course Objectives	
1.	To apply heat conduction equations to different surface configurations under steady state and transient conditions and solve problems
2.	To apply free and forced convective heat transfer correlations to internal and external flows through/over various surface configurations and solve problems
3.	To explain the phenomena of boiling and condensation, apply LMTD and NTU methods of thermal analysis to different types of heat exchanger configurations and solve problems
4.	To explain basic laws for Radiation and apply these principles to radiative heat transfer between different types of surfaces to solve problems
5.	To apply diffusive and convective mass transfer equations and correlations to solve problems for different applications

UNIT - I	CONDUCTION	12

General Differential equation of Heat Conduction – Cartesian and Polar Coordinates – One Dimensional Steady State Heat Conduction – plane and Composite Systems – Conduction with Internal Heat Generation – Extended Surfaces – Unsteady Heat Conduction – Lumped Analysis – Semi Infinite and Infinite Solids – Use of Heisler's charts

UNIT - II	CONVECTION	12

Free and Forced Convection - Hydrodynamic and Thermal Boundary Layer. Free and Forced Convection during external flow over Plates and Cylinders and Internal flow through tubes

UNIT - III	HEAT EXCHANGERS, CONDENSATION AND BOILING	12

Nusselt's theory of condensation-Regimes of Pool boiling and Flow boiling. Correlation in boiling and condensation. Heat Exchanger Types - Overall Heat Transfer Coefficient – Fouling Factors - Analysis – LMTD method - NTU method. Condensation and Boiling : Dimensionless parameters, boiling modes

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UNIT - IV	RADIATION	12
Black Body Radiation – Grey body radiation - Shape Factor – Electrical Analogy – Radiation Shields. Radiation through gases		

UNIT - V	MASS TRANSFER	12
Basic Concepts – Diffusion Mass Transfer – Fick's Law of Diffusion – Steady state Molecular Diffusion – Convective Mass Transfer – Momentum, Heat and Mass Transfer Analogy – Convective Mass Transfer Correlations. Limitations of heat and mass transfer analogy		
		Total Instructional hours : 60

Course Outcomes : Students will be able to	
CO1	Apply heat conduction equations to different surface configurations under steady state and transient conditions and solve problems.
CO2	Apply free and forced convective heat transfer correlations to internal and external flows through/ over various surface configurations and solve problems.
CO3	Explain the phenomena of boiling and condensation, apply LMTD and NTU methods of thermal analysis to different types of heat exchanger configurations and solve problems.
CO4	Explain basic laws for Radiation and apply these principles to radiative heat transfer between different types of surfaces to solve problems.
CO5	Apply diffusive and convective mass transfer equations and correlations to solve problems for different applications.

Text Books	
1.	J.P. Holman, Heat Transfer, 10^{th} Ed., McGraw-Hill, 2010.
2.	Yunus A. Cengel, "Heat Transfer A Practical Approach", Tata McGraw Hill, 5^{th} Edition 2015.

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Reference Books	
1.	Y. A. Cengel and A.J. Ghajar, Heat and Mass Transfer: Fundamentals and Applications, 5th Ed., McGraw-Hill, 2014.
2.	Lienhard, J.H., “A Heat Transfer Text Book” Dover publication, 2011.
3.	Sachdeva, R.C., “Fundamentals of Engineering Heat & Mass Transfer”, New Age International, New Delhi, 2011.
4.	Kothandaraman, C.P., "Fundamentals of Heat and Mass Transfer", New Age International, New Delhi, 2012.
5.	Nag, P.K., "Heat and Mass Transfer", Tata McGraw Hill, New Delhi, 2011.

Approved by BoS Chairman

B.E.	B23MET502 DESIGN OF MACHINE ELEMENTS	L	T	P	C
		2	1	0	3

(Use of Standard and approved PSG Design data book permitted)

Course Objectives	
1.	To familiarize the various steps involved in the Design Process
2.	To Learn designing shafts and couplings for various applications.
3.	To Learn the design of temporary and permanent Joints.
4.	To Learn designing helical, leaf springs, and flywheels for various applications.
5.	To Learn designing and select sliding and rolling contact bearings, seals and gaskets.

UNIT - I	FUNDAMENTAL CONCEPTS IN DESIGN	9

Introduction to Design process – Factors – Materials selection - direct - Bending and Torsional stress equation - Impact and Shock loading - Factor of safety - Design stress - Theories of failures - Stress concentration - theoretical stress concentration factor - Size factor - Surface limits factor - fatigue stress concentration factor - notch sensitivity - Variable and cyclic loads – Fatigue strength – S-N curve – Continued cyclic stress – Soderberg and Goodman equation - Curved beams – crane hook and 'C' frame-Problems

UNIT - II	SHAFTS AND COUPLINGS	9

Shafts and Axles - Design of solid and hollow shafts based on strength, rigidity and critical speed – Keys and splines – Rigid and flexible couplings

UNIT - III	TEMPORARY AND PERMANENT JOINTS	9

Threaded fasteners - Bolted joints – Simple and eccentrically loaded bolted joints- Welded joints – Butt, Fillet and parallel transverse fillet welds – welded joints subjected to bending, torsional and eccentric loads

UNIT - IV	ENERGY STORING ELEMENTS AND ENGINE COMPONENTS	9

Types of springs, design of helical and concentric springs–surge in springs, Design of laminated springs - Flywheels considering stresses in rims and arms for engines and presses - Solid and Rimmed flywheels

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UNIT - V	BEARINGS	9
Sliding contact and rolling contact bearings - Hydrodynamic journal bearings, Sommerfeld Number, Raimondi & Boyd graphs, -- Selection of Rolling Contact bearings -Seals and Gaskets		
Total Instructional hours : 45		

Course Outcomes : Students will be able to	
CO1	Explain the design machine members subjected to static and variable loads.
CO2	Apply the concepts design to shafts, key and couplings.
CO3	Utilize the concepts of design to bolted and welded joints.
CO4	Identify the concept of design helical, leaf springs, and flywheels.
CO5	Apply the concepts of design and select sliding and rolling contact bearings, seals and gaskets.

Text Books	
1.	Bhandari V, “Design of Machine Elements”, 3rd Edition, Tata McGraw-Hill Book Co, 2010.
2.	Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett “Mechanical Engineering Design”, 9th Edition, Tata McGraw-Hill, 2014.

Reference Books	
1.	Ansel C Ugural, “Mechanical Design – An Integral Approach”, 1st Edition, Tata McGraw-Hill Book Co, 2004.
2.	Design Data Hand Book”, PSG College of Technology, Coimbatore, 2013.
3.	Merhyle Franklin Spotts, Terry E. Shoup, and Lee Emrey Hornberger, “Design of Machine Elements” 8th Edition, Printice Hall, 2004.
4.	Robert C. Juvinall and Kurt M. Marshek, “Fundamentals of Machine component Design”, 6th Edition, Wiley, 2017.
5.	Sundararajamoorthy T.V. and Shanmugam. N, “Machine Design”, Anuradha Publications, Chennai, 2003.

Approved by BoS Chairman

B.E.	B23MET503 DYNAMICS OF MACHINES	L	T	P	C
		2	1	0	3

Course Objectives	
1.	To provide the knowledge on force-motion relationship in components when applying external forces and analysis of standard mechanisms.
2.	To estimate the effects of unbalances resulting from prescribed motions in mechanism.
3.	To deliver knowledge on various types of free vibrations and effects.
4.	To impart the skill on various forced vibration and damping systems and vibration measuring instruments.
5.	To understand the principles in mechanisms used for speed control and stability control.

UNIT - I	FORCE ANALYSIS	9
Static force analysis of mechanisms - D' Alembert's principle - Inertia force and Inertia torque - Dynamic force analysis - Dynamic Analysis in Reciprocating Engines - Gas Forces - Equivalent masses - Bearing loads - Crank shaft Torque. Flywheels, Turning moment diagrams		

UNIT - II	BALANCING	9
Static and dynamic balancing – balancing of rotating masses – Balancing Multi cylinder Engines - Balancing of Reciprocating masses - Primary and secondary unbalanced forces - partial balancing of unbalanced primary force-partial balancing of Locomotives-Variation of tractive force, swaying couple and Hammer blow		

UNIT - III	FREE VIBRATION	9
Basic features of vibratory systems – degrees of freedom – free vibration – equations of motion – natural frequency – types of damping – damped vibration - critical speeds of simple shaft – torsional systems: single, two rotor systems		

UNIT - IV	FORCED VIBRATION	9
Response to periodic forcing – harmonic forcing – unbalanced forcing - force transmissibility and amplitude transmissibility – vibration isolation. Selection of vibration measuring instruments – accelerometer – dynamic properties and selection of structural materials for vibration control		

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UNIT - V	MECHANISM FOR CONTROL	9
Governors – types – centrifugal governors – gravity controlled centrifugal governors – characteristics – effect of friction – controlling force. Gyroscopes – gyroscopic forces and torques – gyroscopic stabilization – gyroscopic effects in automobiles, ships and airplanes		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Apply the principles and calculate static and dynamic forces of mechanisms.
CO2	Determine the balancing masses and their locations of rotating and reciprocating masses.
CO3	Compute the frequency of various types of free vibrations.
CO4	Calculate the frequency of different forced vibrations and damping coefficient.
CO5	Estimate the gyroscopic effect on automobiles, ships and airplanes and determine the speed and lift of various governors.

	Text Books
1.	Rattan S. S. - 'Theory of Machines' - McGraw Hill India Pvt. Ltd. - 2014 - 4th Edition.
2.	Ghosh A. and Mallick A. K. - 'Theory of Mechanisms and Machines' - Affiliated East West Press Pvt. Ltd., New Delhi – 2015.
3.	Shigley J. E. and Uicker J. J. - 'Theory of Machines and Mechanisms' Oxford Publishers - 2014 - SI units Edition.

	Reference Books
1.	F.B. Sayyad, "Dynamics of Machinery", McMillan Publishers India Ltd., Tech-Max Educational resources, 2011.
2.	Sadhu Singh – "Theory of Machines" - Pearson Education - 2011 - 3rd Edition.
3.	Khurmi, R.S.,"Theory of Machines", 14th Edition, S Chand Publications, 2015.
4.	Thomas Bevan, "Theory of Machines", Pearson Education Limited, 2010.
5.	Robert L. Norton, "Kinematics and Dynamics of Machinery", Tata McGraw-Hill, 2017.

Approved by BoS Chairman

B.E.	B23MET504 DIGITAL MANUFACTURING AND IOT	L	T	P	C
		3	3	0	0

Course Objectives	
1.	To study the various aspects of digital manufacturing.
2.	To inculcate the importance of DM in Product Lifecycle Management and Supply chain Management.
3.	To formulate of smart manufacturing systems in the digital work environment.
4.	To impart the skill on various forced vibration and damping systems and vibration measuring instruments.
5.	To elaborate the significance of digital twin.

UNIT - I	INTRODUCTION	9

Introduction – Need – Overview of Digital Manufacturing and the Past – Aspects of Digital Manufacturing: Product life cycle, Smart factory, and value chain management – Practical Benefits of Digital Manufacturing – The Future of Digital Manufacturing

UNIT - II	DIGITAL LIFE CYCLE & SUPPLY CHAIN MANAGEMENT	9

Collaborative Product Development, Mapping Requirements to specifications – Part Numbering, Engineering Vaulting, and Product reuse – Engineering Change Management, Bill of Material and Process Consistency – Digital Mock up and Prototype development – Virtual testing and collateral. Overview of Digital Supply Chain - Scope& Challenges in Digital SC - Effective Digital Transformation - Future Practices in SCM

UNIT - III	SMART FACTORY	9

Smart Factory – Levels of Smart Factories – Benefits – Technologies used in Smart Factory – Smart Factory in IoT- Key Principles of a Smart Factory – Creating a Smart Factory – Smart Factories and Cybersecurity

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UNIT - IV	INDUSTRY 4.0	9
Introduction – Industry 4.0 – Internet of Things – Industrial Internet of Things – Framework : Connectivity devices and services – Intelligent networks of manufacturing – Cloud computing – Data analytics – Cyber physical systems –Machine to Machine communication – Case Studies		

UNIT - V	STUDY OF DIGITAL TWIN	9
Basic Concepts – Features and Implementation – Digital Twin: Digital Thread and Digital Shadow - Building Blocks – Types – Characteristics of a Good Digital Twin Platform – Benefits, Impact & Challenges – Future of Digital Twins		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Impart knowledge to use various elements in the digital manufacturing.
CO2	Differentiate the concepts involved in digital product development life cycle process and supply chain management in digital environment.
CO3	Select the proper procedure of validating practical work through digital validation in Factories.
CO4	Implementation the concepts of IoT and its role in digital manufacturing.
CO5	Analyse and optimize various practical manufacturing process through digital twin.

Text Books	
1.	Zude Zhou, Shane (Shengquan) Xie and Dejun Chen, Fundamentals of Digital
2.	Manufacturing Science, Springer-Verlag London Limited, 2012.
3.	Alasdair Gilchrist, “Industry 4.0: The Industrial Internet of Things”, A press, 2016.

Reference Books	
1.	Lihui Wang and Andrew YehChing Nee, Collaborative Design and Planning for Digital Manufacturing, Springer-Verlag London Limited, 2009.
2.	Andrew Yeh Chris Nee, Fei Tao, and Meng Zhang, “Digital Twin Driven Smart Manufacturing”, Elsevier Science., United States, 2019

Approved by BoS Chairman

B.E / B.Tech	B23MCT505- Holistic Insight into UN SDGs (Common to ALL)	L	T	P	C
		2	0	0	0

Course Objectives	
1.	To understand the origin, purpose, and significance of the UN Sustainable Development Goals (SDGs).
2.	To explore the 17 SDGs, their interconnections, and challenges in achieving them.
3.	To analyze global and local case studies of SDG implementation.
4.	To evaluate the role of governments, businesses, and individuals in sustainable development.
5.	To develop practical solutions and action plans for achieving SDGs at community and policy levels

SYLLABUS:

UNIT - I	INTRODUCTION TO SUSTAINABLE DEVELOPMENT & SDGS	6

Concept of **sustainability** and its evolution.

UN Millennium Development Goals (MDGs) vs. Sustainable Development Goals (SDGs). Overview of the **17 SDGs**, their targets, and indicators.

Importance of **global collaboration** for sustainable development.

UNIT - II	PEOPLE-CENTERED SDGS (SDG 1–6)	6

SDG 1: No Poverty – Causes, measures & policies.

SDG 2: Zero Hunger – Food security & sustainable agriculture.

SDG 3: Good Health & Well-being – Universal healthcare & disease prevention.

SDG 4: Quality Education – Inclusive and equitable education.

SDG 5: Gender Equality – Women's empowerment & equal opportunities.

SDG 6: Clean Water & Sanitation – Water conservation & access to sanitation.

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UNIT - III	ECONOMIC & INFRASTRUCTURE SDGS (SDG 7–12)	6
SDG 7: Affordable & Clean Energy – Renewable energy solutions. **SDG 8:** Decent Work & Economic Growth – Inclusive economic policies. **SDG 9:** Industry, Innovation & Infrastructure – Sustainable development & digital transformation. **SDG 10:** Reduced Inequalities – Social inclusion & global justice. **SDG 11:** Sustainable Cities & Communities – Smart urban planning & resilience. **SDG 12:** Responsible Consumption & Production – Circular economy & waste management.		

UNIT - IV	ENVIRONMENTAL SDGS (SDG 13–15)	6
SDG 13: Climate Action – Climate change impacts & mitigation strategies. **SDG 14:** Life Below Water – Ocean conservation & marine biodiversity. **SDG 15:** Life on Land – Forest preservation & biodiversity protection.		

UNIT - V	Governance & Global Partnerships (SDG 16–17)	6
SDG 16: Peace, Justice & Strong Institutions – Human rights & good governance. **SDG 17:** Partnerships for the Goals – Role of international cooperation, businesses & individuals.		

Course Outcomes: Students will be able to	
CO1	Explain the origin, purpose, and significance of the UN Sustainable Development Goals.
CO2	Summarize the 17 SDGs, their interconnections, and challenges in achieving them.
CO3	Interpret global and local case studies of SDG implementation.
CO4	Describe the roles of governments, businesses, and individuals in sustainable development.
CO5	Illustrate practical solutions and action plans for achieving SDGs at community and policy levels.

Approved by BoS Chairman

Text Books	
1.	Sachs, J. D. (2015). The Age of Sustainable Development. Columbia University Press.
2.	United Nations (2015). Transforming Our World: The 2030 Agenda for Sustainable Development.
3.	Griggs, D., Stafford-Smith, M., Gaffney, O., & Rockström, J. (2017). Sustainable Development Goals: Harnessing Business to Achieve the SDGs Through Finance, Technology and Innovation. Routledge.
4.	Mebratu, D., & Swilling, M**. (2019).** Transformational Infrastructure for Development of a Wellbeing Economy. Springer.

Reference Books	
1.	Leal Filho, W. (Ed.). (2020). Encyclopedia of the UN Sustainable Development Goals. Springer.
2.	Sachs, J. D. (2021). The Decade of Action: Mobilizing the World to Achieve the SDGs. Columbia University Press.

Approved by BoS Chairman

B.E.	B23MEP501 KINEMATICS AND DYNAMICS LABORATORY	L	T	P	C
		0	0	2	1

Course Objectives	
1.	To provide a foundation for the study of machine design.
2.	To supplement the principles learnt in kinematics and Dynamics of Machinery.
3.	To understand how certain measuring devices are used for dynamic testing.
4.	To develop skills for designing and analysing linkages, cams, gears and other mechanisms.
5.	Development of individual and team communications skills.

LIST OF EXPERIMENTS		
1.	a.	Study of gear parameters.
	b.	Experimental study of velocity ratios of simple, compound, Epicyclic and differential
2.	a.	Kinematics of Four Bar, Slider Crank, Crank Rocker, Double crank, Double rocker,
	b.	Kinematics of single and double universal joints.
3.	a.	Determination of Mass moment of inertia of Fly wheel and Axle system.
	b.	Determination of Mass Moment of Inertia of axisymmetric bodies using Turn Table Apparatus.
4.	Motorized gyroscope – Study of gyroscopic effect and couple.	
5.	Governor - Determination of range sensitivity, effort etc., for Watts, Porter, Proell and Hartnell Governors.	
6.	Cams – Cam profile drawing, Motion curves and study of jump phenomenon	
7.	a.	Single degree of freedom Spring Mass System – Determination of natural Frequency and verification of Laws of springs – Damping coefficient determination.
8.	Determination of torsional natural frequency of single Rotor systems. - Undamped and Damped Natural frequencies.	
9.	Vibration of Equivalent Spring mass system – undamped and damped vibration.	
10.	Whirling of shafts – Determination of critical speeds of shafts with concentrated loads.	

11.	a.	Balancing of rotating masses
	b.	Balancing of reciprocating masses.
12.	a.	Transverse vibration of Free-Free beam – with and without concentrated masses.
	b.	Forced Vibration of Cantilever beam – Mode shapes and natural frequencies.
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Determine the velocity ratio of various types of gear trains.
CO2	Determine the mass moment of inertia of the different types of component
CO3	Estimate the magnitude of gyroscopic couple using motorized gyroscope.
CO4	Analyze the different types of vibrations and its effects on the machine components.
CO5	Calculate the speed range of different types of governors.

B.E.	B23MEP502 THERMAL ENGINEERING LABORATORY II	L	T	P	C
		0	0	4	2

Course Objectives	
1.	To provide the fundamental knowledge necessary to understand the behaviour of thermal systems.
2.	To provide a detailed experimental analysis in the field of heat transfer through solids, fluids, and vacuum.
3.	To analyse the thermal properties and performance of heat transfer, heat exchanger, vapour compression refrigerator and air conditioner
4.	To provide the concept of mass transfer operations and able to find the diffusivity and mass transfer coefficient of membrane.

LIST OF EXPERIMENTS	
1.	Determination of thermal conductivity of guarded plate
2.	Thermal conductivity measurement of pipe insulation using lagged pipe apparatus
3.	Determination of effectiveness on a metallic fin
4.	determination of overall heat transfer coefficient of a composite wall
5.	Determination of heat transfer coefficient in a free convection on a vertical tube
6.	Determination of heat transfer coefficient in a forced convention flow through a pipe
7.	Determination of Stefan – Boltzmann constant
8.	Determination of emissivity of a black and grey surface
9.	Determination of LMDT and effectiveness in parallel flow heat exchanger
10.	Determination of LMDT and effectiveness in counter flow heat exchanger
11.	Performance test on Vapour compression refrigerator
12.	Performance test on Air – conditioner
13.	Determination of diffusivity of liquid in air
14.	Determination of mass transfer coefficient of vaporization of naphthalene balls in air
	Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Apply the fundamental knowledge in heat transfer and basic principles.
CO2	Classify the heat transfer of various materials
CO3	Illustrate the performance of heat transfer, heat exchanger, vapour compression refrigerator and air conditioner
CO4	Find the thermal conductivity, heat transfer coefficient and emissivity of materials.
CO5	Find the diffusivity and mass transfer coefficient of given medium on air.

Approved by BoS Chairman

Semester – VI

B.E.	B23MET601 DESIGN OF TRANSMISSION SYSTEM	L	T	P	C
		2	1	0	3
(Use of Standard and approved PSG Design data book permitted)					

Course Objectives	
1.	To gain knowledge on the principles and procedure for the design of Mechanical power Transmission components.
2.	To understand the standard procedure available for Design of Transmission of Mechanical elements.
3.	To satisfy functional and strength requirements to learn to use standard practices and standard data.
4.	To Identify various bevel, worm &cross helical gears and analyze their terminologies.
5.	To learn to use catalogues and standard machine components.

UNIT - I	TRANSMISSION SYSTEMS FOR FLEXIBLE ELEMENTS	9
Selection of V belts and pulleys – selection of Flat belts and pulleys -Wire ropes and pulleys - Selection of Transmission chains and Sprockets. Design of pulleys and sprockets		

UNIT - II	SPUR GEARS AND PARALLEL AXIS HELICAL GEARS	9
Gear Terminology - Speed ratios and number of teeth - Force analysis - Tooth stresses - Dynamic effects - Fatigue strength - Factor of safety - Gear materials – Module and Face width - power rating calculations based on strength and wear considerations - Parallel axis Helical Gears – Pressure angle in the normal and transverse plane - Equivalent number of teeth - forces and stresses. Estimating the size of the helical gears		

UNIT - III	BEVEL, WORM AND CROSS HELICAL GEARS	9
Straight bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of pair of straight bevel gears. Worm Gear: Merits and demerits - terminology. Thermal capacity, materials - forces and stresses, efficiency, estimating the size of the worm gear pair. Cross helical: Terminology - helix angles - Estimating the size of the pair of cross helical gears		

UNIT - IV	DESIGN OF GEAR BOXES	9
Geometric progression - Standard step ratio - Ray diagram, kinematics layout - Design of sliding mesh gear box - Constant mesh gear box. Design of multi speed gear box		

UNIT - V	DESIGN OF CAM CLUTCHES AND BRAKES	9
Cam Design: Types - pressure angle and under cutting base circle determination – forces and surface stresses. Design of plate clutches – axial clutches - cone clutches – internal expanding rim clutches - internal and external shoe brakes		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Design of flexible components using basic principles and procedure.
CO2	Design of gear transmission systems with the available standard procedure.
CO3	Analyze the mechanical properties and thermal capacity of the gear transmission systems.
CO4	Assume the working principles of mechanical components employed in mechanical transmission systems.
CO5	Evaluate the basic engineering principles and procedures to design the transmission elements.

	Text Books
1.	Shigley J.E and Mischke C.R., “Mechanical Engineering Design”, Sixth Edition, Tata McGraw-Hill , 2020.
2.	Sundararajamoorthy T.V, Shanmugam .N, "Machine Design", Anuradha Publications, Chennai, 2018.

	Reference Books
1.	Maitra G.M., Prasad L.V., “Hand book of Mechanical Design”, II Edition, Tata McGraw-Hill, 2014.
2.	Bhandari, V.B., “Design of Machine Elements”, Tata McGraw-Hill Publishing Company Ltd., 2010.
3.	Prabhu. T.J., “Design of Transmission Elements”, Mani Offset, Chennai, 2020.
4.	Hamrock B.J., Jacobson B., Schmid S.R., “Fundamentals of Machine Elements”, McGraw-Hill Book Co., 2011.
5.	Ugural A,C, "Mechanical Design, An Integrated Approach", McGraw-Hill, 2014.

B.E.	B23MET602 AUTOMATION IN MANUFACTURING	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the basics of Manufacturing and Automation concepts.
2.	To understand about the design, analysis and implementation of manufacturing support systems
3.	To understand the needs and application of various material and tool handling systems.
4.	To understand group technology concepts, coding systems and implementation of flexible manufacturing systems.
5.	To understand the anatomy, configuration and application of Industrial robots and basics of smart manufacturing.

UNIT - I	FUNDAMENTALS OF MANUFACTURING & AUTOMATION	9

Brief introduction to CAD and CAM – Manufacturing Planning, Manufacturing control - Axiomatic Design - Concurrent Engineering-CIM concepts – Computerized elements of CIM system – Types of production - Manufacturing models and Metrics – Mathematical models of Production Performance – Simple problems – Manufacturing Control – Simple Problems – Basic Elements of an Automated system – Levels of Automation – Lean Production and Just-In-Time Production

UNIT - II	MANUFACTURING SUPPORT SYSTEMS	9

Process planning – Computer Aided Process Planning Logical steps in Computer Aided Process Planning – Aggregate Production Planning and the Master Production Schedule – Material Requirement planning – Capacity Planning- Control Systems-Shop Floor Control-Inventory Control –Brief on Manufacturing Resource Planning-II-ERP & PLM

UNIT - III	MATERIAL HANDLING & STORAGE SYSTEMS	9

Material Handling Systems - Conveyors, Feeders, Stackers &Reclaimers, automatic pallet changers - Types and applications - AGV - Guidance, steering, routing & Vehicle Management - Tool Handling Systems, ATC, Tool Fault Detection Systems- AS/RS, Functions and its types

UNIT - IV	CELLULAR MANUFACTURING & FLEXIBLE MANUFACTURING SYSTEMS	9
Group Technology, Product and Process based Layouts-Types of Coding & Classification systems, Optiz Coding Systems, Composite Part Concept, Production Flow Analysis- Cellular Manufacturing-FMS & its Components, Application & Benefits, Planning and Implementation, Quantitative Analysis of FMS, Fundamentals and Analysis of Transfer Lines		

UNIT - V	INDUSTRIAL ROBOTICS & SMART MANUFACTURING	9
Robot Configuration & Anatomy, Industrial robots Applications & Case Study- Manufacturing processes, Assembly, Inspection, Material handling & Warehousing. Digital manufacturing- Need & Case study, Advantages over conventional manufacturing-Smart manufacturing Techniques-IOT, Dark Factory, Big data processing, Cyber-Physical Systems-Automated Inspection, CMM, Machine Vision systems		
Total Instructional hours : 45		

Course Outcomes : Students will be able to	
CO1	Understand the basics of Manufacturing, its fundamentals, types and Automation principles used in Manufacturing Industries.
CO2	Ability to convert customer requirements into product related data and its subsequent plan for manufacturing it effectively and to improve productivity.
CO3	Ability to understand the use and application of modern material handling, tool handling systems and storage systems.
CO4	Ability to group the work parts, identify and design the proper layout for manufacturing them.
CO5	Ability to identify and implement a proper robotic system for any application and understand the significance of smart manufacturing.

Text Books	
1.	Shigley J.E and Mischke C. R., “Mechanical Engineering Design”, Sixth Edition, Tata McGraw-Hill , 2020.
2.	Sundararajamoorthy T. V, Shanmugam .N, "Machine Design", Anuradha Publications, Chennai, 2018.

Reference Books	
1.	Maitra G.M., Prasad L.V., "Hand book of Mechanical Design", II Edition, Tata McGraw-Hill, 2014.
2.	Bhandari, V.B., "Design of Machine Elements", Tata McGraw-Hill Publishing Company Ltd., 2010.
3.	Prabhu. T.J., "Design of Transmission Elements", Mani Offset, Chennai, 2020.
4.	Hamrock B.J., Jacobson B., Schmid S.R., "Fundamentals of Machine Elements", McGraw-Hill Book Co., 2011.
5.	Ugural A.C, "Mechanical Design, An Integrated Approach", McGraw-Hill , 2014.

B.E.	B23MET603 FINITE ELEMENT ANALYSIS	L	T	P	C
		2	1	0	3

Course Objectives	
1.	Develop governing Equations for Boundary, Initial and Eigen Value problems, Weighted Residual Methods Ritz Technique and basic concepts of the finite element method
2.	Apply the basic finite element equations for structural applications of bar, truss, beam element, heat transfer problems and longitudinal and transverse vibration frequencies.
3.	Analyze the finite element equations for two dimensional elements of triangular, quadrilateral and higher order elements.
4.	Interpret the finite element equations for axisymmetric, plate and shell elements
5.	Evaluate finite element equations for Isoparametric and serendipity elements and write a computer programs based on finite element methods.

UNIT - I	INTRODUCTION	9

Historical Background – Mathematical Modelling of field problems in Engineering – Basic concepts of the Finite Element Method - Element Equations - Finite Element Modeling- Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Ritz Technique

UNIT - II	ONE-DIMENSIONAL PROBLEMS	9

One Dimensional Second Order Equations – Discretization – Element types - Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors - Assembly of Matrices - Solution of problems from solid mechanics and heat transfer. Longitudinal vibration frequencies and mode shapes. Fourth Order Beam Equation – Transverse deflections and Natural frequencies of beams

UNIT - III	TWO DIMENSIONAL SCALAR VARIABLE PROBLEMS	9

Second Order 2D Equations involving Scalar Variable Functions – Variational formulation – Finite Element formulation – Triangular elements – Shape functions and element matrices and vectors. Application to Field Problems - Thermal problems – Quadrilateral elements Higher Order Elements

UNIT - IV	TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS	9
Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Body forces and temperature effects – Stress calculations - Plate and shell elements		

UNIT - V	ISOPARAMETRIC FORMULATION	9
Natural co-ordinate systems – Isoparametric elements – Shape functions for iso parametric elements – One and two dimensions – Serendipity elements – Numerical integration and application to plane stress problems - Matrix solution techniques – Solutions Techniques to Dynamic problems – Introduction to Analysis Software		
Total Instructional hours : 45		

Course Outcomes : Students will be able to	
CO1	Summarize the basics of finite element formulation.
CO2	Apply finite element formulations to solve one dimensional problems.
CO3	Apply finite element formulations to solve two dimensional scalar problems.
CO4	Apply finite element method to solve two dimensional vector problems.
CO5	Apply finite element method to solve problems on isoparametric element and dynamic problems.

Text Books	
1.	Reddy J.N. "An Introduction to the Finite Element Method", McGraw Hill, International Edition, 2020
2.	Chandrupatla and Belegundu, "Introduction To Finite Elements In Engineering", 4th Edition, Pearson India, 2015

Reference Books	
1.	George R. Buchanan, " Finite Element Analysis", Schaum's Outline, 2020
2.	Dr. S. S. Bhavikatti, "Finite Element Analysis", 3rd Edition, New Age International (P) Ltd Publishers, 2015
3.	Daryl Logan, " A First Course in the Finite Element Method", 1st Edition, Cengage India, 2012.
4.	D. K. Maharaj, "A Textbook of Finite Element Analysis Formulation and Programming", Wiley, 2019.
5.	M. Asghar Bhatti, "Fundamental Finite Element Analysis and Applications: With Mathematical and Mat lab Computations", Wiley, 2012

B.E.	B23MET604 ARTIFICIAL INTELLIGENCE IN MANUFACTURING SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives	
1.	Explain the role, applications, and advantages of AI in manufacturing, including its impact on process capabilities and future advancements.
2.	Classify different data types, apply data preprocessing techniques, and utilize clustering and normalization methods to prepare data for AI applications.
3.	Examine AI-driven predictive analytics, enabling technologies for Industry 4.0, and their integration with enterprise and operational technologies.
4.	Assess AI's influence on global business practices, its contributions to sustainable industries, and its transformative effects on various sectors.
5.	Explore AI-powered smart applications in agriculture, healthcare, education, transportation, smart cities, and metal cutting for enhanced efficiency and innovation.

UNIT - I	ARTIFICIAL INTELLIGENCE (AI) IN MANUFACTURING	9

Overview, Need and Application of AI in Manufacturing – Advantages – AI as a Catalyst to Smart Manufacturing – Advantages and Shortcomings - Risk Associates with AI. AI in Process Capabilities: Improvement at Process Level – Benefits at Organizational Level – AI as a Key Component of Future Manufacturing

UNIT - II	DATA TYPES AND ITS PREPARATION	9

Data Types – Structured – Unstructured – Static – Streamed – Attitudinal – Behavioral – Demographic - Data Driven Analytics - User Driven Analytics - Data Validity – Variety - Velocity of Constantly Changing – Attributes - Converting Raw Data into Matrix - Data Clustering - K means Algorithm - Nearest Neighbors - Identifying Objective of Data - Cleaning the Data - Structuring the Data – Data Preparation – Normalization - Binning – Sampling

UNIT - III	AI AND PREDICTIVE ANALYTICS	9
Introduction, Enabling Technologies for Industry 4.0 - Data Technologies (DT) : Data Pre-processing, Feature Engineering, Data-driven Analytics, Cyber Physical Production systems and Digital Twin - Platform Technologies (PT) - Operations Technology (OT): Product Lifecycle Management (PLM), Enterprise Resource Planning (ERP), Manufacturing Execution System (MES), Customer Relationship Management (CRM), Supply Chain Management (SCM) - Case study: Intelligent Bandsaw System & Challenges		

UNIT - IV	AI ON GLOBAL BUSINESS AND SUSTAINABILITY	9
Introduction – Need for AI in Global Business – Future Impact of AI in Global Business Practices, Achieving Sustainability – Smart Manufacturing – Futuristic Agriculture – Transforming Construction – Revolutionizing Manufacturing – Strategic Retailing – Revamping Media and Entertainment – Remodelling Financial Services – Reshaping Education, Adverse Impacts of AI in Sustainability		

UNIT - V	SMART APPLICATIONS OF AI	9
Smart Agriculture – Smart Healthcare – Smart Education – Smart Grids – Smart Transportation and Autonomous Vehicles – Smart Homes – Smart Cities – AI in metal cutting		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Explain the need for ai in manufacturing sector.
CO2	Identify and prepare data for predictive analytics
CO3	Illustrate the concepts of industrial ai and predictive analytics
CO4	Describe the various concepts of ai in global business and its sustainability
CO5	Explain the different types of smart applications using AI

Text Books	
1.	Stuart J. Russell and Peter Norvig, “Artificial Intelligence A Modern Approach”, Prentice Hall, 2010 for Units I, III.
2.	Kaushik Kumar, Divya Zindani, Paulo Davim, “Artificial Intelligence in Mechanical and Industrial Engineering”, 1st Edition, CRC Press, New York, 2021 for Unit II.
3.	Geeta Rana, Alex Khang, Ravindra Sharma, Alok Kumar Goel, Ashok Kumar Dubey, “Reinventing Manufacturing and Business Processes Through Artificial Intelligence”, 1st Edition, CRC Press, New York, 2022 for Unit IV.
4.	Masoud Soroush, Michael Baldea, Thomas F. Edgar, “Smart Manufacturing Concepts and Methods”, 1st Edition, Elsevier, United States, 2020 for Unit V.

Reference Books	
1.	John D. Kelleher, Brian Mac Namee, Aoife D'Arcy, “Fundamentals of Machine Learning for Predictive Data Analytics”, 2nd Edition, MIT Press, Cambridge, 2020.
2.	U. Dinesh Kumar, “Business Analytics The Science of Data-driven Decision Making”, Wiley India, 2017.

B.Tech CSBS	B23MCT605 CYBER SAFETY CONCEPTS	L	T	P	C
		2	0	0	0

Course Objectives	
1.	To understand various types of cyber-attacks and cyber-crimes
2.	To learn threats and risks within context of the cyber security
3.	To have an overview of the cyber laws & concepts of cyber forensics
4.	To study the defensive techniques against these attacks
5.	To understand various cyber security privacy issues

UNIT- I	Introduction to Cyber Security	9
Basic Cyber Security Concepts, layers of security, Vulnerability, threat, Harmful acts, Internet Governance – Challenges and Constraints, Computer Criminals, CIA Triad, Assets and Threat, motive of attackers, active attacks, passive attacks, Software attacks, hardware attacks, Cyber Threats-Cyber Warfare, Cyber Crime, Cyber terrorism, Cyber Espionage, etc., Comprehensive Cyber Security Policy.		

UNIT- II	Cyberspace and the Law & Cyber Forensics	9
Introduction, Cyber Security Regulations, Roles of International Law. The INDIAN Cyberspace, National Cyber Security Policy. Introduction, Historical background of Cyber forensics, Digital Forensics Science, The Need for Computer Forensics, Cyber Forensics and Digital evidence, Forensics Analysis of Email, Digital Forensics Lifecycle, Forensics Investigation, Challenges in Computer Forensics		

UNIT- III	Cybercrime: Mobile and Wireless Devices	9
Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication service Security, Attacks on Mobile/Cell Phones, Organizational security Policies and Measures in Mobile Computing Era, Laptops.		

Approved by BoS Chairman

UNIT- IV	Cyber Security	9
Organizational Implications: Introduction, cost of cybercrimes and IPR issues, web threats for organizations, security and privacy implications, social media marketing: security risks and perils for organizations, social computing and the associated challenges for organizations		

UNIT- V	Privacy Issues	9
Basic Data Privacy Concepts: Fundamental Concepts, Data Privacy Attacks, Data linking and profiling, privacy policies and their specifications, privacy policy languages, privacy in different domains medical, financial, etc.		
		Total Instructional hours: 45

Course Outcomes : Students will be able to	
CO1	Analyze and evaluate the cyber security needs of an organization.
CO2	Understand Cyber Security Regulations and Roles of International Law.
CO3	Design and develop a security architecture for an organization.
CO4	Understand fundamental concepts of data privacy attacks.
CO5	Explain fundamental concepts of data privacy and analyze the role of privacy policies and privacy- preserving techniques.

Text Books	
1.	Nina Godbole and Sunit Belpure, Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Wiley
2.	B.B. Gupta, D.P. Agrawal, Haoxiang Wang, Computer and Cyber Security: Principles, Algorithm, Applications, and Perspectives, CRC Press, ISBN 9780815371335,2018.
Reference Books	
1.	Cyber Security Essentials, James Graham, Richard Howard and Ryan Otson, CRC Press.
2.	Introduction to Cyber Security, Chwan-Hwa(john) Wu,J. David Irwin, CRC Press T&F Group.

Approved by BoS Chairman

B.E.	B23MEP601 SIMULATION AND ANALYSIS LABORATORY	L	T	P	C
		0	0	4	2

Course Objectives	
1.	To understand the stress analysis of various beams by giving suitable loads and constraints.
2.	To study the 2-D structural and non-structural model and perform structural analysis.
3.	To apply the thermal stresses in a component to determine conduction and convection.
4.	To practice the structures based on the vibration and perform harmonic analysis upon them.
5.	To execute the mechanical systems using simulation software.

LIST OF EXPERIMENTS	
A.	**SIMULATION**
1.	MATLAB basics, Dealing with matrices, Graphing-Functions of one variable and two variables.
2.	Use of Matlab to solve simple problems in vibration.
3.	Mechanism Simulation using Multibody Dynamic software.
B.	**ANALYSIS**
1.	Force and Stress analysis using link elements in Trusses, cables etc.
2.	Stress and deflection analysis in beams with different support conditions.
3.	Stress analysis of flat plates and simple shells.
4.	Stress analysis of axi – symmetric components.
5.	Thermal stress and heat transfer analysis of plates.
6.	Thermal stress analysis of cylindrical shells.
7.	Vibration analysis of spring-mass systems.
8.	Model analysis of Beams.
9.	Harmonic, transient and spectrum analysis of simple systems.
	Total Instructional hours : 45

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Approved by BoS Chairman

Course Outcomes : Students will be able to	
CO1	Apply the stress analysis of various beams by giving suitable loads and constraints.
CO2	Take part in the 2-D structural and non-structural model and perform structural analysis.
CO3	Examine the thermal stresses in a component to determine conduction and convection.
CO4	Determine the structures based on the vibration and perform harmonic analysis upon them.
CO5	Perceive the mechanical systems using simulation software.

Approved by BoS Chairman

Vertical - 1

MODERN MOBILITY SYSTEMS

B.E.	B23MEE901 AUTOMOTIVE MATERIALS, COMPONENTS, DESIGN AND TESTING	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To study the functional requirements of engine components and suitable materials.
2.	To learn to design of cylinder and piston components.
3.	To learn to design of connecting rod and crank shaft.
4.	To learn to design of flywheel and valve train.
5.	To study the Engine Testing cycles, Emission measurement technologies.

UNIT - I	FUNCTIONAL REQUIREMENTS OF ENGINE COMPONENTS AND SUITABLE MATERIALS	9
Functional requirements of engine components – Piston, piston pin, cylinder liner, connecting rod, crankshaft, valves, spring, engine block, cylinder head, and flywheel. Suitable materials for engine components		

UNIT - II	DESIGN OF CYLINDER AND PISTON COMPONENTS	9
Design of cylinder, cylinder head, piston, piston rings and piston pin – more details in necessary		

UNIT - III	DESIGN OF CONNECTING ROD AND CRANK SHAFT	9
Design of connecting rod – Shank design – small end design – big end design – bolts design. Design of overhang crank shaft under bending and twisting – Crank pin design – Crank web design – Shaft design		

UNIT - IV	DESIGN OF FLYWHEEL AND VALVE TRAIN	9
Design of valve – inlet valve – exhaust valve - Valve springs – tappet – rocker arm. Determination of mass of flywheel for a given coefficient of fluctuation of speed. Design of flywheel - rim - hub - arm		

UNIT - V	ENGINE TESTING	9
Engine test cycles – WLTC – WHSC – WHVC – NRTC – ISO 8178. Dynamometer - Chassis dynamometer - transient dynamometer. Emission measurement technologies and instruments - NOX – Smoke – Particulate matter – CO – CO2 - HC. - Particle counter		
		Total Instructional hours : 45

Approved by BoS Chairman

Course Outcomes : Students will be able to	
CO1	Identify the functional requirements of engine components and select appropriate materials based on performance criteria.
CO2	Analyze and apply design principles to develop and evaluate the cylinder and piston components for given engine specifications.
CO3	Implement design concepts to optimize the performance of the connecting rod and crankshaft through problem-solving techniques.
CO4	Apply design methodologies to enhance the functionality of the flywheel and valve train for improved engine efficiency.
CO5	Conduct performance evaluations of engine test cycles, dynamometers, and emission measurement technologies using appropriate instruments.

Text Books	
1.	Khurmi. R.S. & Gupta. J.K., "A text book of Machine Design", Eurasia Publishing House (Pvt) Ltd, 2001.
2.	The Automotive Chassis: Volume 1 : Components Design (Mechanical Engineering Series) by Giancarlo Genta and Lorenzo Morello, 24 December 2019.

Reference Books	
1.	Hiroshima Yamagata, "The science and technology of materials in automotive engines", Woodhead Publishing Limited, Cambridge, England.
2.	Jain.R.K, "Machine Design", Khanna Publishers, New Delhi, 2005.
3.	Manufacturing Automotive Components from Sustainable Natural Fiber Composites (SpringerBriefs in Materials) by Lobna A. Elseify, Mohamad Midani, et al. | 9 August 2021.
4.	Mechanical and Materials Engineering of Modern Structure and Component Design (Advanced Structured Materials Book 70) by Andreas Öchsner and Holm Altenbach | 6 June 2015.
5.	Advanced Technology for Design and Fabrication of Composite Materials and Structures : Applications to the Automotive, Marine, Aerospace and Applications of Fracture Mechanics) by George C. Sih, Alberto Carpinteri, et al. | 15 December 2010.

Approved by BoS Chairman

B.E.	B23MEE902 CONVENTIONAL AND FUTURISTIC VEHICLE TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To study the advanced engine technologies.
2.	To learn various advanced combustion technologies and its benefits.
3.	To learn the methods of using low carbon fuels and its significance.
4.	To learn and understand the hybrid and electric vehicle configurations.
5.	To study the application of fuel cell technology in automotives.

UNIT - I	ADVANCED ENGINE TECHNOLOGY	9

Gasoline Direct Injection, Common Rail Direct Injection, Variable Compression Ratio Turbocharged Engines, Electric Turbochargers, VVT, Intelligent Cylinder De-activation, After Treatment Technologies, Electric EGR, Current EMS architecture

UNIT - II	COMBUSTION TECHNOLOGY	9

Spark Ignition combustion, Compression Ignition Combustion, Conventional Dual Fuel Combustion, Low Temperature Combustion Concepts– Controlled Auto Ignition, Homogeneous Charge Compression Ignition, Premixed Charge Compression Ignition, Partially Premixed Compression Ignition, Reactivity Controlled Compression Ignition, Gasoline Direct Injection Compression Ignition

UNIT - III	LOW CARBON FUEL TECHNOLOGY	9

Alcohol Fuels, Ammonia Fuel and Combustion, Methane Technology, Dimethyl Ether, Hydrogen Fuel Technology, Challenges, and way forward

UNIT - IV	HYBRID AND ELECTRIC VEHICLE (BATTERY POWERED)	9

Conventional Hybrids (Conventional ICE + Battery), Modern Hybrids (RCCI/GDCI Engine + Battery), Pure Electric Vehicle Technology – Challenges and Way forward

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UNIT - V	FUEL CELL TECHNOLOGY	9
Fuel cells for automotive applications - Technology advances in fuel cell vehicle systems -Onboard hydrogen storage - Liquid hydrogen and compressed hydrogen - Metal hydrides, Fuel cell control system - Alkaline fuel cell - Road map to market		
	Total Instructional hours : 45	

Course Outcomes : Students will be able to	
CO1	Identify and examine the latest trends in engine technology and their practical applications in the automotive industry.
CO2	Illustrate the necessity of advanced combustion technologies and demonstrate their role in reducing the carbon footprint.
CO3	Analyze and compare the characteristics of low-carbon fuels with conventional fuels to evaluate their effectiveness in achieving sustainable development goals
CO4	Apply fundamental principles to explain the working and energy flow in various hybrid and electric vehicle configurations.
CO5	Examine the role of fuel cell technology in automotive applications and demonstrate its feasibility in sustainable transportation.

Text Books	
1.	Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
2.	Rakesh Kumar Maurya, Characteristics and Control of Low Temperature Combustion Engines. ISBN 978-3-319-68507-6, SPRINGER.

Reference Books	
1.	Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2.	James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
3.	Rand D.A.J, Woods, R & Dell RM Batteries for Electric vehicles, John Wiley & Sons, 1998.

Approved by BoS Chairman

B.E.	B23MEE903 ADVANCED VEHICLE ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To introduce the basic concepts of electric vehicle and their characteristics
2.	To introduce different types of motors and the selection of motor for vehicle applications.
3.	To acquaint the student with different sensors and systems used in autonomous and connected vehicles.
4.	To give an overview of networking with sensors and systems.
5.	To introduce the modern methods of diagnosing on-board the vehicle troubles.

UNIT - I	ELECTRIC VEHICLES	9

EV architectures, advantages and disadvantages, Electrical and mechanical energy storage technologies, battery management. Performance of Electric Vehicles, Tractive effort and Transmission requirement, Vehicle performance, Tractive effort in normal driving

UNIT - II	ELECTRIC VEHICLE MOTORS	9

Electric Propulsion basics, motor capacity determination, Induction motor, DC motor, Permanent Magnet Motor, Switch Reluctance Motor, Configuration, Characteristics, Performance and control of Drives

UNIT - III	AUTONOMOUS AND CONNECTED VEHICLES	9

Vehicle-to-Vehicle Technology, Vehicle to Road and Vehicle to Vehicle Infrastructure, Basic Control System, Surroundings Sensing Systems, Role of Wireless Data Networks, Advanced Driver Assistance Systems, Basics of Radar System, Ultrasonic Sonar Systems, Lidar System, Camera Technology, Basics of Wireless Technology, Receiver System

UNIT - IV	AUTOMOTIVE NETWORKING	9

Bus Systems – Classification, Applications in the vehicle, Coupling of networks, networked vehicles, Buses - CAN Bus, LIN Bus, MOST Bus, Bluetooth, Flex Ray, Diagnostic Interfaces

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UNIT - V	ON-BOARD TESTING	9
Integration of Sensor Data to On-Board Control Systems (OBD), OBD requirements, certification, enforcement, systems, testing, Catalytic converter and Exhaust Gas Recirculation system monitoring, Introduction to Cyber-physical system		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Acquire an overview of electric vehicles and their importance in automotive.
CO2	Discuss the characteristics and the selection of traction motor.
CO3	Comprehend the vehicle-to-vehicle and autonomous technology.
CO4	Explain the networking of various modules in automotive systems, communication protocols and diagnostics of the sub systems.
CO5	Be familiar with on-board diagnostics systems.

Text Books	
1.	John G Hayes and G AbaasGoodarzi, Electric Powertrain, 1^{st} Edition, John Wiley & Sons Ltd., 2018.
2.	Hussain T Mouftah, Melike Erol-kantarci and Samesh Sorour, Connected and Autonomous Vehicles in Smart Cities,CRC Press, 1^{st} Edition, 2020.

Reference Books	
1.	Dominique Paret, Multiplexed Networks for Embedded Systems, John Wiley & Sons Ltd., 2007.
2.	Hong Cheng, Autonomous Intelligent Vehicles : Theory, Algorithms & Implementation, Springer, 2011.
3.	Advanced Technology Vehicles Manufacturing (ATVM) Loan Program (Energy Science, Engineering and Technology : Congressional Policies, Practices and Procedures) by Andrew M Wright and Harrison R Scott, 5 September 2012.
4.	Advanced Motorsport Engineering: Units for Study at Level 3 by Andrew Livesey, 1 September 2011.

Approved by BoS Chairman

B.E.	B23MEE904 VEHICLE HEALTH MONITORING, MAINTENANCE AND SAFETY	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To enable the student to understand the principles, functions and practices adapted in maintenance activities of vehicles.
2.	To study the powertrain maintenance, fault diagnosis, maintenance of Batteries
3.	To develop vehicle system maintenance and service of clutch, brake.
4.	To study the concepts of vehicle safety and regulations.
5.	To study and understand the simulation of safety concepts.

UNIT - I	INTRODUCTION	9
Need for Maintenance – importance, classification of maintenance work-basic problem diagnosis. Maintenance of vehicle systems – power pack, tyres, safety systems. Scheduled maintenance services – service intervals – On-board diagnostics, Computerized engine analyzer study and practice - OBD and scan tools		

UNIT - II	POWERTRAIN MAINTENANCE	9
Exhaust emission test of petrol and diesel engine ; Electronic fuel injection and engine management service - fault diagnosis - OBD-III and scan tool, identifying DTC and servicing emission controls, Maintenance of Batteries, Starting System, Charging System and Body Electrical - Fault Diagnosis Using Scan Tools		

UNIT - III	VEHICLE SYSTEM MAINTENANCE	9
Clutch - adjustment and service, Maintenance and Service of Hydraulic brake, Bleeding of brakes, Checking ABS and components. Maintenance and Service of McPherson strut, coil spring. tyre wear, measurement of read depth and tyre rotation, Computerized wheel balancing & wheel alignment, Maintenance and Service of steering linkage, steering column, Rack and pinion steering		

Approved by BoS Chairman

UNIT - IV	VEHICLE SAFETY	9
Concepts of vehicle safety - Seat belt, regulations, automatic seat belt tightener system, collapsible steering column, air bags, electronic system for activating air bags, bumper design for safety, Active Safety - ABS, EBD, CSC, Traction control system, Modern electronic features in vehicles like tyre pressure monitoring, Automatic headlamp ON, Rain sensing wipers		

UNIT - V	SIMULATION OF SAFETY CONCEPTS	9
Active safety : driving safety, conditional safety, perceptibility safety, operating safety passive safety : exterior safety, interior safety, deformation behavior of vehicle body, speed and acceleration characteristics of passenger compartment on impact. Collision warning system, causes of rear end collision, frontal object detection, rear vehicle object detection system, object detection system with braking system Interactions		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Apply vehicle health monitoring techniques to diagnose and maintain optimal vehicle performance and safety.
CO2	Implement maintenance procedures for powertrain components to enhance vehicle reliability and efficiency.
CO3	Perform maintenance activities on various vehicle systems to ensure proper functioning and longevity.
CO4	Demonstrate awareness and practical application of vehicle safety measures to minimize risks and enhance road safety.
CO5	Utilize simulation tools to analyze and evaluate vehicle safety concepts for improved crashworthiness and occupant protection.

Approved by BoS Chairman

Text Books	
1.	5th Edition, "Advanced Automotive Fault Diagnosis Automotive Technology : Vehicle Maintenance and Repair" By Tom Denton.
2.	Safety Management System and Documentation Training Programme Handbook by S.V. Paul ISBN: 9788123923444.

Reference Books	
1.	Ed May, "Automotive Mechanics Volume One" and Two, Mc Graw Hill Publications, 10th edition, 2018.
2.	Bosch Automotive Handbook, Tenth Edition, 2018.
3.	Jack Erjavek, "A systems approach to Automotive Technology", Cengage Learning, 5th Edition, 2012.
4.	William H. Crouse and Donald L. Anglin, "Automotive Mechanics", Tata McGraw Hill, 10th Edition, 2004.
5.	Vehicle Service Manuals of Reputed Indian Manufacturers.

Approved by BoS Chairman

B.E.	B23MEE905 CAE AND CFD APPROACH IN FUTURE MOBILITY	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To study the use of computer in mobility software or mobility.
2.	To study the concepts computer aided design and rapid prototyping
3.	To introduce the basic concepts of the finite element's methods.
4.	To introduce basics and fundamental of the computational fluid dynamics
5.	To introduce Turbulence Modelling and various simulation techniques.

UNIT - I	INTRODUCTION TO CAE / CFD	9

Introduction to use of computer in Mobility Product Life Cycle, Software for mobility. Introduction to design process and role of computers in the design process, use of modern computational tools used for design and analysis, Concept of modelling and simulation. CFD as a design and research tool, Applications of CFD in mobility engineering

UNIT - II	CAD AND RAPID PROTOTYPING	9

Curves and Surfaces: Geometric modelling curves and surfaces, Wire frame models, Parametric representations, Parametric curves and surfaces, Solid modelling: Fundamentals of solid modelling, Different solid representation schemes, Boundary representation (B-rep), Constructive solid geometry (CSG). Mechanism design and assembly. CAD/CAM Data Exchange Formats: Types of file formats & their exchange, Graphics standards. CAD Data and Programming Techniques for RP: Transformations, Solid modelling for RP, Surface modelling, STL file generation, Defects in STL files and repairing algorithms, Interface formats

UNIT - III	INTRODUCTION TO FEA	9

Basic Concept of Finite Element Method, Ritz and Rayleigh Ritz methods, Method of weighed residuals, Galerkin method. Governing differential equations of one- and two-dimensional problems, One Dimensional Second Order Equations – Discretization – Linear and Higher order Elements – Interpolation and shape functions, Derivation of Shape functions and Stiffness matrices and force vectors - Assembly of Matrices - Solution of static problems and case studies in stress analysis of mechanical components using 2D and 3D elements

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UNIT - IV	INTRODUCTION TO CFD	9
CFD vs. experimentation; continuity, navier-stokes and energy equations; modelling and discretization techniques; basic steps in CFD computation Various simplifications, Dimensionless equations and parameters, Incompressible inviscid flows, Source panel method, and Vortex panel method. Conservation form of the equations, shock fitting and shock capturing, Time marching and space marching. 3-D structured and unstructured grid generation, mesh smoothing and sensitivity checks		

UNIT - V	PROBLEM SOLVING USING CFD	9
Turbulence Modelling, different turbulent modelling scheme. Incompressible Viscous Flows : Applications to internal flows and boundary layer flows. Eddy viscosity and non-eddy viscosity models; Vehicle Aerodynamic Simulation Wind tunnel and on-road simulation of vehicles; Simulation of Ahmed and Windsor bodies; Vorticity based grid - free simulation technique; simulation in climatic and acoustic wind tunnels; velocity vector and pressure contour simulation		
Total Instructional hours : 45		

Course Outcomes : Students will be able to	
CO1	Apply the fundamental concepts of Computer-Aided Engineering (CAE) and Computational Fluid Dynamics (CFD) to engineering problems.
CO2	Develop computer-aided designs and implement rapid prototyping techniques for product development.
CO3	Utilize the principles of Finite Element Methods (FEM) to analyze engineering structures and components.
CO4	Implement computational fluid dynamics (CFD) techniques to analyze fluid flow and heat transfer phenomena.
CO5	Solve engineering problems and perform simulations using Computational Fluid Dynamics (CFD) tools.

Approved by BoS Chairman

Text Books	
1.	Computational Fluid Dynamics : A Practical Approach by Jiyuan Tu, Guan Heng Yeoh, Chaoqun Liu.
2.	Applied Computational Fluid Dynamics by S.C. Gupta.

Reference Books	
1.	Ibrahim Zeid “Mastering CAD CAM” Tata McGraw-Hill Publishing Co. 2007.
2.	Groover, M.P., CAD/CAM : Computer-Aided Design and Manufacturing, Pearson Education, 2008.
3.	Tirupathi R. Chandrupatla and Ashok D.Belegundu, “Introduction to Finite Elements in Engineering”, International Edition, Pearson Education Limited, 2014.
4.	Dhanaraj. R and Prabhakaran Nair. K, “Finite Element Analysis”, Oxford Publications, 2015.
5.	Versteeg, H.K., and Malalasekera, W.,”An Introduction to Computational Fluid Dynamics” : The finite volume Method, Pearson Education, 2014.
6.	Ghoshdastidar, P.S., “Computer Simulation of flow and heat transfer”, Tata McGraw Hill, 1998.

Approved by BoS Chairman

B.E.	B23MEE906 HYBRID AND ELECTRIC VEHICLE TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To introduce the concept of hybrid and electric drive trains.
2.	To elaborate on the types and utilisation of hybrid and electric drive trains.
3.	To expose on different types of AC and DC drives for electric vehicles.
4.	To learn and utilise different types of energy storage systems
5.	To introduce concept of energy management strategies and drive sizing

UNIT - I	INTRODUCTION	9

Basics of vehicle performance, vehicle power source characterization, transmission characteristics, History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies

UNIT - II	HYBRID ELECTRIC DRIVE TRAINS	9

Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis. Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis

UNIT - III	CONTROL OF AC & DC DRIVES	9

Introduction to electric components used in hybrid and electric vehicles, Configuration, and control - DC Motor drives, Induction Motor drives, Permanent Magnet Motor drive, and Switch Reluctance Motor drives, drive system efficiency

UNIT - IV	ENERGY STORAGE	9

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Energy storage and its analysis - Battery based, Fuel Cell based, and Super Capacitor based, Hybridization of different energy storage devices

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UNIT - V	DRIVE SIZING AND ENERGY MANAGEMENT STRATEGIES	9
Sizing the drive system : Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selection of appropriate energy storage technology, Energy Management Strategies : Introduction to energy management strategies used in hybrid and electric vehicles, classification, and comparison of energy management strategies,Implementation issues		
Total Instructional hours : 45		

Course Outcomes : Students will be able to	
CO1	Discuss Characterise and configure hybrid drivetrains requirement for a vehicle.
CO2	Design and apply appropriate hybrid and electric drive trains in a vehicle.
CO3	Design and install suitable AC and DC drives for electric vehicles.
CO4	Discuss arrive at a suitable energy storage system for a hybrid / electric vehicle.
CO5	Apply energy management strategies to ensure better economy and efficiency.

Text Books	
1.	Iqbal Husain, Electric and Hybrid Vehicles : Design Fundamentals, Third Edition, 2021.
2.	James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

Reference Books	
1.	Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles : Fundamentals, Theory and Design, CRC Press, 2004.
2.	Rand D.A.J, Woods, R & Dell RM Batteries for Electric vehicles, John Wiley & Sons, 1998.
3.	Hybrid, Electric and Fuel-Cell Vehicles, International Edition by Jack Erjavec, 6 June 2012.
4.	Energy Management in Hybrid Electric Vehicles using Co-Simulation by Christian Paar, 11 February 2011.
5.	Hybrid Electric Vehicle Design and Control : Intelligent Omnidirectional Hybrids (Mechanical Engineering) by Yangsheng Xu , Jingyu Yan, et al. 16 December 2013.

Approved by BoS Chairman

B.E.	B23MEE907 THERMAL MANAGEMENT OF BATTERIES AND FUEL CELLS	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To study the working principle of Li-ion Batteries and Battery Packs.
2.	To learn the thermal management system in Battery modules.
3.	To develop the different case studies in Battery Thermal Management System.
4.	To learn the working principle of Fuel Cells cooling methods.
5.	To learn the inside components of Thermal Management Systems in various famous Electric and Fuel Cell Electric Vehicles.To elaborate on the types and utilisation of hybrid and electric drive trains.

UNIT - I	ADVANCED BATTERIES	9

Li-ion Batteries - chemistry, different formats, operating areas, efficiency, aging. Battery Management System- Configuration, Characteristics. Tesla Model S- 18650 Cell specifications, P85 Battery Pack mechanical structure, Texas Instruments BMS. Supercapacitors Vs batteries. Diamond battery concepts

UNIT - II	THERMAL MANAGEMENT IN BATTERIES	9

Thermal Management Systems - impact, Types - Air, Liquid, Direct refrigerant, Heat pipe, Thermo Electric, Phase Change Material Cooling methods. Solid-liquid PCM Types- Organic, Inorganic, Eutectics. PCM Thermal properties and applications. Tesla Model-S Battery Module- bonding techniques, thermal management

UNIT - III	BATTERY THERMAL MANAGEMENT CASE STUDIES	9

EV Battery Cooling - challenges and solutions. Heat Exchanger Design and Optimization Model for EV Batteries using PCMs - system set up, selection of PCMs. Chevrolet Volt Model Battery Thermal Management System - Case study. Modelling Liquid Cooling of a Li-Ion Battery Pack with COMSOL Multiphysics - simulation concepts

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UNIT - IV	THERMAL MANAGEMENT IN FUEL CELLS	9
Fuel Cells - operating principle, hydrogen - air fuel cell system characteristics, other fuel cell technologies, polarization curves, applications. Fuel cell thermal management - basic model, energy balance, governing equations, characteristic curve, sizing, cooling methods, advantages, restrictions		

UNIT - V	FUEL CELL THERMAL MANAGEMENT CASE STUDIES	9
Fuel cell system- balance of plant - components required. Fuel cell power plant sizing problems - Fuel Cell Electric Vehicle Fuel economy calculations - Battery EVs Vs Fuel Cell EVs. Toyota Mirai FCV - Operating principle, High pressure hydrogen tank, Boost convertor, NiMH Battery, Internal circulation system, Hydrogen refueling - Case studies		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Discuss the different Li-ion Batteries and Fuel Cell performances.
CO2	Design a Battery Pack with appropriate PCM.
CO3	Apply Cooling Models using Simulation
CO4	Estimate fuel economy.
CO5	Utilize different Thermal Management System approaches during real world usage.

Text Books	
1.	Ibrahim Dinçer, Halil S. Hamut, and Nader Javani, “Thermal Management of Electric Vehicle Battery Systems’’, Wiley, 2017.
2.	Jiuchun Jiang and Caiping Zhang, “Fundamentals and applications of Lithium-Ion batteriesin Electric Drive Vehicles’’, Wiley, 2015.
3.	John G. Hayes and G. Abas Goodarzi, “Electric Powertrain”, Wiley, 2018.
4.	Davide Andrea, “Battery Management Systems for Large Lithium-Ion Battery Packs” ARTECH House, 2010.

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Reference Books	
1.	Nag.P.K, “Engineering Thermodynamics”, 5^{th} Edition, Tata McGraw Hill Education, New Delhi, 2013.
2.	“Vehicle thermal Management Systems Conference Proceedings”, 1^{st} Edition, Coventry Techno centre, UK. 2013.
3.	Younes Shabany,” Heat Transfer : Thermal Management of Electronics Hardcover”, CRC Press. 2010.
4.	T. Yomi Obidi, “Thermal Management in Automotive applications”, SAE International. 2015.

Approved by BoS Chairman

B.E.	B23MEE908 IOT FOR ELECTRIC VEHICLES	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To design and drive the mathematical model of a BLDC motor and its characteristics
2.	To learn the different control schemes for BLDC motor.
3.	To study the basics of fuzzy logic
4.	To study the FPGA & VHDL basics
5.	To implement fuzzy logic control of BLDC motor in real time

UNIT - I	MATHEMATICAL MODEL AND CHARACTERISTICS ANALYSIS OF THE BLDC MOTOR	9
Structure and Drive Modes - Basic Structure, General Design Method, Drive Modes. Mathematical Model, Differential Equations, Transfer Functions, State-Space Equations. Characteristics Analysis, Starting Characteristics, Steady-State Operation, Dynamic Characteristics, Load Matching Commutation Transients		

UNIT - II	SPEED CONTROL FOR ELECTRIC DRIVES	9
Introduction - PID Control Principle, Anti windup Controller, Intelligent Controller. Vector Control. Control applied to BLDC motor used in EV		

UNIT - III	FUZZY LOGIC	9
Membership functions : features, fuzzification, methods of membership value assignments Defuzzification: lambda cuts - methods - fuzzy arithmetic and fuzzy measures : fuzzy arithmetic - extension principle - fuzzy measures - measures of fuzziness - fuzzy integrals - fuzzy rule base and approximate reasoning : truth values and tables, fuzzy propositions, formation of rules decomposition of rules, aggregation of fuzzy rules, fuzzy reasoning-fuzzy inference systems, overview of fuzzy expert system - fuzzy decision making		

UNIT - IV	FPGA AND VHDL BASICS	9
Introduction – FPGA Architecture - Advantages - Review of FPGA family processors - Spartan 3, Spartan 6 and Spartan 7. VHDL Basics - Fundamentals - Instruction set-data type conditional statements - programs like arithmetic, sorting, PWM generation, Speed detection		

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UNIT - V	REAL TIME IMPLEMENTATION	9
Inverter design, identifying rotor position via hall effect sensors, open loop and fuzzy logic control of48 V BLDC motor using FPGA-real-time monitoring of the health and performance of an EV's battery		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Design the mathematical model of a BLDC motor and to discuss about its characteristics.
CO2	Demonstrate the PID control, ant windup controller, Intelligent Controller and Vector Control. Control applied to BLDC motor.
CO3	Illustrate the basics of fuzzy logic system.
CO4	Describe the basics of VHDL & FPGA applied to control of EVs.
CO5	Design and implement of fuzzy logic control scheme for BLDC motor using FPGA in real time.

Reference Books	
1.	Electric Powertrain Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles, John G. Hayes, G. Abas Goodarzi, Wiley 1^{st} Edition 2018.
2.	VHDL Primer, A (3^{rd} Edition), Jayaram Bhasker, Prentice Hall, 1^{st} Edition 2015.
3.	Iqbal Hussain, "Electric and Hybrid Vehicles: Design Fundamentals, Third Edition" CRC Press, Taylor & Francis Group, 2021, 1^{st} Edition.
4.	Chang-liang, Permanent Magnet Brushless DC Motor Drives and Controls, Xia Wiley 2012, 1^{st} Edition.
5.	M.N. Cirstea, A. Dinu, J.G. Khor, M. McCormick, Neural and Fuzzy Logic Control of Drives and Power Systems, Newnes publications, 1^{st} Edition, 2002.
6.	Wei Liu, Hybrid Electric Vehicle System Modeling and Control, Wiley 2017, 2^{nd} Edition
7.	Electric and Plug-in Hybrid Vehicle Networks Optimization and Control, Emanuele Crisostomi • Robert Shorten, Sonja Stüdli • Fabian Wirth, CRC Press, 1^{st} Edition, 2018.

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Vertical - 2

PRODUCT AND PROCESS DEVELOPMENT

B.E.	B23MEE909 VALUE ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To study the value engineering process and able to identify its functions within the process.
2.	To determine the appropriate value engineering methodology for a given project and propose appropriate training to centralized and decentralized modes.
3.	To learn various decision-making processes and cost evaluation models and apply them in appropriately in the product development life-cycle.
4.	To explore in-depth understanding of various value engineering applications in human resources, manufacturing and marketing.
5.	To demonstrate to implement value engineering solutions and propose to perfect them.

UNIT - I	VALUE ENGINEERING BASICS	9

Origin of value engineering - Meaning of value engineering - Definition of value engineering and Value analysis- Value Management - Value Analysis Versus Value Engineering - Value Analysis versus Traditional cost reduction techniques - Types of Value function – Basic and Secondary functions – concept of cost and worth - creativity In Value Engineering - uses, applications, advantages and limitations of Value analysis

UNIT - II	VALUE ENGINEERING JOB PLAN AND PROCESS	9

Seven phases of job plan - FAST Diagramming as Value Engineering Tool - Behavioral and organizational aspects of Value Engineering - Ten principles of Value analysis - Benefits of Value Engineering

UNIT - III	VALUE ENGINEERING TECHNIQUES	9

Creativity - Brain storming - Gordon technique - Morphological Analysis - ABC Analysis- Probabilistic approach - Make or Buy decisions – Function cost worth analysis (FCWA) - Function Analysis System technique (FAST) - Break Even Analysis - Life cycle cost (LCC)

UNIT - IV	WORKSHEETS AND GUIDELINES	9

Preparation of worksheets - general and information phase - Function Classification, relationship and summary - Meaningful costs - Cost analysis - idea listing and comparison - Feasibility ranking - Investigator phase, study summary - guidelines for writing value engineering proposal - Financial aspects - List cycle cost analysis - Oral presentation - Audit - Case studies and Discussion

J.P.Murugesan

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UNIT - V	VERSATILITY OF VALUE ENGINEERING	9
Value engineering operation in maintenance and repair activities - value engineering in non hardware projects - Initiating a value engineering programme Introduction - training plan - career development for value engineering specialties		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Summarize a product cost based on value engineering principles in terms of its values, functions and worthiness.
CO2	Illustrate the product and articulate it in various phases of value engineering.
CO3	Interpret and select appropriate methods, standards and apply them on value engineering project and propose appropriate training
CO4	Apply querying theory and FAST to prefect a value engineering project implementation.
CO5	Develop various case studies related to value engineering project implementation.

Text Books	
1.	S.S.Iyer, “Value Engineering”, New Age International (P) Limited, 2019.
2.	Anil Kumar. and Mukhopadhyaya., “Value Engineering: Concepts Techniques and applications”, SAGE Publications, 1st Edition, 2003.

Reference Books	
1.	Del L. Younker., “Value Engineering : analysis and methodology”, CRC Press, 2003.
2.	Lawrence D. Miles., “Techniques of Value Analysis and Engineering”, Lawrence D. Miles Value Foundation, 3rd Edition, 2015.
3.	Richard Park., “Value Engineering A Plan for Invention”, CRC Press, 2017.

Approved by BoS Chairman

B.E.	B23MEE910 ADDITIVE MANUFACTURING	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To introduce the development of Additive Manufacturing (AM), various business opportunities and applications.
2.	To familiarize various software tools, processes and techniques to create physical objects that satisfy product development / prototyping requirements, using AM.
3.	To be acquainted with vat polymerization and direct energy deposition processes.
4.	To be familiar with powder bed fusion and material extrusion processes.
5.	To gain knowledge on applications of binder jetting, material jetting and sheet lamination processes.

UNIT - I	INTRODUCTION	9

Overview - Need - Development of Additive Manufacturing (AM) Technology : Rapid Prototyping Rapid Tooling - Rapid Manufacturing - Additive Manufacturing. AM Process Chain - ASTM/ISO 52900 Classification - Benefits. Applications: Building Printing - Bio Printing - Food Printing Electronics Printing. Business Opportunities and Future Directions – Case studies : Automobile, Aerospace, Healthcare

UNIT - II	DESIGN FOR ADDITIVE MANUFACTURING	9

Concepts and Objectives - AM Unique Capabilities - Part Consolidation – Topology Optimization Generative design - Lattice Structures - Multi-Material Parts and Graded Materials – Data Processing: CAD Model Preparation - AM File formats: STL-Problems with STL - AMF Design for Part Quality Improvement: Part Orientation - Support Structure - Slicing - Tool Path Generation – Design rules for Extrusion based AM

UNIT - III	VAT POLYMERIZATION AND DIRECTED ENERGY DEPOSITION	9

Photo polymerization : Stereo lithography Apparatus (SLA)- Materials - Process – top down and bottom up approach - Advantages - Limitations - Applications. Digital Light Processing (DLP) - Process - Advantages - Applications. Continuous Liquid Interface Production (CLIP) Technology. Directed Energy Deposition: Laser Engineered Net Shaping (LENS) - Process - Material Delivery - Materials - Benefits - Applications

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UNIT - IV	POWDER BED FUSION AND MATERIAL EXTRUSION	9
Powder Bed Fusion : Selective Laser Sintering (SLS) : Process - Powder Fusion Mechanism - Materials and Application. Selective Laser Melting (SLM), Electron Beam Melting (EBM): Materials - Process - Advantages and Applications. Material Extrusion: Fused Deposition Modelling (FDM) - Process - Materials - Applications and Limitations		

UNIT - V	OTHER ADDITIVE MANUFACTURING PROCESSES	9
Binder Jetting : Three - Dimensional Printing - Materials - Process - Benefits - Limitations - Applications. Material Jetting : Multijet Modelling - Materials - Process - Benefits - Applications. Sheet Lamination : Laminated Object Manufacturing (LOM) - Basic Principle - Mechanism : Gluing or Adhesive Bonding - Thermal Bonding - Materials - Application and Limitation		
Total Instructional hours : 45		

Course Outcomes : Students will be able to	
CO1	Recognize the development of AM technology and how AM technology propagated into various businesses and developing opportunities.
CO2	Acquire knowledge on process of transforming a concept into the final product in AM technology.
CO3	Elaborate the vat polymerization and direct energy deposition processes and its applications.
CO4	Acquire knowledge on process and applications of powder bed fusion and material extrusion.
CO5	Evaluate the advantages, limitations, applications of binder jetting, material jetting and sheet lamination processes.

Text Books	
1.	Ian Gibson, David Rosen, Brent Stucker, Mahyar Khorasani “Additive manufacturing technologies”. 3rd edition Springer Cham, Switzerland, 2021.
2.	Andreas Gebhardt and Jan - Steffen Hötter “Additive Manufacturing : 3D Printing for Prototyping and Manufacturing”, Hanser publications, United States, 2015.

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Reference Books	
1.	Andreas Gebhardt, “Understanding Additive Manufacturing : Rapid Prototyping, Rapid Manufacturing”, Hanser Gardner Publication, Cincinnati., Ohio, 2011.
2.	Milan Brandt, “Laser Additive Manufacturing : Materials, Design, Technologies, and Applications”, Woodhead Publishing., United Kingdom, 2016.
3.	Amit Bandyopadhyay and Susmita Bose, “Additive Manufacturing”, 1st Edition, CRC Press., United States, 2015.

Approved by BoS Chairman

B.E.	B23MEE911 CAD / CAM	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To Introduce and understand the Basic of Design.
2.	To study the two dimensional drafting and bill of material creation.
3.	To learn three dimensional modeling and its advantages.
4.	To study the basic and purpose of assembling modeling.
5.	To study the basics of computer aided machining and part programming.

UNIT - I	BASICS OF DESIGNS	9

Understanding of Projections, Scales, units, GD & T, its 14 symbols, Special characteristics, Title Block readings. Revision / ECN status of drawings – Customer Specific requirements – Drawing Grid reading

UNIT - II	2D DRAFTING	9

Projection views – Orthographic view, Axillary view, Full; Half Section views, Broken Section view, Offset Section view – Title Block creation – BOM Creation – Notes creation – Ballooning of 2D drawing and its features for Inspection reporting

UNIT - III	3D MODELING	9

Conversion of Views – 2D to 3D; 3D to 2D – Parametric and Non-Parametric Modeling – Tree features of 3D Modeling and its advantages – Surface Modeling – BIW (Body In White) – Solid Modeling, Boolean operations like Unites, Subtraction, Intersect, etc

UNIT - IV	ASSEMBLY MODELING	9

Basics of Assembly modeling, Purpose of Assembly modeling; its advantages – Top to Down; Bottom Up modeling approaches – Analysis of Clearances – Undercuts – Interferences – Stack up analysis – Cumulative effect of Tolerances in after assembly conditions.- motion analysis

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UNIT - V	CAM	9
Basics of CNC Machining, CNC and Part Programing, CAM programing, Elements of CAM Orientation, Boundary Creation, Cutter Path Selection, Cutter Compensation – Machining Stocks, Roughing, Re-roughing, Semi Finishing ; Finishing – Tool Path Generation. Machining program simulation, integration of program with machine; Estimation of CNC Cycle time. – Post Process NC Code conversion and Setup Sheet Preparation		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Outline the basics of the design and concepts.
CO2	Develop the two dimensional drafting and projection views.
CO3	Interpret the three dimensional modeling, parametric and Non-parametric modeling.
CO4	Summarize the assembly modeling and top down, bottom up approaches.
CO5	Develop the computer aided machining and writing part programming.

Text Books	
1.	J. Srinivas - CAD/CAM Principles & Application, Oxford HED, 2016.
2.	Ibrahim Zeid - CAD/CAM : Theory and Practice, Special Indian Edition Paperback, 2009.

Reference Books	
1.	Haideri Farazdak - CAD/CAM and AUTOMATION, Tech-Neo Publications LLP, 2019.
2.	Anup Goel, A. Jacob Moses, Dr. Renjin J. Bright - Computer Aided Design & Manufacturing, Paper back, 2023.
3.	P N Rao - CAD/CAM : Principles and Applications, Paperback, 2017.

Approved by BoS Chairman

B.E.	B23MEE912 DESIGN FOR X	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To introduce the economic process selection principles and general design principles for manufacturability in the development and design of products for various engineering applications.
2.	To learn the design consideration principles of forming in the design of extruded, stamped, and forged products.
3.	To learn design consideration principles of machining in the design of turned, drilled, milled, planed, shaped, slotted, and ground products.
4.	To learn design consideration principles of welding in the design of welded products.
5.	To learn design consideration principles in additive manufacturing.

UNIT - I	INTRODUCTION	9

General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances Geometric Tolerances – Assembly limits - Datum features - Tolerance stacks

UNIT - II	FACTORS INFLUENCING FORM DESIGN	9

Working principle, Material, Manufacture, Design- Possible solutions - Materials choice – Influence of materials on form design - form design of welded members, forgings and castings

UNIT - III	COMPONENT DESIGN - MACHINING CONSIDERATION	9

Design features to facilitate machining - drills - milling cutters - keyways - Doweling procedures, counter sunk screws - Reduction of machined area - simplification by separation - simplification by amalgamation - Design for machinability - Design for economy

UNIT - IV	COMPONENT DESIGN – CASTING CONSIDERATION	9

Redesign of castings based on parting line considerations - Minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design - Modifying the design - group technology - Computer Applications for DFMA

Approved by BoS Chairman

UNIT - V	DESIGN FOR ADDITIVE MANUFACTURING	9
Introduction to AM, 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		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Explain the design principles for manufacturability.
CO2	Summarize the factors influencing in form design.
CO3	Apply the component design features of various machines.
CO4	Organize the design consideration principles of welding in the design of welded products.
CO5	Organize the design consideration principles of additive manufacturing.

Text Books	
1.	O. Molloy, E.A. Warman, S. Tilley, Design for Manufacturing and Assembly : Concepts, Architectures and Implementation, Springer, 2012.
2.	James G. Bralla, “Design for Manufacturability Handbook”, McGraw Hill Professional, 1998.

Reference Books	
1.	CorradoPoli, Design for Manufacturing : A Structured Approach, Elsevier, 2001.
2.	Erik Tempelman, Hugh Shercliff, Bruno Ninaber van Eyben, Manufacturing and Design: Understanding the Principles of How Things Are Made, Elsevier, 2014.
3.	Graedel T. Allen By. B, Design for the Environment Angle Wood Cliff, Prentice Hall. ReasonPub., 1996.

Approved by BoS Chairman

B.E.	B23MEE913 ERGONOMICS IN DESIGN	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To introduce to industrial design based on ergonomics.
2.	To consider ergonomics concept in manufacturing.
3.	To apply ergonomics in design of controls and display.
4.	To apply environmental factors in ergonomics design.
5.	To develop aesthetics applicable to manufacturing and product.

UNIT - I	INTRODUCTION	9

An approach to industrial design, Elements of design structure for industrial design in engineering application in modern manufacturing systems - Ergonomics and Industrial Design: Introduction to Ergonomics, Communication system, general approach to the man-machine relationship, Human component of work system, Machine component of work system, Local environment-light, Heat, Sound

UNIT - II	ERGONOMICS AND PRODUCTION	9

Introduction, Anthropometric data and its applications in ergonomic, working postures, Body Movements, Work Station Design, Chair Design. Visual Effects of Line and Form : The mechanics of seeing, Psychology of seeing, Figure on ground effect, Gestalt's perceptions - Simplicity, Regularity, Proximity, Wholeness. Optical illusions, Influences of line and form

UNIT - III	DESIGN PRINCIPLES FOR DISPLAY AND CONTROLS	9

Displays : Design Principles of visual Displays, Classification, Quantitative displays, Qualitative displays, check readings, Situational awareness, Representative displays, Design of pointers, Signal and warning lights, colour coding of displays, Design of multiple displays Controls : Design considerations, Controls with little efforts – Push button, Switches, rotating Knobs. Controls with muscular effort – Hand wheel, Crank, Heavy lever, Pedals. Design of controls in automobiles, Machine Tools

J.P.

Approved by BoS Chairman

UNIT - IV	ENVIRONMENTAL FACTORS	9
Colour: Colour and light, Colour and objects, Colour and the eye – after Image, Colour blindness, Colour constancy, Colour terms – Colour circles, Munsel colour notation, reactions to colour and colour combination – colour on engineering equipments, Colour coding, Psychological effects, colour and machine form, colour and style		

UNIT - V	AESTHETIC CONCEPTS	9
Concept of unity, Concept of order with variety, Concept of purpose, Style and environment, Aesthetic expressions - Symmetry, Balance, Contrast, Continuity, Proportion. Style - The components of style, House style, Style in capital good. Introduction to Ergonomic and plant layout software's, total layout design		
Total Instructional hours : 45		

Course Outcomes : Students will be able to	
CO1	Appreciate ergonomics need in the industrial design.
CO2	Apply ergonomics in creation of manufacturing system.
CO3	Discuss on design of controls and display.
CO4	Consider environmental factors in ergonomics design.
CO5	Report on importance of aesthetics to manufacturing system and product.

Text Books	
1.	Marcelo M. Soares, Francisco Rebelo "Ergonomics in Design : Methods and Techniques (Human Factors and Ergonomics)", First Edition (Reprint), CRC Press, 2019.
2.	SendPoints., "Ergonomics in Product Design", First Edition, Sendpoints Publishing C0.Ltd., 2018.

Reference Books	
1.	Benjamin W. Niebel, Motion and Time Study, 7th Edition, Richard, D. Irwin Inc., 2002.
2.	Brain Shakel,"Applied Ergonomics Hand Book", Butterworth Scientific London, 1988.
3.	Bridger, R.C., "Introduction to Ergonomics", 2nd Edition, McGraw Hill Publications, 2003.
4.	Martin Helander, A Guide to human factors and Ergonomics, Taylor and Francis, 2006.

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Approved by BoS Chairman

B.E.	B23MEE914 NEW PRODUCT DEVELOPMENT	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To introduce the fundamental concepts of the new product development.
2.	To develop material specifications, analysis and process.
3.	To Learn the Feasibility Studies & reporting of new product development.
4.	To study the New product qualification and Market Survey on similar products of new product development.
5.	To learn Reverse Engineering. Cloud points generation, converting cloud data to 3D model.

UNIT - I	FUNDAMENTALS OF NPD	9

Introduction – Reading of Drawing – Grid reading, Revisions, ECN (Engg. Change Note), Component material grade, Specifications, customer specific requirements – Basics of monitoring of NPD applying Gantt chart, Critical path analysis – Fundamentals of BOM (Bill of Materials), Engg. BOM & Manufacturing BOM. Basics of MIS software and their application in industries like SAP, MS Dynamics, Oracle ERP Cloud – QFD

UNIT - II	MATERIAL SPECIFICATIONS, ANALYSIS & PROCESS	9

Material specification standards – ISO, DIN, JIS, ASTM, EN, etc. – Awareness on various manufacturing process like Metal castings & Forming, Machining (Conventional, 3 Axis, 4 Axis, 5 Axis), Fabrications, Welding process. Qualifications of parts mechanical, physical & Chemical properties and their test report preparation and submission. Fundamentals of DFMEA & PFMEA, Fundamentals of FEA, Bend Analysis, Hot Distortion, Metal and Material Flow, Fill and Solidification analysis

UNIT - III	ESSENTIALS OF NPD	9

RFQ (Request of Quotation) Processing – Feasibility Studies & reporting – CFT (Cross Function Team) discussion on new product and reporting – Concept design, Machine selection for tool making, Machining – Manufacturing Process selection, Machining Planning, cutting tool selection – Various Inspection methods – Manual measuring, CMM – GOM (Geometric Optical Measuring), Lay out marking and Cut section analysis. Tool Design and Detail drawings preparation, release of details to machine shop and CAM programing. Tool assembly and shop floor trials. Initial sample submission with PPAP documents

Approved by BoS Chairman

UNIT - IV	CRITERIONS OF NPD	9
New product qualification for Dimensions, Mechanical & Physical Properties, Internal Soundness proving through X-Ray, Radiography, Ultrasonic Testing, MPT, etc. Agreement with customer for testing frequencies. Market Survey on similar products, Risk analysis, validating samples with simulation results, Lesson Learned & Horizontal deployment in NPD		

UNIT - V	REPORTING & FORWARD - THINKING OF NPD	9
Detailed study on PPAP with 18 elements reporting, APQP and its 5 Sections, APQP vs PPAP, Importance of SOP (Standard Operating Procedure) – Purpose & documents, deployment in shop floor. Prototyping & RPT - Concepts, Application and its advantages, 3D Printing – resin models, Sand cores for foundries; Reverse Engineering. Cloud points generation, converting cloud data to 3D model – Advantages & Limitation of RE, CE (Concurrent Engineering) – Basics, Application and its advantages in NPD (to reduce development lead time, time to Market, Improve productivity and product cost)		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Discuss fundamental concepts and customer specific requirements of the New Product development.
CO2	Discuss the Material specification standards, analysis and fabrication, manufacturing process.
CO3	Develop Feasibility Studies & reporting of New Product development.
CO4	Analyzing the New product qualification and Market Survey on similar products of new product development.
CO5	Develop Reverse Engineering. Cloud points generation, converting cloud data to 3D model.

Text Books	
1.	Sten Jonsson “Product Development : Work for Premium Values”, First Edition (Reprint), CRC Press, 2004.
2.	Karl T. Ulrich (Author), Steven D. Eppinger (Author), Maria C. Yang., “Product Design and Development”, 7th Edition, McGraw Hill, 2020.

Approved by BoS Chairman

Reference Books	
1.	Steven C. Wheelwright, “Revolutionizing Product Development: Quantum Leaps in Speed, Efficiency and Quality”, Free Press Publications, 2011.
2.	James M. Morgan , Jeffrey K. Liker “The Toyota Product Development System : Integrating People, Process, and Technology”, CRC Press, 2006.
3.	Dr. H.R. Thakkar, Dr. M.A. Bulsara,” Product Design and Value Engineering”, 2nd Edition, Charotar Publishing House Pvt. Ltd, 2015.

Approved by BoS Chairman

B.E.	B23MEE915 PRODUCT LIFECYCLE MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To study about the history, concepts and terminology in PLM.
2.	To learn the functions and features of PLM / PDM.
3.	To develop different modules offered in commercial PLM / PDM tools.
4.	To demonstrate PLM / PDM approaches for industrial applications.
5.	To use PLM / PDM with legacy data bases, Coax & ERP systems.

UNIT - I	HISTORY, CONCEPTS AND TERMINOLOGY OF PLM	9

Introduction to PLM, Need for PLM, opportunities of PLM, Different views of PLM - Engineering Data Management (EDM), Product Data Management (PDM), Collaborative Product Definition Management (CPDM), Collaborative Product Commerce (CPC), Product Lifecycle Management (PLM). PLM/PDM Infrastructure – Network and Communications, Data Management, Heterogeneous data sources and applications

UNIT - II	PLM / PDM FUNCTIONS AND FEATURES	9

User Functions – Data Vault and Document Management, Workflow and Process Management, Product Structure Management, Product Classification and Programme Management. Utility Functions – Communication and Notification, data transport, data translation, image services, system administration and application integration

UNIT - III	DETAILS OF MODULES IN A PDM/PLM SOFTWARE	9

Case studies based on top few commercial PLM/PDM tools – Teamcenter, Windchill, ENOVIA, Aras PLM, SAP PLM, Arena, Oracle Agile PLM and Autodesk Vault - Architecture of PLM software - selection criterion of software for particular application - Brand name to be removed

Approved by BoS Chairman

UNIT - IV	ROLE OF PLM IN INDUSTRIES	9
Case studies on PLM selection and implementation (like auto, aero, electronic) - other possible sectors, PLM visioning, PLM strategy, PLM feasibility study, change management for PLM, financial justification of PLM, barriers to PLM implementation, ten step approach to PLM, benefits of PLM for – business, organisation, users, product or service, process performance- process compliance and process automation		

UNIT - V	BASICS ON CUSTOMISATION/INTEGRATION OF PDM / PLM SOFTWARE	9
PLM Customization, use of EAI technology (Middleware), Integration with legacy data base, CAD, SLM and ERP		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Summarize the history, concepts and terminology of PLM.
CO2	Develop the functions and features of PLM / PDM.
CO3	Discuss different modules offered in commercial PLM / PDM tools.
CO4	Interpret the implement PLM / PDM approaches for industrial applications.
CO5	Integrate PLM / PDM with legacy data bases, CAx & ERP systems.

Text Books	
1.	Product Lifecycle Management for a Global Market, Springer, (2016).
2.	Product Life Cycles and Product Management, Praeger Publishers Inc (27 March 1989) ISBN-10: 0899303196.

Approved by BoS Chairman

Reference Books	
1.	Antti Saaksvuori and AnselmiImmonen, “Product Lifecycle Management”, (3rd Edition), Springer Publisher, 2008.
2.	Ivica Crnkovic, Ulf Asklund and Annita Persson Dahlqvist, “Implementing and Integrating Product Data Management and Software Configuration Management”, Artech House Publishers, 2003.
3.	John Stark, “Global Product : Strategy, Product Lifecycle Management and the Billion Customer Question”, Springer Publisher, 2007.
4.	John Stark, “Product Lifecycle Management : 21st Century Paradigm for Product Realisation”, (2nd Edition)., Springer Publisher, 2011.
5.	Michael Grieves, “Product Life Cycle Management”, Tata McGraw Hill, 2006.

Approved by BoS Chairman

B.E.	B23MEE916 PRODUCT DESIGN AND OPTIMIZATION	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To Comprehend Product Development Processes and Organizations.
2.	To Apply Product Planning Techniques for Opportunity Identification.
3.	To Formulate Product Specifications and Concept Development Strategies.
4.	To Utilize Optimization Principles in Mechanical Design.
5.	To Implement Optimization Techniques in Product Development.

UNIT - I	DEVELOPMENT PROCESSES AND ORGANIZATIONS	9

Introduction to New Product and Product design - Characteristics of Successful Product – The Challenges in Product Development - Product Development Process – Adapting Generic Product Development Process - Product Development Process Flows - Product Development Organizations

UNIT - II	PRODUCT PLANNING	9

Types of Opportunities - Structure of Opportunity Identification – Opportunity Identification Process – Product Planning Process – Four Types of Product Development Projects – Steps in Product Planning – Identifying Customer Needs

UNIT - III	PRODUCT SPECIFICATIONS AND CONCEPT DEVELOPMENT	9

Product Specifications – Target and Final Specifications. Concept Generation : Five Step Method - Concept Selection – Concept Screening – Concept Scoring – Concept Testing

UNIT - IV	INTRODUCTION TO OPTIMIZATION	9

Introduction to Optimum Design - Global and Local – Problems - General Characteristics of Mechanical Elements – Adequate and Optimum Design – General Principles of Optimization – Formulation of Objective Function – Design Constraints – Classification of Optimization Problem – Saddle Point – Single Variable Optimization – Multi Variable Optimization with no Constraints

Approved by BoS Chairman

UNIT - V	UNCONSTRAINED OPTIMIZATION TECHNIQUES	9
Single Variable and Multi variable Optimization with Constraints – Techniques of Unconstrained Minimization - Golden Section - Pattern and Gradient Search Methods - Interpolation Methods – Quadratic Function Method		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Infer the basic need for new product design and development process.
CO2	Identify opportunities and customer needs for new product development.
CO3	Discover the product specification and develop concepts for new product.
CO4	Make use of unconstrained optimization techniques to identify optimum value.

Text Books	
1.	Eppinger, S.D. and Ulrich, K.T. " Product design and development", 6th Edition, McGraw-Hill Higher Education, 2020 for Units I, II, III.
2.	Rao Singaresu S. "Engineering Optimization – Theory and Practice", 4th Edition, New Age International Pvt. Ltd., New Delhi, 2015 for Units IV, V.

Reference Books	
1.	Devdas Shetty, "Product Design For Engineers", 1st Edition Cengage Learning, 2015.
2.	Kalyanamoy Deb. "Optimization for Engineering Design Algorithms and Examples", 2nd Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2021.

J.P.

Approved by BoS Chairman

Vertical - 3

ROBOTICS AND AUTOMATION

B.E.	B23MEE917 SENSORS AND INSTRUMENTATION	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the concepts of measurement technology.
2.	To learn the various sensors used to measure various physical parameters.
3.	To learn the fundamentals of signal conditioning, data acquisition and communication systems used in mechatronics system development.
4.	To learn about the optical, pressure and temperature sensor.
5.	To understand the signal conditioning and DAQ systems.

UNIT - I	INTRODUCTION	9
Basics of Measurement – Classification of errors – Error analysis – Static and dynamic characteristics of transducers – Performance measures of sensors – Classification of sensors – Sensor calibration techniques – Sensor Output Signal Types		

UNIT - II	MOTION, PROXIMITY AND RANGING SENSORS	9
Motion Sensors – Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer – GPS, Bluetooth, Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR)		

UNIT - III	FORCE, MAGNETIC AND HEADING SENSORS	9
Strain Gage, Load Cell, Magnetic Sensors – types, principle, requirement and advantages : Magneto resistive – Hall Effect – Current sensor Heading Sensors – Compass, Gyroscope, Inclinometers		

UNIT - IV	OPTICAL, PRESSURE AND TEMPERATURE SENSORS	9
Photo conductive cell, photo voltaic, Photo resistive, LDR – Fiber optic sensors – Pressure – Diaphragm, Bellows, Piezoelectric – Tactile sensors, Temperature – IC, Thermistor, RTD, Thermocouple. Acoustic Sensors – flow and level measurement, Radiation Sensors - Smart Sensors - Film sensor, MEMS & Nano Sensors, LASER sensors		

Approved by BoS Chairman

UNIT - V	SIGNAL CONDITIONING AND DAQ SYSTEMS	9
Amplification – Filtering – Sample and Hold circuits – Data Acquisition: Single channel and multi-channel data acquisition – Data logging - applications - Automobile, Aerospace, Home appliances, Manufacturing, Environmental monitoring		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Recognize with various calibration techniques and signal types for sensors.
CO2	Describe the working principle and characteristics of force, magnetic, heading, pressure and temperature, smart and other sensors and transducers.
CO3	Apply the various sensors and transducers in various applications.
CO4	Select the appropriate sensor for different applications.
CO5	Acquire the signals from different sensors using Data acquisition systems.

Text Books	
1.	Ernest O Doebelin, “Measurement Systems – Applications and Design”, Tata McGraw-Hill, 2009.
2.	Sawney A K and Puneet Sawney, “A Course in Mechanical Measurements and Instrumentation and Control”, Dhanpat Rai & Co, 12th edition New Delhi, 2013.

Reference Books	
1.	C. Sujatha ... Dyer, S.A., Survey of Instrumentation and Measurement, John Wiley & Sons, Canada, 2001.
2.	Hans Kurt Tönshoff (Editor), Ichiro, “Sensors in Manufacturing” Volume 1, Wiley-VCH April 2001.
3.	John Turner and Martyn Hill, “Instrumentation for Engineers and Scientists”, Oxford Science Publications, 1999.
4.	Patranabis D, “Sensors and Transducers”, 2nd Edition, PHI, New Delhi, 2011.
5.	Richard Zurawski, “Industrial Communication Technology Handbook”, 2nd edition, CRC Press, 2015.

Approved by BoS Chairman

B.E.	B23MEE918 ELECTRICAL DRIVES AND ACTUATORS	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To familiarize a relay and power semiconductor devices.
2.	To get a knowledge on drive characteristics.
3.	To obtain the knowledge on DC motors and drives.
4.	To obtain the knowledge on AC motors and drives.
5.	To obtain the knowledge on Stepper and Servo motor.

UNIT - I	RELAY AND POWER SEMI-CONDUCTOR DEVICES	9

Study of Switching Devices – Relay and Types, Switching characteristics - BJT, SCR, TRIAC, GTO, MOSFET, IGBT and IGCT : SCR, MOSFET and IGBT - Triggering and commutation circuit - Introduction to Driver and snubber circuits

UNIT - II	DRIVE CHARACTERISTICS	9

Electric drive – Equations governing motor load dynamics – steady state stability – multi quadrant Dynamics: acceleration, deceleration, torque, and Direction starting & stopping – Selection of motor

UNIT - III	DC MOTORS AND DRIVES	9

DC Servomotor - Types of PMDC & BLDC motors - principle of operation - emf and torque equations - characteristics and control – Drives-H bridge - Single and Three Phases – 4 quadrant operation – Applications

UNIT - IV	STEPPER AND SERVO MOTOR	9

Introduction – Induction motor drives – Speed control of 3-phase induction motor – Stator voltage control – Stator frequency control – Stator voltage and frequency control – Stator current control – Static rotor resistance control – Slip power recovery control

Approved by BoS Chairman

UNIT - V	STEPPER AND SERVO MOTOR	9
Stepper Motor : Classifications - Construction and Principle of Operation – Modes of Excitation - Drive System - Logic Sequencer - Applications. Servo Mechanism – DC Servo motor - AC Servo motor – Applications		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Recognize the principles and working of relays, drives and motors.
CO2	Explain the working and characteristics of various drives and motors.
CO3	Apply the solid state switching circuits to operate various types of Motors and Drivers
CO4	Interpret the performance of Motors and Drives.
CO5	Suggest the Motors and Drivers for given applications.

Text Books	
1.	Bimbhra B.S., "Power Electronics", 5th Edition, Kanna Publishers, New Delhi, 2012.
2.	Mehta V.K. & Rohit Mehta, "Principles of Electrical Machines", 2nd Edition, S.Chand & Co. Ltd., New Delhi, 2016.

Reference Books	
1.	Gobal K. Dubey, "Fundamentals of Electrical Drives", 2nd Edition, Narosal Publishing House, New Delhi, 2001.
2.	Theraja B.L. &Theraja A.K., "A Text Book of Electrical Technology", 2nd Edition, S.Chand & Co. Ltd., New Delhi, 2012.
3.	Singh M.D. &Kanchandhani K.B., "Power Electronics", McGraw Hill, New Delhi, 2007

Approved by BoS Chairman

B.E.	B23MEE919 EMBEDDED SYSTEMS AND PROGRAMMING	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To familiarize the architecture and fundamental units of microcontroller.
2.	To know the microcontroller programming methodology and to acquire the interfacing skills and data exchange methods using various communication protocols.
3.	To design the interface circuit and programming of I/O devices, sensors and actuators.
4.	To understand ARM processor architecture and its functions to meet out the computational and interface needs of growing mechatronic systems.
5.	To acquaint the knowledge of real time embedded operating system for advanced system developments.

UNIT - I	INTRODUCTION TO MICROCONTROLLER	9

Fundamentals Functions of ALU - Microprocessor - Microcontrollers – CISC and RISC – Types Microcontroller - 8051 Family - Architecture - Features and Specifications - Memory Organization - Instruction Sets – Addressing Modes

UNIT - II	PROGRAMMING AND COMMUNICATION	9

Fundamentals of Assembly Language Programming – Instruction to Assembler – Compiler and IDE - C Programming for 8051 Microcontroller – Basic Arithmetic and Logical Programming - Timer and Counter - Interrupts – Interfacing and Programming of Serial Communication, I2C, SPI and CAN of 8051 Microcontroller – Bluetooth and WI-FI interfacing of 8051 Microcontroller

UNIT - III	PERIPHERAL INTERFACING	9

I/O Programming – Interfacing of Memory, Key Board and Displays – Alphanumeric and Graphic, RTC, interfacing of ADC and DAC, Sensors - Relays - Solenoid Valve and Heater - Stepper Motors, DC Motors - PWM Programming – Closed Loop Control Programming of Servomotor – Traffic Light

UNIT - IV	ARM PROCESSOR	9

Introduction ARM 7 Processor - Internal Architecture – Modes of Operations – Register Set – Instruction Sets – ARM Thumb - Thumb State Registers – Pipelining – basic programming of ARM 7 - Applications

Approved by BoS Chairman

UNIT - V	SIGNAL CONDITIONING AND DAQ SYSTEMS	9
System on Chip - Broadcom BCM2711 SoC – SBC architecture - Models and Languages – Embedded Design – Real Time Embedded Operating Systems - Real Time Programming Languages – Python for Embedded Systems- GPIO Programming – Interfacing		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Know the various functional units of microcontroller, processors and system-on-chip based on the features and specifications.
CO2	Recognize the role of each functional units in microcontroller, processors and system-on-chip based on the features and specifications.
CO3	Interface the sensors, actuators and other I/O's with microcontroller, processors and system on chip based interfacing.
CO4	Design the circuit and write the programming microcontroller, processors and system on chip.
CO5	Develop the applications using Embedded system.

Text Books	
1.	Frank Vahid and Tony Givagis, "Embedded System Design", 2011, Wiley.
2.	Kenneth J. Aylala, "The 8051 Microcontroller, the Architecture and Programming Applications", 2003.

Reference Books	
1.	Muhammad Ali Mazidi and Janice GillispicMazdi, "The 8051 Microcontroller and Embedded Systems", Pearson Education, 2006.
2.	Simon Monk, Programming the Raspberry Pi, Second Edition: Getting Started with Python McGraw Hill TAB; 2nd edition, 2015
3.	James W. Stewart, "The 8051 Microcontroller Hardware, Software and Interfacing", Regents Prentice Hall, 2003.
4.	John B. Peatman, "Design with Microcontrollers", McGraw Hill International, USA, 2005.

Approved by BoS Chairman

B.E.	B23MEE920 ROBOTICS	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To learn about basics of robots and their classifications.
2.	To understand the robot kinematics in various planar mechanisms.
3.	To learn about the concepts in robot dynamics.
4.	To understand the concepts in trajectory planning and programming.
5.	To know about the various applications of robots.

UNIT - I	BASICS OF ROBOTICS	9
Introduction - Basic components of robot - Laws of robotics - classification of robot - robot architecture, work space - accuracy - resolution – repeatability of robot		

UNIT - II	MOTION, PROXIMITY AND RANGING SENSORS	9
Robot kinematics : Introduction - Matrix representation - rigid motion & homogeneous transformation - D-H, forward & inverse kinematics of 2DOF and 3 DOF planar and spatial mechanisms		

UNIT - III	FORCE, MAGNETIC AND HEADING SENSORS	9
Introduction - Manipulator dynamics – Lagrange - Euler formulation- Newton - Euler formulation		

UNIT - IV	OPTICAL, PRESSURE AND TEMPERATURE SENSORS	9
Trajectory Planning - Joint space and Cartesian space technique, Introduction to robot control, Robot programming and Languages - Introduction to ROS		

UNIT - V	SIGNAL CONDITIONING AND DAQ SYSTEMS	9
Sensors and Actuators for Robots, Power transmission systems, Rotary to rotary motion, Rotary to linear motion, Harmonics drives – gear system - belt drives. Robot end effectors & Grippers : Introduction - types & classification - Mechanical gripper - gripper force analysis - other types & special purpose grippers. Robot Applications : pick and place, manufacturing, automotive, medical, space and underwater		
		Total Instructional hours : 45

Approved by BoS Chairman

Course Outcomes : Students will be able to	
CO1	State the basic concepts and terminologies of robots.
CO2	Know the Procedures for Forward and Inverse Kinematics, Dynamics for Various Robots.
CO3	Derive the Forward and Inverse Kinematics, Dynamics for Various Robots.
CO4	Apply the various programming techniques in industrial applications.
CO5	Analyze the use of various types of robots in different applications.

Text Books	
1.	John.J.Craig, " Introduction to Robotics : Mechanics & Control", Pearson Publication, Fourth edition, 2018.
2.	K.S.Fu, R.C.Gonzalez, C.S.G. Lee, "Robotics : Sensing, Vision & Intelligence", Tata McGraw - Hill Publication, First Edition, 1987.

Reference Books	
1.	M.P.Groover, M.Weiss, R.N. Nagal, N.G.Odrey, “Industrial Robotics - Technology, Programming and Applications”, Tata McGraw-Hill Education Pvt Limited, 2nd Edition, 2012.
2.	Jazar, “Theory of Applied Robotics : Kinematics, Dynamics and Control”, Springer, 2nd Edition, 2010.
3.	S K Saha, “Introduction to Robotics”, Tata McGraw-Hill, ISBN: 9789332902800, Second Edition, 9789332902800
4.	Sathya Ranjan Deb, “Robotics Technology & flexible Automation” Second edition, Tata McGraw-Hill Publication, 2009.

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Approved by BoS Chairman

B.E.	B23MEE921 SMART MOBILITY AND INTELLIGENT VEHICLES	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To introduce students to the various technologies and systems used to implement smart mobility and intelligent vehicles.
2.	To learn Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, LIDAR Sensor Technology and Systems and other sensors for automobile vision system.
3.	To learn Basic Control System Theory applied to Autonomous Automobiles.
4.	To produce overall impact of automating like various driving functions, connecting the automobile to sources of information that assist with a task.
5.	To allow the automobile to make autonomous intelligent decisions concerning future actions of the vehicle that potentially impact the safety of the occupants through connected car & autonomous vehicle technology.

UNIT - I	INTRODUCTION TO AUTOMATED, CONNECTED AND INTELLIGENT VEHICLES	9
Concept of Automotive Electronics, Electronics Overview, History & Evolution, Infotainment, Body, Chassis, and Powertrain Electronics, Introduction to Automated, Connected, and Intelligent Vehicles. Case studies: Automated, Connected, and Intelligent Vehicles		

UNIT - II	SENSOR TECHNOLOGY FOR SMART MOBILITY	9
Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, Lidar Sensor Technology and Systems, Camera Technology, Night Vision Technology, Other Sensors, Use of Sensor Data Fusion, Integration of Sensor Data to On-Board Control Systems		

UNIT - III	CONNECTED AUTONOMOUS VEHICLE	9
Basic Control System Theory applied to Automobiles, Overview of the Operation of ECUs, Basic Cyber-Physical System Theory and Autonomous Vehicles, Role of Surroundings Sensing Systems and Autonomy, Role of Wireless Data Networks and Autonomy		

Approved by BoS Chairman

UNIT - IV	**VEHICLE WIRELESS TECHNOLOGY & NETWORKING**	**9**
Wireless System Block Diagram and Overview of Components, Transmission Systems – Modulation/ Encoding, Receiver System Concepts – Demodulation/Decoding, Wireless Networking and Applications to Vehicle Autonomy, Basics of Computer Networking – the Internet of Things, Wireless Networking Fundamentals, Integration of Wireless Networking and On-Board Vehicle Networks		

UNIT - V	**CONNECTED CAR & AUTONOMOUS VEHICLE TECHNOLOGY**	**9**
Connectivity Fundamentals, Navigation and Other Applications, Vehicle-to-Vehicle Technology and Applications, Vehicle-to-Roadside and Vehicle-to-Infrastructure Applications, Autonomous Vehicles - Driverless Car Technology, Moral, Legal, Roadblock Issues, Technical Issues, Security Issues		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Recognize the concept of cyber-physical control systems and their application to collision avoidance and autonomous vehicles.
CO2	Select the concept of remote sensing and the types of sensor technology needed to implement remote sensing.
CO3	Familiar with the concept of fully autonomous vehicles.
CO4	Apply the basic concepts of wireless communications and wireless data networks.
CO5	Analyze the concept of the connected vehicle and its role in automated vehicles.

Text Books	
1.	"Intelligent Transportation Systems and Connected and Automated Vehicles", 2016, Transportation Research Board.
2.	Radovan Miucic, "Connected Vehicles : Intelligent Transportation Systems", 2019, Springer.

Reference Books	
1.	Tom Denton, "Automobile Electrical and Electronic systems, Roultedge", Taylor & Francis Group, 5th Edition, 2018.

Approved by BoS Chairman

B.E.	B23MEE922 HAPTICS AND IMMERSIVE TECHNOLOGIES	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To learn various immersive technologies of VR, AR and MR.
2.	To learn software related to immersive technologies.
3.	To learn the concepts of developing AR applications.
4.	To learn the concepts of developing VR and unreal engine.
5.	To study the haptic perception and extended reality.

UNIT - I	INTRODUCTION TO IMMERSIVE TECHNOLOGIES	9
Introduction on Virtual reality – Augmented reality – Mixed reality – Extended reality – VR Devices – AR Devices – Applications		

UNIT - II	SOFTWARE TOOLS	9
Intro to Unity – Unity editor workspace – Intro to C# and visual studio - Programming in Unity – Intro to Unreal Engine – UE4 Editor workspace – Intro to Blueprint programming – Programming in Ue4		

UNIT - III	BUILDING AR APPLICATION WITH UNITY	9
AR SDKs for unity and unreal engine – Working with SDKs for unity – Developing AR application in unity - Building AR application		

UNIT - IV	BUILDING VR APPLICATION WITH UNREAL ENGINE	9
VR SDKs for unity and unreal engine – Developing VR application in Ue4 – Building VR application		

UNIT - V	HAPTIC PERCEPTION AND EXTENDED REALITY	9
Extended Reality - Introduction to Haptics – Devices and possibilities – Custom Device development – Device Integration		
		Total Instructional hours : 45

Approved by BoS Chairman

Course Outcomes : Students will be able to	
CO1	Apply detailed knowledge about immersive technology.
CO2	Gaining the knowledge of different types of Tools and Devices.
CO3	Acquiring the knowledge about Unity and Unreal Engine.
CO4	Explain the developing application in immersive technologies.
CO5	Discuss about haptics in immersive technologies.

Text Books	
1.	Immersive Multimodal Interactive Presence, by Angelika Peer (Editor), Christos D. Giachritsis (Editor), Springer; 2012th edition (13 April 2014), ISBN-10 : 1447162137.
2.	XR Haptics, Implementation & Design Guidelines, by Eric Vezzoli , Chris Ullrich, Gijs den Butter, Rafal Pijewski, March 13, 2022.

Reference Books	
1.	Practical Augmented Reality, by Steve Aukstakalnis, Addison-Wesley Professional; 1st edition (8 September 2016).
2.	Augmented Reality - Theory, Design and Development, by Chetankumar G Shetty.
3.	Strategic Communication and AI, by Simon Moore, Roland Hübscher, Routledge; 1st edition (10 September 2021), ISBN-10 : 0367627795.
4.	Immersive Analytics, by Kim Marriott, Falk Schreiber, Springer; 1st ed. 2018 edition (15 October 2018).
5.	Immersive Analytics A Clear and Concise Reference, by Gerardus Blokdyk, 5 STAR Cooks (5 September 2018).

Approved by BoS Chairman

B.E.	B23MEE923 DRONE TECHNOLOGIES	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the basics of drone concepts.
2.	To learn and understand the fundaments of design, fabrication and programming of drone.
3.	To impart the knowledge of an flying and operation of drone.
4.	To know about the various applications of drone.
5.	To understand the safety risks and guidelines of fly safely.

UNIT - I	INTRODUCTION TO DRONE TECHNOLOGY	9
Drone Concept - Vocabulary Terminology - History of drone - Types of current generation of drones based on their method of propulsion - Drone technology impact on the businesses - Drone business through entrepreneurship - Opportunities/applications for entrepreneurship and employability		

UNIT - II	DRONE DESIGN, FABRICATION AND PROGRAMMING	9
Classifications of the UAV - Overview of the main drone parts - Technical characteristics of the parts - Function of the component parts - Assembling a drone - The energy sources - Level of autonomy - Drones configurations - The methods of programming drone - Download program - Install program on computer - Running Programs - Multi rotor stabilization - Flight modes - Wi-Fi connection		

UNIT - III	DRONE FLYING AND OPERATION	9
Concept of operation for drone - Flight modes - Operate a small drone in a controlled environment - Drone controls Flight operations – management tool – Sensors - Onboard storage capacity - Removable storage devices - Linked mobile devices and applications		

UNIT - IV	BUILDING VR APPLICATION WITH UNREAL ENGINE	9
Choosing a drone based on the application -Drones in the insurance sector - Drones in delivering mail, parcels and other cargo - Drones in agriculture - Drones in inspection of transmission lines and power distribution - Drones in filming and panoramic picturing		

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UNIT - V	FUTURE DRONES AND SAFETY	9
The safety risks - Guidelines to fly safely - Specific aviation regulation and standardization - Drone license - Miniaturization of drones - Increasing autonomy of drones - The use of drones in swarms		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Know about a various type of drone technology, drone fabrication and programming.
CO2	Execute the suitable operating procedures for functioning a drone.
CO3	Select appropriate sensors and actuators for Drones.
CO4	Develop a drone mechanism for specific applications.
CO5	Create the programs for various drones.

	Text Books
1.	"Drone Technology : Future Trends and Practical Applications" by Sachi Nandan Mohanty and JVR Ravindra, Wiley-Scrivener; 1st edition (14 June 2023), ISBN-10 : 1394166532.
2.	"Introduction to UAV Systems", 4th Edition, Dr. Thomas J Gleason, Col Paul G Fahlstrom, Wiley; 4th edition (24 August 2012), ISBN-10 : 1119978661.

	Reference Books
1.	"Drone Development from Concept to Flight : Design, Assemble, and Discover the Applications of Unmanned Aerial Systems" by David Busch, Birmingham, UK : Packt Publishing Ltd, 1st Edition, 2024.
2.	"The Drone Pilot's Handbook" by Adam Juniper, Ilex Pr (3 May 2016), ISBN-10 : 1781572984.
3.	The Future of Drone Use : Opportunities and Threats from Ethical and Legal Perspectives, T.M.C. Asser Press; 1st ed. 2016 edition (24 October 2016), ISBN-10 : 9462651310.
4.	"Drones for Good : How to Bring Societal Benefits from a Drone Revolution" by Gordon D. Hoople and Austin Choi-Fitzpatrick, Springer International Publishing AG (21 May 2020), ISBN -10 : 3031009886.
5.	"Unmanned Aircraft Systems : UAVS Design, Development, and Deployment" by Reg Austin, 1st Edition, Kindle Edition, (21 September 2011).

Approved by BoS Chairman

B.E.	B23MEE924 AGRICULTURAL ROBOTICS AND AUTOMATION	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To learn about Farming related Machines.
2.	To understand the global position and information system in machines.
3.	To know about traction and testing.
4.	To familiarize the concept on weed management.
5.	To learn about machinery selection.

UNIT - I	INTRODUCTION	9
History of Mechanized Agriculture - Farming Operations and Related Machines - Tillage, Planting Cultivation, and Harvesting, Agricultural Automation - Agricultural Vehicle Robot		

UNIT - II	PRECISION AGRICULTURE	9
Sensors – types and agricultural applications, Global Positioning System (GPS) - GPS for civilian use, Differential GPS, Carrier-phase GPS, Real-time kinematic GPS, Military GPS, Geographic Information System, Variable Rate Applications and Controller Area Networks		

UNIT - III	TRACTION AND TESTING	9
Hitching - Principles of hitching, Types of hitches, Hitching and weight transfer, Control of hitches, Tires and Traction models, Traction predictor spread sheet, Soil Compaction, Traction Aids, Tractor Testing		

UNIT - IV	SOIL TILLAGE AND WEED MANAGEMENT	9
Tillage Methods and Equipment, Mechanics of Tillage Tools, Performance of Tillage Implements, Hitching of Tillage Implements, Weed Management - Conventional Cropping Systems, Tools, Crop Rotation, Mechanical Cultivation		

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UNIT - V	MACHINERY SELECTION	9
Screw Conveyors, Pneumatic Conveyors, Bucket Elevators, Forage Blowers and Miscellaneous Conveyors, Machinery Selection - Field Capacity and Efficiency, Draft and Power Requirements, Machinery Costs		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Recognize the areas in agricultural process where robotics can be applied.
CO2	Integrate sensor and system for a required specific process in agricultural applications.
CO3	Apply Mechanics to the design various robot parameters.
CO4	Convert various mechanisms into robot by providing actuation at specific links and joints of the mechanism.
CO5	Develop suitable robotic system for specific agricultural tasks.

Text Books	
1.	Ajit K. Srivastava, Carroll E. Goering, Roger P. Rohrbach, Dennis R. Buckmaster, “Engineering Principles of Agricultural Machines”, ASABE Publication, 2012.
2.	Myer Kutz, “Handbook of Farm, Dairy and Food Machinery Engineering”, Academic Press, 2019.

Reference Books	
1.	Qin Zhang, Francis J. Pierce, “Agricultural Automation Fundamentals and Practices”, CRC Press, 2016.
2.	Stephen L Young, Francis J. Pierce, “Automation : The Future of Weed Control in Cropping Systems”, Springer, Dordrecht Heidelberg New York London, 2014.
3.	R.A. Kepner, Roy Bainer, E.L. Barger, “Principles of Farm Machinery”, 3rd Edition, CBS Publishers, New Delhi, 2005.
4.	Guangnan Chen, “Advances in Agricultural Machinery and Technologies”, 1st Edition, CRC Press, 2021.

Approved by BoS Chairman

Vertical - 4

PROCESS EQUIPMENT AND PIPING DESIGN

B.E.	B23MEE925 DESIGN OF PRESSURE VESSELS	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To introduce the Mathematical knowledge to design pressure vessels and piping.
2.	To learn the ability to carry of stress analysis in pressure vessels and piping.
3.	To study the design of vessels and theory of reinforcement.
4.	To study buckling and fracture analysis in vessels.
5.	To learn piping layout and flow diagram.

UNIT - I	INTRODUCTION	9
Methods for determining stresses – Terminology and Ligament Efficiency – Applications		

UNIT - II	STRESSES IN PRESSURE VESSELS	9
Introduction – Stresses in a circular ring, cylinder – Dilation of pressure vessels, Membrane stress Analysis of Vessel – Cylindrical, spherical and, conical heads – Thermal Stresses – Discontinuity stresses in pressure vessels		

UNIT - III	DESIGN OF VESSELS	9
Design of Tall cylindrical self-supporting process columns – Supports for short vertical vessels – Stress concentration at a variable Thickness transition section in a cylindrical vessel, about a circular hole, elliptical openings. Theory of Reinforcement – Pressure Vessel Design		

UNIT - IV	BUCKLING AND FRACTURE ANALYSIS IN VESSELS	9
Buckling phenomenon – Elastic Buckling of circular ring and cylinders under external pressure –collapse of thick walled cylinders or tubes under external pressure – Effect of supports on Elastic Buckling of Cylinders – Buckling under combined External pressure and axial loading		

UNIT - V	PIPING	9
Introduction – Flow diagram – piping layout and piping stress Analysis		
		Total Instructional hours : 45

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Course Outcomes : Students will be able to	
CO1	Explain Methods for determining stresses Terminology and Ligament Efficiency, Applications.
CO2	Analyse stress in pressure vessels.
CO3	Design and analysis of pressure vessels.
CO4	Analyse of buckling and fracture in pressure vessels.
CO5	Design and analysis piping layout and piping.

Text Books	
1.	John F. Harvey, “Theory and Design of Pressure Vessels”, CBS Publishers and Distributors, 2001.
2.	Theory and Design of Pressure Vessels (Pb 2001) by HARVEY J.F., 1 January 2001.

Reference Books	
1.	Henry H. Bedner, “Pressure Vessels, Design Hand Book", CBS publishers and Distributors,1987.
2.	Stanley, M. Wales, “Chemical Process Equipment, Selection and Design". Buterworths series in Chemical Engineering, 1988.
3.	William. J., Bees, “Approximate Methods in the Design and Analysis of Pressure Vessels and Piping”, Pre ASME Pressure Vessels and Piping Conference, 1997.
4.	Sam Kannapan, “Introduction to Pipe Stress Analysis”. John Wiley and Sons, 1985.

Approved by BoS Chairman

B.E.	B23MEE926 FAILURE ANALYSIS AND NDT TECHNIQUES	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To introduce need and scope of failure analysis and fundamental sources of failures.
2.	To learn about non-destructive testing and basic principles of visual inspection.
3.	To study about magnetic testing and principles, techniques.
4.	To learn the principle of radiography testing and its inspection techniques and methods.
5.	To study the acoustic testing principle and technique and instrumentation.

UNIT - I	INTRODUCTION	9

Introduction and need and scope of failure analysis. Engineering Disasters and understanding failure analysis. Fundamental sources of failures. Deficient design. Improper Manufacturing & amp; Assembly. Tree diagram and FMEA

UNIT - II	VISUAL INSPECTION	9

Introduction to Non-Destructive Testing : An Introduction, Visual examination, Basic Principle, The Eye, Optical aids used for visual inspection, Applications. Liquid Penetrant Testing : Physical principles, Procedure for penetrant testing, Penetrant testing materials, Penetrant testing methods, Sensitivity, Applications, Limitations and Standards

UNIT - III	MAGNETIC TESTING	9

Magnetic Particle Testing, Eddy Current Testing: Magnetism-basic definitions and principle of magnetic particle testing, Magnetizing techniques, induced current flow, Procedure used for testing a component, Equipment Used for magnetic particle testing, Sensitivity, Limitations. Eddy Current Testing: Principles, Instrumentation for eddy current testing Techniques. Sensitivity Advanced Eddy Current Test Methods, Applications, Limitations

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UNIT - IV	RADIOGRAPHY TESTING	9
Radiography, Ultrasonic Testing: Basic principle, Electromagnetic radiation, Sources, Radiation attenuation in the specimen. Effect of radiation in film, Radiographic imaging, Inspection techniques, Applications of radiographic inspection, Limitations, Safety in Industrial Radiography, Standards, Neutron radiography. Ultrasonic Testing: Basic properties of sound beam, Ultrasonic transducers, Inspection methods, Techniques for Normal Beam Inspection, Techniques for Angle Beam Inspection, Flaw characterization techniques, Ultrasonic flaw detection equipment, Modes of Display, Immersion Testing, Applications of Ultrasonic Testing, Advantages, Limitations		

UNIT - V	ACOUTISTIC TESTING	9
Acoustic Emission Testing : Principle of Acoustic Emission Testing, Technique, Instrumentation, Sensitivity, Applications, Standards. Thermograph : Basic Principles, Detectors and Equipment, Techniques, Applications, Codes and Standards. In Situ Metallographic Examination : Approach to the Selection of Site for Metallographic examination, Replication process, Significance of Microstructure observation, Decision making, Applications, Codes and Standards. (Digital signal process)		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Apply failure analysis techniques to identify fundamental sources of failures and assess their impact on engineering components.
CO2	Perform non-destructive testing (NDT) using visual inspection techniques to detect material defects and irregularities.
CO3	Implement magnetic testing techniques to evaluate material properties and detect surface and subsurface defects.
CO4	Utilize radiography testing methods to inspect internal defects in materials and assess their structural integrity.
CO5	Apply acoustic testing principles and instrumentation to evaluate material behavior and detect flaws in engineering structures.

Approved by BoS Chairman

Text Books	
1.	Baldev Raj, T.Jayakumar, M.Thavasimuthu Practical Non-Destructive Testing, Narosa Publishing House, 2014.
2.	Ravi Prakash, Non-Destructive Testing Techniques, 1st revised edition, New Age International Publishers, 2010.

Reference Books	
1.	ASM Metals Handbook, Non-Destructive Evaluation and Quality Control, American Society of Metals, Metals Park, Ohio, USA, 200, Volume - 17.
2.	ASNT, American Society for Non-Destructive Testing, Columbus, Ohio, NDT Handbook, Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4, Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol. 7, Ultrasonic Testing.
3.	Charles, J. Hellier, Handbook of Non-destructive evaluation, McGraw Hill, New York 2001.
4.	Paul E Mix, Introduction to Non-destructive testing: a training guide, Wiley, 2nd Edition, New Jersey, 2005
5.	J. Prasad and C.G.K. Nair, Non-Destructive Test and Evaluation of Materials, Tata McGraw-Hill Education, 2nd edition (2011).

Approved by BoS Chairman

B.E.	B23MEE927 MATERIAL HANDLING AND SOLID PROCESSING EQUIPMENT	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To provide knowledge on materials handling equipment.
2.	To provide knowledge on Industrial Vehicles.
3.	To provide knowledge on conveyor equipment.
4.	To provide knowledge on Auxiliary Equipment and Hoisting Equipment.
5.	To provide knowledge on Bulk Handling Equipment and Systems.

UNIT - I	INTRODUCTION TO MATERIALS HANDLING	9

Basic principles & objectives in material handling and its benefits - Classification of material handling equipment - selection of material handling equipments - guidelines for effective utilisation of material handling equipments - unit load concept

UNIT - II	INDUSTRIAL VEHICLES	9

Introduction and types - Hand trucks - Two wheel Hand Trucks - Multiple wheel Hand Trucks - Hand Lift Trucks - Power Trucks - Fixed Platform Truck - Platform Lift Truck - Pallet Lift Truck - Walkie Truck - Straddle Carrier - Fork Lift Trucks - Specifications of FLT - FLT Attachments - Tractors - Industrial Tractor - Trailer-Self-propelled trucks and fork trucks - Automated guided vehicles Theory

UNIT - III	CONVEYORS	9

Classification of conveyors - Definition - Description - General Characteristics - types and uses of belt Conveyors - Roller conveyors - Haulage Conveyors - Screw Conveyors - Bucket Conveyors - Chain Conveyors - Cable Conveyors - Pneumatic and Hydraulic conveyors - Computer controlled conveyor system

UNIT - IV	AUXILIARY EQUIPMENTAND HOISTING EQUIPMENT	9

Hoppers - Gates - Feeders - Chutes-positioners - Ball Table - Weighing and Control Equipment - Pallet loaders and unloaders - applications and advancements - Hoisting Equipment - parts of hoisting equipment - Description and uses of hoists - Description and uses of ropes - description and purpose of crane hooks - Elevators - Cranes - Derricks - and its types

Approved by BoS Chairman

UNIT - V	BULK HANDLING EQUIPMENT AND SYSTEMS	9
Storage of bulk solids - bulk handling equipment - Robotic handling - Materials handling at the workplace - Robots and their classification - Major components of a robot - classification of Robotic manipulators - Robotic handling applications		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Discuss the basic concepts of material handling equipment.
CO2	Explain the basic working principles of various industrial Vehicles.
CO3	Develop the basic working principles of various conveyors.
CO4	Elaborate the basic working principles of various Auxiliary Equipment and Hoisting Equipment.
CO5	Explain the basic working principles of various Bulk Handling Equipment and Systems.

Text Books	
1.	Allegri (Sr.), T.H., Material Handling – Principles and Practices, CBS Publishers and Distributors, Delhi, 2019.
2.	Siddharta Ray, Introduction to Materials Handling, New Age International Publisher Jiuchun, 2017.
3.	Jiang and Caiping Zhang, “Fundamentals and applications of Lithium-Ion batteriesin Electric Drive Vehicles’’, Wiley, 2015.

Reference Books	
1.	Bolz, H.A and Hagemann, G.E (ed.), ‘‘Materials Handling Handbook’’, Ronald Press 8005:2015, Classification of Unit Loads, Bureau of Indian Standards.
2.	Apple, J.A., ‘‘Material Handling System Design’’, John Wiley & Sons, 2015.
3.	Theodore H., Allegre Sr., Material Handling Principles and Practice, CBS Publishers and Distributors. Delhi, 2017.
4.	Immer J.R., Material Handling, Tata McGraw Hill Publication, 2010.

Approved by BoS Chairman

B.E.	B23MEE928 ROTATING MACHINERY DESIGN	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To familiarize the course member with various operations of gas turbines and other driven rotating machines.
2.	To familiarize students with the common problems associated with the mechanical design and the lifting of the major rotating components of the gas turbine engine.
3.	To study the failure criteria of rotating machinery.
4.	To learn the design of discs, blades for rotating machinery.
5.	To study about blade vibrations Damage Mechanisms.

UNIT - I	INTRODUCTION	9

Overview of the different operational regimes for gas turbine applications: base load, peak load, standby and backup operations, alongside their individual operational requirements. Fundamentals of Creep and Fatigue damage mechanisms. Material, design and operational parameters that affect creep and fatigue. Experimental and test procedures to characterise creep and fatigue damage

UNIT - II	DESIGNING FORCES	9

Loads / forces / stresses in gas turbine engines: loads - rotational inertia, flight, precession of shafts, pressure gradient, torsion, seizure, blade release, engine mountings and bearings - Discussion of major loadings - rotating components and pressure casing components

UNIT - III	FAILURE CRITERIA	9

Monotonic failure criteria: proof, ultimate strength. Theories of failure - bi-axial loads. Other failure mechanisms - gas turbine engines including creep and fatigue. Fatigue properties - SN and RM diagrams. Stress concentration, mean stress, Cumulative fatigue, Goodman diagram and safety factor for gas turbine components. Larson-Miller time-temperature parameter

UNIT - IV	BLADE DESIGN	9

Design of discs, blades. Illustration of magnitude stresses in conventional axial flow blades - simple desk-top method - effects of leaning the blade. Design of flanges and bolted structures. Leakages through a flanged joint and failure from fatigue

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UNIT - V	BLADE VIBRATIONS AND DAMAGE MECHANISMS	9
Natural frequencies turbomachine blades. Blade twist, centrifugal stiffening, Sources of blade excitation, Stationary flow disturbance, rotating stall and flutter. Campbell diagram and troublesome resonances. Allowances for temperature, pre-twist and centrifugal stiffening. Methods for dealing with resonances		
Total Instructional hours : 45		

Course Outcomes : Students will be able to	
CO1	Differentiate the operational regimes and requirements related to different gas turbine applications.
CO2	Describe and distinguish the design requirements and loads encountered by gas turbine components during normal operation.
CO3	Analyse, evaluate and assess the loads, stresses, failure criteria and factors of safety used in gas turbine engines.
CO4	Evaluate impact of vibrations on design and operation of gas turbine.
CO5	Assess the creep and fatigue damage of gas turbine components based on design and operational parameters.

Text Books	
1.	A S Rangawala, Turbomachinery Dynamics-Design and operations, McGraw-Hill, 2005, ISBN-13: 978-0071453691.
2.	Design, Modeling and Reliability in Rotating Machinery, Robert X. Perez (Editor) ISBN : 978-1-119-63169-9.

Reference Books	
1.	Turbines, Compressors & Fans S.M. Yahya, Tata McGraw Hill Co. Ltd, 2nd edition, 2002.
2.	Fluid Mechanics & Thermodynamics of Turbo machines S. L. Dixon Elsevier, 2005.
3.	Shaft Alignment Handbook (Mechanical Engineering) by John Piotrowski, 2 November, 2006.
4.	P.P Walsh and P. Peletcher, Gas Turbine Performance' Blackwell Science, 1998, ISBN : 0632047843.

Approved by BoS Chairman

B.E.	B23MEE929 INDUSTRIAL LAYOUT DESIGN AND SAFETY	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To introduce the industrial facility layout design principles, process and material flow analysis and product and equipment analysis.
2.	To learn the facilities layout design algorithms and selecting appropriate software.
3.	To study the facilities layout problem modelling tools and algorithms for production, warehouse, and material handling.
4.	To learn the safety planning and management principles in industries.
5.	To learn the various safety management approaches in industries.

UNIT - I	INTRODUCTION	9

Industrial Facility Layout: Definition, Types of Layout Problems, Engineering Design Problem Approach – Product Analysis, Equipment Selection, Personnel Requirement Analysis, Space Requirement and Availability – Process and Material Flow Analysis, Data Requirement for Layout Decisions, Tools for Presenting Layout Designs

UNIT - II	FACILITIES LAYOUT DESIGN & ALGORITHMS	9

Traditional Approaches to Facility Layout, Systematic Layout Planning, Special Considerations in Office Layout, Engineering Design Problem Approach, Code Compliance, OSHA, ADA Regulations, and Other Considerations in Facility Design – Algorithms for the Layout Problem, Construction Algorithms, Improvement Algorithms, Hybrid Algorithms, Layout Software (CRAFT, BLOCPLAN, PFAST, Layout-iQ, VIP-PLANOPT, Factory CAD, Factory FLOW, Plant Simulation)

UNIT - III	FACILITIES LAYOUT PROBLEM MODELS & ALGORITHMS	9

Models for the Layout Problem, Generic Modeling Tools, Models for the Single-Row Layout Problem, Models for the Multi row Layout Problem with Departments of Equal and Unequal Area – Material Handling, Principles, Types, Models for Material-Handling System Design – Storage and Warehousing, Warehouse Functions, Warehouse Design and Operation

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UNIT - IV	SAFETY PLANNING & MANAGEMENT	9
Introduction : Elements of Safety Programming, Safety Management. Upgrading Safety Developmental Programs : Safety Procedures, Arrangements and Performance Measures, Education, Training and Development in Safety. Safety Performance : An Overview of an Accident, Occupational Health and Industrial Hygiene. Understanding the Risks : Prevention of Accidents Involving Hazardous Substances. Indian Factories Act 1948 for Health and Safety		

UNIT - V	APPROACHES IN SAFETY MANAGEMENT	9
Safeguarding against Common Potential Hazards : Trips, Slips and Falls, Preventing Electrocution, Static Electricity, Hazardous Energy Control. Specific Hazard Control Measures : Forklift Hazard Control, Tractor Hazard Control. Safe Handling and Storage : Material Handling, Compressed Gas Cylinders, Corrosive Substances, Hydrocarbons, Waste Drums and Containers		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Explain the industrial facility layout design principles, process and material flow analysis and product and equipment analysis.
CO2	Discuss the facilities layout design algorithms and selecting appropriate software.
CO3	Describe the facilities layout problem modeling tools and algorithms for production, warehouse, and material handling.
CO4	Explain the safety planning and management principles in industries.
CO5	Illustrate the various safety management approaches in industries.

Text Books	
1.	Sunderesh S. Heragu, “Facilities Design”, 3rd Edition, CRC Press Taylor & Francis Group, 2008.
2.	L.M. Deshmukh, “Industrial Safety Management : Hazard Identification and Risk Control”, Tata McGraw-Hill Publishing Co. Ltd., 2005.

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Reference Books	
1.	Eric Teicholz, “Facility Design and Management Handbook”, Tata McGraw-Hill Publishing Co. Ltd., 2001.
2.	James A. Tompkins, John A. White, Yavuz A. Bozer, and J.M.A. Tanchoco, “Facilities Planning”, 4^{th} Edition, John Wiley & Sons, 2010.
3.	Matthew P. Stevens and Fred E. Meyers, “Manufacturing Facilities Design and Material Handling”, 5^{th} Edition, Purdue University Press, 2013.
4.	Charles D.Reese, Occupational Health and Safety Management : A Practical Approach, CRC Press, 2003.
5.	J Maiti, Pradip Kumar Ray, Industrial Safety Management : 21^{st} Century Perspectives of Asia, Springer, 2017.

Approved by BoS Chairman

B.E.	B23MEE930 DESIGN CODES AND STANDARDS	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To study the Codes and Standards and Need for them in the industry.
2.	To know the different sources and the bodies that publish Codes and Standards.
3.	To familiarize the Government Regulations and its applicability.
4.	To familiarize with different codes used in Different Industry.
5.	To familiarize the Codes and Standards used in Process Industry.

UNIT - I	INTRODUCTION	9

Introduction to Codes and Standards. What is code? What is Standard? Need for codes and standards. Objective of Codes and Standards. Codes, Standards and Good Engineering Practices

UNIT - II	CODES	9

Codes and Standards used in Different Industry. Material, Design, Inspection and Construction Codes. Process Industry Codes. Machinery Design codes. Codes used in Oil and Gas Industry. Welding Codes. Machine Design. Automotive. HVAC. Performance Test Codes. Other Discipline codes

UNIT - III	STANDARDS	9

Sources of Codes and Standards. Who publishes Codes and Standards? International Societies and Professional Bodies. Process of Standardisation and Code publishing in Professional Bodies and Companies. Interdisciplinary Codes

UNIT - IV	REGULATIONS	9

Government and Federal Regulations. Need for them. Indian and International Regulations. Standards organisations. Weather and Climatic codes. IS, ISO, IBR, OISD. Certification Bodies. Authorities and Engineers to certify. PE, Chartered Engineers

Approved by BoS Chairman

UNIT - V	DESIGN CODES	9
Codes and Standards applicable in Process Industry Equipment Design. Pressure Vessel Design Codes. Heat Exchanger Design Codes. Wind and Seismic Codes. Machinery Codes. Package Equipment Design Codes. Performance Test Codes. ASTM, ASME, API, AWS, ANSI, ISO, ASHRAE		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Explain the need for codes and Standards in Industry.
CO2	Discuss the different codes and standards used in different industry.
CO3	Discuss the sources of different codes and standards and the societies that publish them and how these are evolved.
CO4	Explain need for Government regulations and Certification authorities and familiar with common regulations in India and International.
CO5	Discuss knowledge of codes and standards used in Process equipment design for Oil and Gas Industry.

Text Books	
1.	ASME Handbook, Volume 1, ASME, 2019.
2.	Perrys Chemical Engineers' Handbook, McGraw-Hill Education, 9th edition, 2018

Reference Books	
1.	www.asme.org
2.	www.iso.org
3.	www.aws.org
4.	www.ishrae.in

Approved by BoS Chairman

B.E.	B23MEE931 THERMAL AND FIRED EQUIPMENT DESIGN	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To introduce the concepts of thermal and fired equipment.
2.	To study the basis, design and construction of boilers.
3.	To study of typical fuel firing systems in the boiler.
4.	To study of materials requirements for pressure parts.
5.	To study of various boiler auxiliaries system.

UNIT - I	INTRODUCTION	9
Principal equipment in Thermal Power Plant, Historical developments of Boiler, Utility, Industrial boilers, Morden trends in boiler design, Basic knowledge of different types of Thermal Fired Equipment, sub critical and super critical boilers - Coal , Oil ,Gas , Pulverised fuel cyclone, FBC, CFBC, MSW, and Stoker firing, Boiler efficiency, auxiliary power consumption, Performance data, Performance Correction Curves		

UNIT - II	BASIS OF BOILERS AND DESIGN	9
Codes - Design and Construction, IBR, ISO, ASME, BS, Heat balance diagram, Boiler parameters, Fuel analysis and variations, Site conditions, Furnace heat loadings, FOT, Plan area loading, Volumetric loading Balanced Draft and Pressurised Furnace, Natural / Controlled Circulation, Constant and Sliding Pressure, Boiler heat transfer surfaces, Flue gas velocities, boiler auxiliaries, Boiler schemes, Boiler Layouts		

UNIT - III	FIRING SYSTEM - FUEL AND MILLING	9
Coal / Oil / Natural Gas in any combination, Lignite, Blast Furnace Gas / Coke Oven Gas / Corex Gas Carbon Monoxide / Tail gas, Asphalt, Black Liquor, Bagasse, Rice Husk, Washery Rejects, Wheat / Rice straw MSW, wind box, Burner, Type of Stokers, Pulverisers - Bowl mill, Tube mill, Direct firing, Indirect firing, Wall firing (Turbulent / Vortex Burners), Tangential firing (Jet Burners), Fire Ball		

UNIT - IV	PRESSURE PARTS AND DESIGN AND MATERIALS	9
Economiser, Drums, Water Walls, Headers, Links, Super Hater, Super Heaters, Reheaters, Tubes, Spiral Tubes, Surface area, Free Gas Area, Metal temperature, LMTD, Acid Due Point Temperature, Carbon steel, Low alloy steel, Titanium alloy steel		

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Approved by BoS Chairman

UNIT - V	BOILER AUXILIARIES	9
Air preheaters (APH) – bi sector APH, Tri sector APH, Cold PA System, Hot PA System, Tubular APH, Steam coil Air preheater, FANS – Axial, Radial, Performance curves, MILLS - Tube, Vertical mills, Air quality Control systems, DustCollection System - Mechanical Precipitator, Electrostatic Precipitator, FGD, SCR, SNCR		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Explain the concepts of thermal and fired equipment.
CO2	Discuss the basis, design and construction of boilers.
CO3	Describe of typical fuel firing systems in the boiler.
CO4	Discuss the materials requirements for pressure parts.
CO5	Discuss of various boiler auxiliaries system.

Text Books	
1.	S.C. Arora, S. Domkundwar A Course in Power Plant Engineering; Dhanapat Rai and Sons. 1996.
2.	C. Elanchezhian, L. Saravanakumar, B. Vijaya Ramnath, Power Plant Engineering, I.K. International Publishing House, 1st edition, 2007.

Reference Books	
1.	Elwakil M, Power Plant Technology, McGraw Hill, New York, 1964.
2.	V. Ganapathy, Steam Generators and Waste Heat Boilers : For Process and Plant Engineers, CRC Press, 2017.
3.	Donatello Annaratone, Steam Generators : Description and Design, Springer, 1st edition, 2016.
4.	Mamoru Ozawa and Hitoshi Asano, Advances in Power Boilers (JSME Series in Thermal and Nuclear Power Generation) Volume 2, Elsevier, 2021.

Approved by BoS Chairman

B.E.	B23MEE932 ENERGY CONSERVATION IN HVAC SYSTEM	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To Apply Thermodynamic Principles to HVAC Systems.
2.	To Classify different types of climates and identify factors that determine climatic variations.
3.	To Evaluate Indoor Environmental Requirements for Comfort and Efficiency.
4.	To Design and Evaluate Heating and Ventilation Systems.
5.	To Apply Energy-Efficient Practices in Air Conditioning Systems.

UNIT - I	FUNDAMENTALS OF THERMODYNAMICS	9

Introduction to Energy Conservation – Second Law of Thermodynamics – Exergy Analysis – Reversibility and Irreversibility – Air Conditioning Systems and Cycles – Heat pumps – Psychrometry

UNIT - II	CLIMATES AND BUILDINGS	9

Climate – Types - Factors that Determine Climate - Climatic Variations – Thermal Properties and Energy Content of Building Materials – Effect of Geographic Locations – Building Aesthetics and Infiltration

UNIT - III	INDOOR ENVIRONMENTAL REQUIREMENTS	9

Thermal Comfort – Ventilation and Air Quality – Air Conditioning Requirement – Energy Management Options – Energy Audit and Energy Targeting – Design Consideration in Different Climatic Conditions

UNIT - IV	HEATING AND VENTILATION SYSTEMS	9

Energy Conservation and Feasibility Analysis – Conventional Ventilation Systems – Constant Volume and Variable Volume Induction Systems – Indoor Air Quality – Duct Design and Installation

Approved by BoS Chairman

UNIT - V	AIR CONDITIONING SYSTEMS	9
Energy Conservation in Air Handling Units – Fans - Air Condition Apparatus– Window Air Condition System – Central Air Condition System – Energy Efficient Motors – Cooling Load Estimation – Bypass Factor - Room Sensible Heat Factor – Grand Sensible Heat Factor – Effective Room Sensible Heat Factor		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Explain the need for codes and Standards in Industry.
CO2	Discuss the different codes and standards used in different industry.
CO3	Discuss the sources of different codes and standards and the societies that publish them and how these are evolved.
CO4	Explain need for Government regulations and Certification authorities and familiar with common regulations in India and International.
CO5	Discuss knowledge of codes and standards used in Process equipment design for Oil and Gas Industry.

Text Books	
1.	Faye C.Mc Quiston, Jerald D. Paeker and Jeffrey D. Spitler, Hessam Taherian, “Heating, Ventilating, and Air Conditioning: Analysis and Design”, 7th Edition, John Wiley & Sons Inc., Singapore, 2023.

Reference Books	
1.	Carter Stanfield, David Skaves, AHRI, “Fundamentals of HVACR”, 4th Edition, Pearson, Canada,2020.
2.	Jan F. Kreider & Peter S. Curtiss, “Heating and Cooling of Buildings : Design for Efficiency”, 2nd Edition, CRC Press, New York, 2010.
3.	ASHRAE Handbook, “HVAC Systems and Equipment 2011, HVAC Applications”, ASHRAE Inc., Atlanta, 2019.

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Approved by BoS Chairman

Vertical - 5

COMPUTATIONAL ENGINEERING

B.E / B.Tech	B23MEE933 COMPUTATIONAL SOLID MECHANICS	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To study the definition and basics on theory of elasticity.
2.	To learn finite element method and procedure for static linear elasticity.
3.	To study the Non-Linear and History depend problems.
4.	To study time dependent and dynamic problems of small and large strain visco - plasticity.
5.	To study Structural Elements & Interfaces and contact using penalty method.

UNIT - I	BASIC ON THEORY OF ELASTICITY	9

Definitions - notations and sign conventions for stress and strain, Equations of equilibrium. Strain – displacement relations, Stress – strain relations, Lame's constant – cubical dilation, Compressibility of material, bulk modulus, Shear modulus, Compatibility equations for stresses and strains, Principal stresses and principal strains, Mohr's circle, Saint Venant's principle

UNIT - II	FINITE ELEMENT METHOD FOR STATIC LINEAR ELASTICITY	9

Derivation and implementation of a basic 2D FE code with triangular constant strain elements. Generalization of finite element procedures for linear elasticity: interpolation and numerical integration in 1D, 2D and 3D. Deriving finite element equations - constructing variational forms; mixed methods. Accuracy and convergence; the Patch test

UNIT - III	NON LINEAR AND HISTORY DEPEND PROBLEMS	9

Small strain hypo-elastic materials - Small strain visco-plasticity - Large strain elasticity - Large strain visco-plasticity

UNIT - IV	TIME DEPENDENT AND DYNAMIC PROBLEMS	9

First-order systems - the diffusion equation - Explicit time integration – the Newmark method - Implicit time integration - Modal analysis and modal time integration

Approved by BoS Chairman

UNIT - V	STRUCTURAL ELEMENTS & INTERFACES AND CONTACT	9
Continuum Beams – Shells – Cohesive Zones - Enforcing constraints using penalty methods and Lagrange Multipliers - Contact elements (in two dimensions)		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Discuss the definition and basics on theory of elasticity
CO2	Derive the finite element method for static linear elasticity, solve problems.
CO3	Discuss the Non-Linear and History depend problems, Solve problems.
CO4	Discuss time dependent and dynamic problems, solve problems.
CO5	Discuss Structural Elements & Interfaces and contact, solve problems.

Text Books	
1.	L.S.Srinath, Advanced Mechanics of Solids, 3rd Edition 2008.(0070139881 • 9780070139886).
2.	J.N. Reddy, Introduction To Finite Element Method, 4th Edition 2020. (939038527X • 9789390385270).
3.	R.D. Cook, Concepts and Applications of Finite Element Analysis, 4th Edition 2001 (978-0- 471-35605-9).
4.	S. Timoshenko, Theory of Elasticity, McGraw-Hill Education (India) Pvt Limited, 2010. (9780070701229-0070701229)
5.	G. Ramamurty, Applied Finite Element Analysis, I.K. International Publishing House Pvt. Limited, 2013. (9789380578453- 9380578458)

Approved by BoS Chairman

Reference Books	
1.	The Mechanics of Solids and Structures - Hierarchical Modeling and the Finite Element Solution (Computational Fluid and Solid Mechanics)by Miguel Luiz Bucalem and Klaus - Jurgen Bathe, 25 February 2013.
2.	The Finite Element Analysis of Shells - Fundamentals (Computational Fluid and Solid Mechanics) by Dominique Chapelle and Klaus - Jurgen Bathe, 27 January 2013.
3.	Inelastic Analysis of Solids and Structures (Computational Fluid and Solid Mechanics) by M. Kojic and Klaus-Jurgen Bathe, 22 October 2010.
4.	High-Resolution Methods for Incompressible and Low-Speed Flows (Computational Fluid and Solid Mechanics) by D. Drikakis and W. Rider, 22 October 2010.
5.	Discontinuous Finite Elements in Fluid Dynamics and Heat Transfer (Computational Fluid and Solid Mechanics) by Ben Q. Li, 22 October 2010.

Approved by BoS Chairman

B.E / B.Tech	B23MEE934 COMPUTATIONAL FLUID DYNAMICS AND HEAT TRANSFER	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To study the fluid flow simulation techniques and its mathematical behaviour.
2.	To learn the Discretise 1D and 2D systems using finite difference and finite volume techniques.
3.	To Formulate diffusion –convection problems using finite volume method.
4.	To study the flow field for different types of grids.
5.	To learn the need for turbulence models and its types.

UNIT - I	INTRODUCTION	9

Basics of Computational Fluid Dynamics – Governing equations – Continuity, Momentum and Energy equations – Boundary conditions & Types – Time-averaged equations for Turbulent Flow – Classification and Mathematical behaviour of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations, comparison between Analytical, Experimental and Numerical techniques, Techniques of Discretisation and Numerical errors

UNIT - II	FINITE DIFFERENCE AND FINITE VOLUME METHODS FOR DIFFUSION	9

Derivation of finite difference equations – General Methods for first and second order accuracy – Finite volume formulation for steady and transient diffusion 1D and 2D problems – Use of Finite Difference and Finite Volume methods, Accuracy of solution, optimum step-size, Euler, Crank-Nickolson, and pure implicit methods, stability of schemes

UNIT - III	FINITE VOLUME METHOD FOR CONVECTION DIFFUSION	9

Steady one-dimensional convection and diffusion – Central, upwind differencing schemes, properties of discretization schemes, Hybrid, Power-law, QUICK Schemes, Computation of Boundary layer flow, von Neumann stability analysis

UNIT - IV	FLOW FIELD ANALYSIS	9

Stream function and vorticity, Representation of the pressure gradient term, Staggered grid – Momentum equations, Pressure and Velocity corrections – Pressure Correction equation, SIMPLE algorithm and its variants – PISO Algorithms, Computation of internal and external thermal boundary layer

Approved by BoS Chairman

UNIT - V	TURBULENCE MODELLING	9
Turbulence model requirement and types, mixing length model, Two equation (k-Є) models – High and low Reynolds number models, LES, DNS, Mesh Generation and refinement Techniques-software tools, Stability of solver, Courant Fredrick Levy number, relaxation factor, and grid independence test		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Apply the fundamentals of CFD, and develop case specific governing equations.
CO2	Discuss finite difference and finite volume based analysis for steady and transient diffusion problems.
CO3	Implement various mathematical schemes under finite volume method for convention diffusion.
CO4	Solve complex problems in the field of fluid flow and heat transfer with the support of high speed computers.
CO5	Apply the various discretization methods, solution procedure and the concept of turbulence modelling.

Text Books	
1.	Versteeg, H.K., and Malalasekera, W., "An Introduction to Computational Fluid Dynamics" : The finite volume Method, Pearson Education, 2014.
2.	Ghoshdastidar, P.S., "Computational Fluid Dynamics and Heat Transfer", Cengage Learning, 2017.

Reference Books	
1.	John. F. Wendt, "Computational Fluid Dynamics – An Introduction", Springer, 2013.
2.	K. Muralidhar & T. Sundararajan, Computational Fluid Flow and Heat Transfer, Narora Publishing House, 1994.
3.	Suhas V, Patankar, "Numerical Heat transfer and Fluid flow", Taylor & Francis, 2009.
4.	Uriel Frisch, Turbulence, Cambridge University Press, 1999.
5.	Yogesh Jaluria & Kenneth E. Torrance, "Computational Heat Transfer", CRC press, 2002.

Approved by BoS Chairman

B.E. / B.Tech	B23MEE935 THEORY ON COMPUTATION AND VISUALIZATION	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To study the concepts and techniques of discrete mathematics for theoretical computer science.
2.	To learn different formal languages and their relationship.
3.	To classify and construct grammars for different languages and vice-versa.
4.	To study Visualization, Graphical and Quantitative Information.
5.	To learn Visualization design and data Ink.

UNIT - I	REVIEW OF MATHEMATICAL THEORY	9

Sets, Functions, Logical statements, Proofs, Relations, Languages, Principal of Mathematical Induction, Strong Principle, Recursive Definitions, Structural Induction

UNIT - II	REGULAR LANGUAGES AND FINITE AUTOMATA	9

Regular Expressions, Regular Languages, Application of Finite Automata, Automata with output – Moore machine & amp; Mealy machine, Finite Automata, Memory requirement in a recognizer, Definitions, union - intersection and complement of regular languages, Non Deterministic Finite Automata, Conversion from NFA to FA, ??- Non Deterministic Finite Automata, Conversion of NFA- ? to NFA, Kleene's Theorem, Minimization of Finite automata, Regular And Non Regular Languages – pumping lemma

UNIT - III	CONTEXT FREE GRAMMAR (CFG) AND PUSHDOWN AUTOMATA	9

Definitions and Examples, Unions Concatenations And Kleene's of Context free language, Regular Grammar for Regular Language, Derivations and Ambiguity, Unambiguous CFG and Algebraic Expressions, Bacos Naur Form (BNF), Normal Form – CNF. Definitions, Deterministic PDA, Equivalence of CFG and PDA & amp; Conversion, Pumping lemma for CFL, Intersections and Complements of CFL, Non-CFL

UNIT - IV	VALUE OF VISUALIZATION	9

Information Visualization, In Readings in Information Visualization, Graphical Excellence, Graphical Integrity, Sources of Graphical Integrity In The Visual Display of Quantitative Information

Approved by BoS Chairman

UNIT - V	VISUALIZATION DESIGN	9
The Power of Representation, Data-Ink and Graphical Redesign, Data-Ink Maximization and Graphical Design, Data Density and Small Multiples		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Discussing the concepts and techniques of discrete mathematics for theoretical computer science.
CO2	Explain the different formal languages and their relationship.
CO3	Discussing to classify and construct grammars for different languages and vice-versa.
CO4	Explaining the Visualization, Graphical and Quantitative Information.
CO5	Appling the Visualization design and data Ink.

Text Books	
1.	Introduction to the Theory of Computation by Michael Sipser.
2.	Automata Theory, Languages, and Computation By John Hopcroft, Rajeev Motowani, and Jeffrey Ullman.

Reference Books	
1.	Introduction to Languages and the Theory of Computation, 4^{th} by John Martin, Tata Mc Graw Hill.
2.	An introduction to automata theory and formal languages By Adesh K. Pandey, Publisher : S.K. Kataria & amp; Sons.
3.	Introduction to computer theory By Deniel I. Cohen , Joh Wiley & amp; Sons, Inc.
4.	Computation : Finite and Infinite By Marvin L. Minsky Prentice-Hall.

Approved by BoS Chairman

B.E. / B.Tech.	B23MEE936 COMPUTATIONAL BIO-MECHANICS	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To Introduction of principles and concepts of bio-mechanics.
2.	Focuses on the studies of tissues and structure of musculoskeletal system.
3.	To study the mechanics of joints and human motion.
4.	To explain the computational approaches in biomechanics.
5.	To learn the quantification of forces and motion.

UNIT - I	INTRODUCTION TO BIOMECHANICS	9

Perspective of biomechanics, Terminologies, Kinematic and kinetic concepts for analyzing human motion, Kinetic concepts for analyzing human motion, Linear kinetics of human movement, Equilibrium, Angular kinetics of human Movement, Mechanical properties of soft tissues, bones, and muscles

UNIT - II	BIOMECHANICS OF TISSUES AND STRUCTURES OF THE MUSCULOSKELETAL SYSTEM	9

Biomechanics of Bone, Biomechanics of Articular Cartilage, Tendons and Ligaments, Peripheral Nerves and Spinal Nerve Roots, Skeletal Muscle

UNIT - III	BIOMECHANICS OF JOINTS AND HUMAN MOTION	9

Knee, Hip, Foot and Ankle, Lumbar Spine, Cervical Spine, Shoulder, Elbow Wrist, and Hand, Linear kinematic and kinetic aspects of human movement, angular kinematic and kinetic aspects of human movement, equilibrium and human moment

UNIT - IV	COMPUTATIONAL APPROACHES IN BIOMECHANICS	9

Finite Element Analysis in Biomechanics, Computational modelling of Vancouver Periprosthetic Fracture in Femur, Scaffolds, artificial hip and knee joints, Aortic Valve

Approved by BoS Chairman

UNIT - V	GAIT ANALYSIS	9
Exoskeleton design, Ergonomics, Sports mechanics, Performance Analysis, Biomechanical analysis, 3D printing		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Discuss the principles of mechanics.
CO2	Elaborate the tissues and structures of the musculoskeletal system.
CO3	Discuss of joint mechanics and human motion.
CO4	Create Examples of computational mathematical modelling applied in biomechanics.
CO5	Describe the analysis of human motion.

Text Books	
1.	Susan J Hall, Basic Biomechanics, 6th Edition, The McGraw-Hill Companies Inc., 2011.
2.	Jay D Humphrey and Sherry L Delange, An Introduction to Biomechanics : Solids and Fluids, Analysis and Design, 1st edition, Springer-Verlag, 2010.

Reference Books	
1.	Margareta Nordin and Victor H Frankel, Basic Biomechanics of the Musculoskeletal System, 3rd Edition, Lippincott Williams and Wilkins, 2001.
2.	Ozkaya, Nihat, Nordin, and Margareta, Fundamentals of Biomechanics : Equilibrium, Motion, and Deformation, 2nd Edition, Springer, 2009.
3.	Pritam Pain, Sreerup Banerjee, Goutam Kumar Bose, Advances in Computat Biomechanics, 2022.
4.	Kinetics and Dynamics : From Nano- to Bio-Scale : 12 (Challenges and Advances in Computational Chemistry and Physics) by Piotr Paneth and Agnieszka Dybala-Defratyka, 12 August 2010.
5.	Computational Approaches to Biochemical Reactivity: 19 (Understanding Chemical Reactivity) by Gábor Náray-Szabó and Arieh Warshel, 31 March 2002.

Approved by BoS Chairman

B.E. / B.Tech	B23MEE938 CAD / CAE	L	T	P	C
		3	0	0	3

Course Objectives	
1.	Applying the fundamental concepts of computer graphics and its tools in a generic framework.
2.	Creating and manipulating geometric models using curves, surfaces, and solids.
3.	Applying concept of 3D modeling, visual realism, and CAD standard practices in engineering Design.
4.	Developing mathematical models for Boundary Value Problems and their numerical solution.
5.	Formulating solution techniques to solve non-linear problems.

UNIT - I	FUNDAMENTALS OF COMPUTER GRAPHICS	9

Design process - Computer Aided Design – Computer graphics – co-ordinate systems - 2D and 3D transformations - Graphic primitives (point, line, circle drawing algorithms) - Clipping - viewing transformation. Standards for computer graphics

UNIT - II	GEOMETRIC MODELING	9

Representation of curves - Hermite cubic spline curve, Bezier curve, B-spline curves, Surface Modeling – Surface Entities, Representation of Surface, Bezier Surface, B-Spline Surface and Coons Surface. Solid Modeling - Solid Entities, Solid Representation, Boundary Representation (B-Rep), Sweeps Representation, Constructive Solid Geometry (CSG)

UNIT - III	VISUAL REALISM and CAD STANDARDS	9

Need for hidden surface removal, The Depth - Buffer Algorithm, Properties that help in reducing efforts, Scan Line coherence algorithm, Span - Coherence algorithm, Area-Coherence Algorithms, Warnock's Algorithm, Priority Algorithms – shading – coloring – computer animation
Standards for computer graphics - Graphical Kernel System (GKS) - standards for exchange images - Open Graphics Library (OpenGL) - Data exchange standards - IGES, STEP, CALS etc

Approved by BoS Chairman

UNIT - IV	FINITE ELEMENT ANALYSIS PUMPS	9
Historical Background – Weighted Residual Methods - Basic Concept of FEM – Variational Formulation of Boundary Value Problems – Ritz Method – Finite Element Modelling – Element Equations – Linear and Higher order Shape functions – Bar, Beam Elements – Applications to Heat Transfer problems		

UNIT - V	NON-LINEAR ANALYSIS	9
Introduction to Non-linear problems - some solution techniques - computational procedure - material non-linearity - Plasticity and visco-plasticity, stress stiffening, contact interfaces - problems of gaps and contact - geometric non-linearity - modeling considerations - Free and Mapped meshing - Mesh quality - Error estimate - Introduction to Analysis Software		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Discuss the fundamental concepts of computer graphics and its tools in a generic framework.
CO2	Create and manipulate geometric models using curves, surfaces and solids.
CO3	Discuss concept of 3D modeling , visual realism and standard CAD practices in engineering design.
CO4	Develop the mathematical models for one dimensional finite element problems and their numerical solutions.
CO5	Formulate solution techniques to solve non-linear problems.

Text Books	
1.	Ibrahim Zeid “Mastering CAD CAM”, Tata McGraw-Hill Publishing Co. 2007.
2.	Seshu.P, “Textbook of Finite Element Analysis”, PHI Learning Pvt. Ltd., New Delhi, 2012.

Approved by BoS Chairman

Reference Books	
1.	William M Neumann and Robert F.Sproul, “Principles of Computer Graphics”, McGraw Hill Book Co. Singapore, 1989.
2.	Donald Hearn and M. Pauline Baker, “Computer Graphics”, Prentice Hall, Inc, 1992.
3.	Foley, Wan Dam, Feiner and Hughes, “Computer Graphics Principles & Practice”, Pearson Education, 2003.
4.	Rao, S.S., “The Finite Element Method in Engineering”, 6^{th} Edition, Butterworth-Heinemann, 2018.
5.	Reddy ,J.N. “Introduction to the Finite Element Method”, 4^{th} Edition, Tata McGraw Hill, 2018.

LIST OF EXPERIMETS	
1.	Design and animate Piston Cylinder assembly and motion study using CAD software.
2.	Design and simulate Connecting rod and crank shaft using CAD software.
3.	Design and simulate Two Cylinder Engine assembly using CAD software.
4.	Coupled Simulation of structural / thermal analysis
5.	Harmonic, Transient and spectrum analysis of simple systems.
6.	Buckling analysis.
Total Instructional hours : 60 **Lecture Hours = 30 . Practical Hours = 30.**	

Approved by BoS Chairman

B.E. / B.Tech	B23MEE939 MACHINE LEARNING FOR INTELLIGENT SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To introduce basic machine learning techniques such as regression, classification.
2.	To learn about introduction of clustering, types and segmentation methods.
3.	To learn about fuzzy logic, fuzzification and defuzzification.
4.	To learn about basics of neural networks and neuro fuzzy networks.
5.	To learn about Recurrent neural networks and Reinforcement learning.

UNIT - I	INTRODUCTION TO MACHINE LEARNING	9

Philosophy of learning in computers, Overview of different forms of learning, Classifications vs. Regression, Evaluation metrics and loss functions in Classification, Evaluation metrics and loss functions in Regression, Applications of AI in Robotics

UNIT - II	CLUSTERING AND SEGMENTATION METHODS	9

Introduction to clustering, Types of Clustering, Agglomerative clustering, K-means clustering, Mean Shift clustering, K-means clustering application study, Introduction to recognition, K-nearest neighbor algorithm, KNN Application case study, Principal component analysis (PCA), PCA Application case study in Feature Selection for Robot Guidance

UNIT - III	FUZZY LOGIC ANALYSIS	9

Introduction to Fuzzy Sets, Classical and Fuzzy Sets, Overview of Classical Sets, Membership Function, Fuzzy rule generation, Fuzzy rule generation, Operations on Fuzzy Sets, Numerical examples, Fuzzy Arithmetic, Numerical examples, Fuzzy Logic, Fuzzification, Fuzzy Sets, Defuzzification, Application Case Study of Fuzzy Logic for Robotics Application

UNIT - IV	NEURAL NETWORKS	9

Mathematical Models of Neurons, ANN architecture, Learning rules, Multi-layer Perceptrons, Back propagation, Introduction of Neuro-Fuzzy Systems, Architecture of Neuro Fuzzy Networks, Application Case Study of Neural Networks in Robotics

Approved by BoS Chairman

UNIT - V	RNN AND REINFORCEMENT LEARNING	9
Unfolding Computational Graphs, Recurrent neural networks, Application Case Study of recurrent networks in Robotics, Reinforcement learning, Examples for reinforcement learning, Markov decision process, Major components of RL, Q-learning. Application Case Study of reinforcement learning in Robotics		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Understand basic machine learning techniques such as regression, classification.
CO2	Understand about clustering and segmentation.
CO3	Model a fuzzy logic system with fuzzification and defuzzification.
CO4	Understand the concepts of neural networks and neuro fuzzy networks.
CO5	Gain knowledge on Reinforcement learning.

Text Books	
1.	Micheal Negnevitsky, Artificial Intelligence : A Guide to Intelligent Systems, 3^{rd} Edition, Addision Wesley, England, 2011.
2.	Bruno Siciliano, Oussama Khatib, “Handbook of Robotics”, 2016 2^{nd} Edition, Springer.

Reference Books	
1.	Simon Haykin, “Neural Networks and Learning Machines : A Comprehensive Foundation”, Third Edition, Pearson, delhi 2016.
2.	Timothy J Ross, “Fuzzy Logic with Engineering Applications”, 4^{th} Edition, Chichester, 2011, Sussex Wiley.

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Approved by BoS Chairman

B.E. / B.Tech.	B23MEE940 ENGINEERING FAILURE ANALYSIS	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To Explain the importance of failure study of mechanical components.
2.	To Discuss about various material characterization tools and analyse the failure.
3.	To Equip students with knowledge on how to design against failures and Skills required in carrying out failure analysis.
4.	To Understanding of failure against wear and creep loading.
5.	To Understanding of failure in joints and degradation.

UNIT - I	INTRODUCTION	9
Material failure modes and their identification - Tools for failure analysis : Optical microscopy, Transmission electron microscopy, Scanning electron microscopy. Systematic approach to failure analysis		

UNIT - II	MECHANICAL ASPECTS OF FAILURE	9
Tensile test - Static loading - Combined stress - Principal stresses - Theories of failure - Triaxial stresses and constraint - Plane stress - Plane strain - Stress concentration factors and notch sensitivity - Shock and impact loading		

UNIT - III	FATIGUE	9
Loading under high cycle fatigue conditions - Test methods - S-N-P curves - endurance diagrams - influence factors - Low cycle fatigue, fretting fatigue; Fatigue design for combined stress; cumulative damage and life prediction, statistical interpretation of fatigue test data. Failures related to corrosion - hot corrosion and stress corrosion cracking - Damages due to hydrogen - Creep of metallic materials - service failures during high temperature service - Failures related to wear		

UNIT - IV	FRACTURE MECHANICS AND FAILURES	9
Fracture processes - Meaning of ductile and brittle fracture - Effect of strain rate and temperature - Linear elastic fracture mechanics - fracture mechanics principles in design practice - Elastic Plastic fracture mechanics - Examples of crack-growth Analysis for cyclic loading		

Approved by BoS Chairman

UNIT - V	FAILURES IN JOINTS AND FASTENERS	9
Welded constructions and screw fastenings - Environmental degradation - Embrittlement of metals and alloys		
Total Instructional hours : 45		

Course Outcomes : Students will be able to	
CO1	Identify and explain different types of failure of engineering materials and their characteristic features.
CO2	Differentiate the significance, usage and limitations of various material characterization tools used for failure studies.
CO3	Apply various theories of failure to the components subjected to multidirectional loading.
CO4	Apply the principles of fracture mechanics and design for failure against fracture.
CO5	Develop expertise on the experimental techniques and simulations utilized for failure • analysis of various components and interpret the probable reasons for failure.

J. P. [signature]

Approved by BoS Chairman

Vertical - 6

INDUSTRY 4.0

		L	T	P	C
B.E.	B23MEE941 – ADVANCED MANUFACTURING SYSTEMS	3	0	0	3

Course Objectives	
1.	To provide insights into modern manufacturing systems and evolving paradigms.
2.	To develop skills in implementing lean, JIT, and cellular systems for productivity.
3.	To explore the flexibility and responsiveness offered by agile and reconfigurable systems.
4.	To understand the functionality and integration of MES in smart manufacturing environments.

UNIT - I	INTRODUCTION TO MODERN MANUFACTURING PARADIGMS	9
Evolution of manufacturing - Mass production vs. lean/agile production - Characteristics of advanced systems - Role of ICT in manufacturing - Case studies		
UNIT - II	**LEAN MANUFACTURING AND JIT**	**9**
Lean principles - Waste elimination (Muda) - Kanban systems - JIT scheduling - Value stream mapping		
UNIT - III	**CELLULAR AND FLEXIBLE MANUFACTURING**	**9**
Group technology - Cell formation techniques - FMS architecture - Tool management - Case studies on flexible systems		
UNIT - IV	**AGILE AND RECONFIGURABLE MANUFACTURING**	**9**
Agile manufacturing principles - Reconfigurable systems - Adaptability and scalability - Mass customization - Human-machine interface		
UNIT - V	**MANUFACTURING EXECUTION SYSTEMS (MES)**	**9**
MES architecture and functions - Integration with ERP/SCADA/PLM - Production tracking and traceability - Real-time performance monitoring - MES case studies		
	Total Instructional hours : 45	

Approved by BoS Chairman

Course Outcomes : Students will be able to	
CO1	Explain the evolution, trends, and critical performance aspects of modern manufacturing paradigms.
CO2	Apply lean manufacturing and JIT strategies to eliminate waste and improve operational efficiency.
CO3	Design and evaluate cellular layouts and flexible systems to handle variety and volume efficiently.
CO4	Develop agile and reconfigurable manufacturing strategies to meet dynamic market demands.
CO5	Explain MES architecture and its integration for real-time visibility, traceability, and production control.

Text Books	
1.	Mikell P. Groover – Automation, Production Systems, and Computer-Integrated Manufacturing, Pearson, Fifth Edition (2021), ISBN : 978-93-615-9295-9.
2.	Rajiv K. Kohli – Modern Manufacturing Systems, Apple Academic Press (2023), ISBN : 978-1774910443.
3.	Michel Baudin – Lean Manufacturing : Tools, Techniques, and How to Use Them, Productivity Press (2001), ISBN : 978-1-4200-2553-8.

Reference Books	
1.	Nitin S. Gokhale – Manufacturing Science and Technology, Ekurhuleni T, APEERUPA (2024), ISBN : 978-93-5578-331-8.
2.	J.T. Black & Steve L. Hunter – Lean Manufacturing Systems and Cell Design, SME (2004), ISBN : 978-0872636477.
3.	Shimon Y. Nof – Springer Handbook of Automation, Springer, 2nd Edition (2023), ISBN : 978-3540788300.
4.	Weiyan Wang – Smart Manufacturing : Concepts and Methods, Springer (2020), ISBN : 978-0-12-820027-8.

J.P. [signature]

Approved by BoS Chairman

B.E.	B23MEE942 – INDUSTRIAL IOT AND SMART SENSORS	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To introduce the fundamentals and architecture of Industrial IoT systems.
2.	To understand industrial-grade sensors and real-time data acquisition techniques.
3.	To explore communication protocols and standards for IIoT integration.
4.	To evaluate storage, cloud solutions, and security in IIoT-based automation systems.

UNIT - I	INTRODUCTION TO IIOT	9
Definition and architecture - IIoT vs IoT - Cyber-physical systems - Digital transformation - Use cases in industry		

UNIT - II	IIoT PROTOCOLS AND COMMUNICATION	9
MQTT, OPC-UA, Modbus TCP/IP, EtherNet/IP - Edge computing - Wireless protocols (ZigBee, BLE, LoRa) - Gateways and middleware		

UNIT - III	SENSORS AND DATA ACQUISITION	9
Types of sensors (temperature, pressure, proximity) - Signal conditioning - DAQ systems - Analog to digital conversion - Sensor calibration		

UNIT - IV	DATA STORAGE AND CLOUD INTEGRATION	9
Fog vs. edge vs. cloud - Cloud platforms (AWS IoT, Azure IoT) - Data lakes and warehouses - IIoT analytics pipeline		

UNIT - V	INDUSTRIAL APPLICATIONS AND CYBERSECURITY	9
Predictive maintenance - Remote diagnostics - Cybersecurity challenges - Standards : NIST, IEC 62443 - Case studies		
Total Instructional hours : 45		

Approved by BoS Chairman

Course Outcomes : Students will be able to	
CO1	Understand IIoT system architecture, components, and its application in smart factories.
CO2	Select and apply suitable communication protocols and network technologies in IIoT environments.
CO3	Analyze and integrate various sensors and DAQ systems for effective real-time monitoring.
CO4	Utilize cloud platforms and analytics tools to manage, process, and visualize industrial IoT data.
CO5	Apply IIoT in industrial domains while ensuring data security, system reliability, and compliance with standards.

Text Books	
1.	Sudip Misra, Chandana Roy, Abhishek Roy – Introduction to Industrial Internet of Things and Industry 4.0, CRC Press (2020), ISBN : 978-0367644710.
2.	Alasdair Gilchrist – Industry 4.0 : The Industrial Internet of Things, Apress (2019), ISBN : 978-1484249703.
3.	Jan Holler et al. – From Machine-to-Machine to the Internet of Things, Academic Press (2014), ISBN : 978-0124076846.
4.	Arshdeep Bahga, Vijay Madisetti – Internet of Things : A Hands-On Approach, Universities Press(2015), ISBN : 978-8173719547.

Reference Books	
1.	Maciej Kranz – Building the Internet of Things Implement New Business Models, Disrupt Competitors, Transform Your Industry, Wiley(2016), ISBN : 978-1119285663.
2.	Sabina Jeschke et al. – Industrial Internet of Things : Cybermanufacturing Systems, Springer (2017), ISBN : 978-3319425580.
3.	Rajkumar Buyya – Fog and Edge Computing : Principles and Paradigms, Wiley (2022), ISBN : 978-1119525066.
4.	David Hanes et al. – IoT Fundamentals : Networking Technologies, Protocols, and Use Cases for the Internet of Things, Cisco Press (2017), ISBN : 978-1587144561.

Approved by BoS Chairman

B.E.	B23MEE943 – PRODUCT LIFECYCLE MANAGEMENT (PLM) AND DIGITAL DESIGN	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To introduce the concepts and importance of PLM in modern product development.
2.	To explore integration of CAD, CAM, and CAE for digital product engineering.
3.	To promote concurrent and collaborative engineering practices for faster time-to-market.
4.	To develop insights into PLM implementation, software tools, and future trends.

UNIT - I	FUNDAMENTALS OF PLM	9
PLM definition and benefits - Product data and metadata - BOM structures - Lifecycle stages		

UNIT - II	CAD / CAM / CAE INTEGRATION	9
Role of design tools - Feature-based modeling - Assembly modeling - CAM strategies and toolpath generation - CAE: structural, thermal, flow analysis		

UNIT - III	COLLABORATIVE AND CONCURRENT ENGINEERING	9
Concurrent engineering tools - Design reviews and DMU - Engineering change management - Cross-functional teams		

UNIT - IV	PLM SYSTEMS AND IMPLEMENTATION	9
PLM software platforms (Teamcenter, Windchill) - PLM workflows and configuration - Data governance and access control - Integration with ERP/MES		

UNIT - V	CASE STUDIES AND TRENDS	9
Automotive, aerospace PLM use cases - Digital thread and continuity - Digital BOM and change control - Future of PLM with AI/ML		
		Total Instructional hours : 45

Approved by BoS Chairman

Course Outcomes : Students will be able to	
CO1	Explain the lifecycle stages and role of PLM in improving product development efficiency and traceability.
CO2	Apply integrated CAD/CAM/CAE tools within a PLM framework for collaborative digital product design.
CO3	Develop collaborative workflows and virtual prototypes using concurrent engineering strategies.
CO4	Configure and manage PLM system components to support enterprise-wide product development initiatives.
CO5	Analyze real-world PLM implementations and emerging technologies shaping the future of digital design.

Text Books	
1.	Michael Grieves – Product Lifecycle Management : Driving the Next Generation of Lean Thinking, McGraw-Hill (2021), ISBN : 978-0071786300.
2.	John Stark – Product Lifecycle Management : 21st Century Paradigm for Product Realisation, Springer (2022), ISBN : 978-1852338107.
3.	P.N. Rao – CAD/CAM Principles and Applications, McGraw-Hill (2017), ISBN : 978-0070681934.

Reference Books	
1.	Kevin Otto & Kristin Wood – Product Design : Techniques in Reverse Engineering and New Product Development, Pearson (2001), ISBN : 978-0130212719.
2.	Andreas Vlahinos – Digital Engineering : An Integrated Approach, Altair Publishing (2021).
3.	Fabio Giudice et al. – Product Design for the Environment, CRC Press (2019), ISBN : 978-0367391348.
4.	Alain Bernard – PLM : Trends and Challenges, Springer (2022).

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Approved by BoS Chairman

B.E.	B23MEE944 – ROBOTICS AND INDUSTRIAL AUTOMATION	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the fundamental components and classifications of industrial robots.
2.	To explore various sensors, actuators, and gripper mechanisms used in robotic systems.
3.	To develop practical skills in robot programming, simulation, and integration with automation platforms.
4.	To investigate advanced topics such as collaborative robotics, mobile robotics, and human-robot interaction.

UNIT - I	BASICS OF INDUSTRIAL ROBOTS	9
Robot anatomy - Kinematics and dynamics - Degrees of freedom - Types of robots and applications.		

UNIT - II	SENSORS, ACTUATORS, AND END - EFFECTORS	9
Position and vision sensors - • Electric, hydraulic, pneumatic actuators - Grippers and tools - Force control.		

UNIT - III	ROBOT PROGRAMMING AND SIMULATION	9
Online vs offline programming - Teach pendant programming - RobotStudio, RoboDK - Path planning and interpolation.		

UNIT - IV	PLC AND SCADA INTEGRATION	9
Ladder logic, function block diagram - PLC-HMI interfacing - SCADA architecture - Communication protocols.		

UNIT - V	COLLABORATIVE AND MOBILE ROBOTICS	9
Cobots and safety standards (ISO / TS 15066) - AMRs and AGVs - AI in robotics - Industrial use cases.		
		Total Instructional hours : 45

Approved by BoS Chairman

Course Outcomes : Students will be able to	
CO1	Explain robot types, configurations, and essential mechanical and kinematic concepts for industrial automation.
CO2	Select and integrate appropriate sensors, actuators, and end-effectors for specific robotic applications.
CO3	Write, simulate, and validate robot programs for common industrial tasks using commercial programming environments.
CO4	Integrate robotic systems with PLCs and SCADA platforms for synchronized industrial automation.
CO5	Evaluate and deploy collaborative and mobile robotic systems with a focus on safety, intelligence, and adaptability.

Text Books	
1.	Mikell P. Groover – Industrial Robotics : Technology, Programming, and Applications, McGraw-Hill (2017), ISBN : 978-1259006210.
2.	R.K. Mittal & I.J. Nagrath – Robotics and Control, Tata McGraw-Hill (2017), ISBN : 978-0070482937.
3.	Craig J.J. – Introduction to Robotics : Mechanics and Control, Pearson (2004), ISBN : 978-0201543612

Reference Books	
1.	Spong, Hutchinson, Vidyasagar – Robot Modeling and Control, Wiley (2020), ISBN : 978-1119523994.
2.	K.S. Fu, R.C. Gonzalez, C.S.G. Lee – Robotics: Control, Sensing, Vision and Intelligence, McGraw-Hill (1986), ISBN : 978-0070226258.
3.	Frank Lamb – Industrial Automation : Hands-On, McGraw-Hill (2013), ISBN : 978-0071816458.
4.	ABB, KUKA, FANUC technical manuals and simulation software guides (2019).

Approved by BoS Chairman

B.E.	B23MEE945 – SMART FACTORY AND INDUSTRY 4.0 TECHNOLOGIES	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the fundamentals and components of Industry 4.0 and the Smart Factory.
2.	To explore the architecture of digitally connected manufacturing systems.
3.	To implement real-time monitoring, control, and collaboration tools.
4.	To evaluate the role of sustainability and energy management in smart factories.

UNIT - I	INTRODUCTION TO INDUSTRY 4.0	9
Evolution of industrial revolutions - Key enablers: CPS, IoT, Big Data, AI - Smart factory concept - Reference architectures (RAMI 4.0, IIRA)		

UNIT - II	DIGITAL CONNECTIVITY AND INTEROPERABILITY	9
OPC-UA, MQTT, REST APIs - Cloud and edge computing - Standards : IEC, ISO, NIST - Interoperability frameworks		

UNIT - III	REAL-TIME MONITORING AND CONTROL	9
SCADA / DCS systems - Condition monitoring - Digital KPIs: energy, yield, cycle time - OEE and dashboarding		

UNIT - IV	HUMAN-MACHINE COLLABORATION	9
AR / VR interfaces - Digital work instructions - Operator 4.0 - Wearable tech and safety		

UNIT - V	SUSTAINABILITY AND SMART ENERGY MANAGEMENT	9
Energy-efficient operations - Emission tracking - Circular manufacturing - Green KPIs and ESG metrics		
		Total Instructional hours : 45

Approved by BoS Chairman

Course Outcomes : Students will be able to	
CO1	Explain the principles, technologies, and architecture that define Industry 4.0 and Smart Factories.
CO2	Apply communication protocols and architectures for seamless data interoperability in smart manufacturing environments.
CO3	Implement and evaluate real-time monitoring and control mechanisms integrated with enterprise systems.
CO4	Analyze and implement technologies that enhance effective human-machine collaboration in Industry 4.0 setups.
CO5	Design strategies and solutions for sustainability, energy efficiency, and environmental responsibility in Smart Factories.

Text Books	
1.	Alp Ustundag & Emre Cevikcan – Industry 4.0 : Managing the Digital Transformation, Springer (2017), ISBN : 978-3319578699.
2.	Klaus Schwab – The Fourth Industrial Revolution, World Economic Forum (2017).
3.	Gilchrist – Industry 4.0 : The Industrial Internet of Things, Apress (2019), sISBN: 978-1484249703.

Reference Books	
1.	Jay Lee – Industrial AI, Springer (2021), ISBN : 978-9811521461.
2.	Detlef Zühlke – Smart Factory Navigator, Springer (2018).
3.	Reiner Anderl – Digital Twin Driven Smart Manufacturing, Springer (2022).
4.	German Federal Ministry – RAMI 4.0 Reference Architecture Model (2023).

Approved by BoS Chairman

B.E.	B23MEE946 – MANUFACTURING DATA ANALYTICS AND AI	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the role of data analytics in modern manufacturing systems.
2.	To explore different types of analytics and their application in process improvement.
3.	To apply machine learning and AI techniques for predictive and prescriptive insights.
4.	To analyze real-world use cases using industry-relevant tools and platforms.

UNIT - I	INTRODUCTION TO DATA ANALYTICS IN MANUFACTURING	9
Types of data : machine, process, quality - Time-series data - KPIs: OEE, MTTR, downtime tracking - Industry 4.0 context		

UNIT - II	DESCRIPTIVE AND DIAGNOSTIC ANALYTICS	9
Data cleaning and preprocessing - Visualization (Power BI, Tableau) - Trend and pattern analysis - Root cause analysis		

UNIT - III	PREDICTIVE ANALYTICS	9
Regression, classification - Machine learning models (SVM, Decision Trees) - Predictive maintenance - Failure mode prediction		

UNIT - IV	PRESCRIPTIVE ANALYTICS AND OPTIMIZATION	9
Optimization models - Scheduling algorithms - AI in supply chain and logistics - Reinforcement learning basics		

UNIT - V	AI TOOLS AND CASE STUDIES	9
Python / R for analytics - TensorFlow, Scikit-learn - Manufacturing case studies - Ethics and explainable AI		
		Total Instructional hours : 45

Approved by BoS Chairman

Course Outcomes : Students will be able to	
CO1	Comprehend the role of data analytics and identify relevant data types and KPIs for manufacturing analysis.
CO2	Apply descriptive and diagnostic analytics techniques to analyze manufacturing data and interpret trends.
CO3	Develop and apply predictive models for maintenance, quality, and efficiency improvement in manufacturing.
CO4	Apply prescriptive analytics and optimization techniques to improve manufacturing decision-making.
CO5	Deploy AI tools to solve industrial problems and communicate data-driven decisions effectively.

Text Books	
1.	Seema Acharya – Data Analytics Using Python, McGraw Hill (2018), ISBN : 978-9352605248.
2.	Ramesh Sharda et al. – Analytics, Data Science & AI, Pearson (2019), ISBN : 978-0135192016.
3.	U. Dinesh Kumar – Business Analytics : The Science of Data-Driven Decision Making, Wiley (2017), ISBN : 978-8126568772.

Reference Books	
1.	Jay Lee – Industrial AI, Springer (2021), ISBN : 978-9811521461.
2.	Anand Rajaraman – Mining of Massive Datasets, Cambridge University Press (2016), ISBN : 978-1316638491.
3.	Eric Siegel – Predictive Analytics, Wiley (2016), ISBN : 978-1119153658.
4.	Brett Lantz – Machine Learning with R, Packt Publishing (2013), ISBN : 978-1782162148.

Approved by BoS Chairman

B.E.	B23MEE947 – SUPPLY CHAIN DIGITIZATION AND SMART LOGISTICS	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the core concepts and challenges in modern supply chains.
2.	To explore how digital tools enhance transparency, efficiency, and decision-making.
3.	To apply technologies such as IoT, blockchain, and AI in logistics.
4.	To evaluate sustainability and resilience in global supply networks.

UNIT - I	FUNDAMENTALS OF SUPPLY CHAIN MANAGEMENT	9
Basics of supply chain and logistics - Flow of materials and information - Value chain integration - SCM components: sourcing, production, distribution - Traditional vs. digital supply chains - SCM metrics and KPIs		

UNIT - II	DIGITAL TECHNOLOGIES IN SUPPLY CHAIN	9
Digital twins for supply chains - IoT in logistics and asset tracking - RFID and barcode systems - Cloud-based SCM solutions - AI/ML for demand forecasting - Secure transactions and tamper-proof records - Blockchain case studies in logistics		

UNIT - III	BLOCKCHAIN AND SECURE TRANSACTIONS	9
Blockchain fundamentals - Smart contracts in supply chain - Traceability and provenance - End-to-end product journey		

UNIT - IV	SMART WAREHOUSING AND INVENTORY OPTIMIZATION	9
Automated storage and retrieval systems (AS / RS) - Drones and robotics in warehousing - Real-time inventory tracking - Predictive inventory planning - Integration with MES / ERP		

UNIT - V	SUSTAINABLE AND RESILIENT SUPPLY CHAINS	9
Circular supply chains - Carbon footprint and emissions tracking - Green logistics - Risk management and resilience strategies - Post-pandemic supply chain recovery		
		Total Instructional hours : 45

Approved by BoS Chairman

Course Outcomes : Students will be able to	
CO1	Understand key supply chain functions and analyze how digitization transforms conventional logistics and procurement.
CO2	Apply digital technologies such as IoT and AI to improve traceability, visibility, and forecasting in supply chain operations.
CO3	Evaluate blockchain use cases for transparency, traceability, and security in supply chain operations.
CO4	Design smart warehousing systems integrated with digital platforms for real-time and predictive inventory control.
CO5	Assess strategies for building sustainable and resilient supply chains aligned with global standards and regulations.

Text Books	
1.	Sunil Chopra – Supply Chain Management : Strategy, Planning, and Operation, Pearson (2015), ISBN : 978-0133800203.
2.	S. Sridhar – Supply Chain Management : Theories & Practices, McGraw Hill (2009), ISBN : 978-0070671003.
3.	Ravi Kalakota – Digital Supply Chain Transformation, Pearson (2021), ISBN : 978-0000990501.

Reference Books	
1.	Simchi-Levi – Designing and Managing the Supply Chain, McGraw Hill (2007), ISBN : 978-0070666986.
2.	Paul Myerson – Digital Supply Networks : Transform Your Supply Chain and Gain Competitive Advantage with Disruptive Technology and Reimagined Processes, McGraw Hill (2020), ISBN : 9781260458206.
3.	Bhattacharya, S. – Blockchain Technology for Industry 4.0, CRC Press(2021), ISBN : 978-9811511394.
4.	Blossey & Koehler – Smart Logistics: Algorithms and Applications, Springer (2024).

Approved by BoS Chairman

B.E.	B23MEE948 – DIGITAL TWIN AND SIMULATION FOR MANUFACTURING	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the concept and architecture of digital twins in manufacturing.
2.	To develop models using simulation techniques for real-time and predictive insights.
3.	To create and validate digital replicas of manufacturing processes.
4.	To explore optimization, predictive analysis, and future applications of digital twins.

UNIT - I	INTRODUCTION TO DIGITAL TWINS	9
Digital twin vs. digital model - Types: product, process, system twins - Applications in manufacturing - Tools overview (Siemens MCD, ANSYS, FlexSim)		

UNIT - II	MODELING AND SIMULATION TECHNIQUES	9
Discrete-event simulation - Kinematic and dynamic modeling - Multi-domain modeling (Simulink, Modelica)		

UNIT - III	PROCESS TWIN DEVELOPMENT	9
Data acquisition and integration - Real-time simulation and control - Virtual commissioning - Case study : assembly line simulation		

UNIT - IV	OPTIMIZATION AND PREDICTIVE ANALYSIS	9
What-if analysis - Machine learning integration - Optimization techniques - Downtime prediction		

UNIT - V	APPLICATIONS AND FUTURE TRENDS	9
Factory layout optimization - Human-machine interaction - Metaverse and XR for digital twins - Sustainability impact		
		Total Instructional hours : 45

Approved by BoS Chairman

Course Outcomes : Students will be able to	
CO1	Understand the fundamentals and architecture of digital twins in the manufacturing ecosystem.
CO2	Apply simulation tools and modeling techniques to replicate and analyze manufacturing systems.
CO3	Develop and validate a process digital twin with real-time synchronization and control integration.
CO4	Use simulation and AI tools to perform predictive analytics and optimization of manufacturing operations.
CO5	Analyze the evolving applications, trends, and maturity models in digital twin development and deployment.

Text Books	
1.	Rajiv Ranjan – Digital Twin : Concepts and Use Cases in Manufacturing, Springer (2022), ISBN : 978-3030818173.
2.	Michael Grieves – Virtually Perfect : Driving Innovative and Lean Products through Product Lifecycle Management, PLM Institute (2011), ISBN : 978-0982138007.
3.	AnyLogic Team – Simulation Modeling with AnyLogic, AnyLogic North America (2012), ISBN : 978-0615710129.

Reference Books	
1.	Jürgen Jasperneite et al. – Digital Twin Technologies and Smart Cities, Elsevier (2020), ISBN : 978-3030187347.
2.	Rajiv Kumar – Industrial Digital Transformation, Wiley (2024).
3.	Rainer Stark et al. – Product Lifecycle Management and the Industry of the Future, Springer (2017).
4.	Dieter Uckelmann – Architecting the Internet of Things, Springer (2011), ISBN : 978-3642191572.

Approved by BoS Chairman

OPEN ELECTIVE

Open Elective - I

B.E.	B23AEO501- PRINCIPLES OF FLIGHT (Common to all Except AERO)	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To study the different component systems and functions.
2.	To understand the basic properties and principles behind the flight.
3.	To study the basic concepts of Aerodynamics.
4.	To study the different structures & construction.
5.	To study the various types of power plants used in aircrafts.

UNIT - I	AIRCRAFT CONFIGURATIONS	9

Brief History-Components of an airplane and their functions. Different types of flight vehicles, classifications. Basic instruments for flying.

UNIT - II	INTRODUCTION TO PRINCIPLES OF FLIGHT	9

Physical properties and structure of the atmosphere, Temperature, pressure and altitude relationships, Evolution of lift, drag and moment. Different types of drag.

UNIT - III	INTRODUCTION TO AERODYNAMICS	9

Aerodynamic forces on aircraft – classification of NACA aerofoils, aspect ratio, wing loading, Mach number, centre of pressure and aerodynamic centre-aerofoil characteristics lift, drag curves.

UNIT - IV	INTRODUCTION TO AIRPLANE STRUCTURES AND MATERIALS	9

General types of construction, Monocoque, semi-monocoque. Typical wing and fuselage structure. Metallic and non-metallic materials, Use of aluminium alloy, titanium, stainless steel and composite materials.

Programme Coordinator

BoS Chairman

UNIT - V	POWER PLANTS USED IN AIRPLANES	9
Basic ideas about piston, turboprop and jet engines, Use of propeller and jets for thrust production., Principles of operation of rocket, types of rockets		
Total Instructional hours : 45		

Course Outcomes : Students will be able to	
CO1	Identify the types and classification of components and control system.
CO2	Identify the properties and principles to analyze lift, drag (including types), moment, and their variation with altitude.
CO3	Identify the aerodynamics forces and NACA Airfoils.
CO4	Identify different type of fuselage and constructions.
CO5	Categorize the different types of engines and principles of rocket.

Text Books	
1.	Anderson, J.D., Introduction to Flight, McGraw-Hill; 8th edition, 2015
2.	E Rathakrishnan, "Introduction to Aerospace Engineering: Basic Principles of Flight", John Wiley, NJ, 2021

Reference Books	
1.	Kermode, A.C., "Flight without Formulae", McGraw-Hill, 1997.
2.	Sadhu Singh, "Internal Combustion Engines and Gas Turbine", SS Kataraia & Sons, 2015.
3.	Stephen.A. Brandt, Introduction to aeronautics: A design perspective, 2nd edition, AIAA Education Series, 2004.

Programme Coordinator	BoS Chairman

B.Tech.	B23AGO501 - Farm Automation	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the fundamentals and scope of farm automation systems.
2.	To study various types of sensors and their role in smart farming.
3.	To analyze the working of automation systems in field operations.
4.	To explore greenhouse automation and resource management.
5.	To examine the role of advanced technologies like AI, drones, and robotics in agriculture.

UNIT I	INTRODUCTION TO FARM AUTOMATION	9
Definition and scope – Historical development – Classification of automation systems: manual, semi-automated and fully automated – Benefits of automation – Limitations and challenges – Status of automation in Indian agriculture – Automation in small and large farms – Farm automation value chain – Socio-economic implications.		

UNIT II	SENSORS AND SMART FARMING COMPONENTS	9
Types of sensors: soil moisture, pH, temperature, humidity, light, nutrient sensors – Actuators – Microcontrollers and microprocessors (Arduino, Raspberry Pi) – IoT architecture for agriculture – Wireless sensor networks – Communication protocols – Data acquisition and cloud connectivity – Mobile apps and remote monitoring systems.		

UNIT III	AUTOMATION IN FIELD OPERATIONS	9
Automatic steering and GPS-guided tractors – Variable Rate Technology (VRT) – Autonomous planters and seeders – Spraying automation – Robotic weeders – Harvesting automation – Drones for crop health monitoring – Field mapping – Automation kits – Safety aspects in field automation.		

UNIT IV	GREENHOUSE AND RESOURCE MANAGEMENT AUTOMATION	9
Greenhouse control systems: Temperature, humidity, light, CO_2 , irrigation and nutrient management – Automation of fertigation and irrigation (drip, sprinkler) – Scheduling using weather data – Software tools and apps for DSS – Renewable energy-based automation – Case studies of protected cultivation systems.		

UNIT V	ADVANCED TECHNOLOGIES IN AUTOMATION	9
Artificial Intelligence (AI) and Machine Learning (ML) in farming decisions – Robotics in seeding, pruning, sorting and packaging – Machine vision systems – Drones and UAVs in agriculture – Automation for post-harvest management – Success stories from India and abroad – Future prospects and trends.		
		Total Instructional Hours: 45

Approved by BoS Chairman

COURSE OUTCOMES: Students will be able to	
CO1	Explain the concept and scope of farm automation.
CO2	Identify and interpret various sensors and smart devices in agriculture.
CO3	Apply automation techniques in field operations.
CO4	Demonstrate the application of automation in greenhouse and resource management.
CO5	Evaluate advanced automation technologies and their integration into smart farming systems.

Text Books	
1.	Nageshwar Rao, *Precision Farming and Agricultural Automation*, Kalyani Publishers, 2020.
2.	Manjunatha K.S., *Farm Machinery and Automation*, Jain Brothers, New Delhi, 2018.
3.	Rajvir Yadav, *Agricultural Automation*, Biotech Books, New Delhi, 2021.

References	
1.	CIGR Handbook of Agricultural Engineering Volume VI – Information Technology, ASABE, USA.
2.	Mehta M.L., Verma S.R., and Sharma V.K., *Farm Machinery and Power Engineering*, Jain Brothers.
3.	Internet of Things: https://nptel.ac.in/courses/106105166
4.	Articles and Case Studies from ICAR, IARI, and SmartFarm India

R. Vasanthi.

Approved by BoS Chairman

B.E/ B.TECH	B23ADO501– GEN AI WITH OPEN SOURCE FRAMEWORK	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To Understand the Core Concepts of Artificial Intelligence
2.	To explain the Fundamentals of Generative AI and Its Architectures
3.	To Outline Open-Source GenAI Tools and Frameworks
4.	To identify the Prompt Engineering Techniques and Build Chatbots
5.	To study the Real-World Applications of Generative AI in Open-Source Domains

UNIT-I	BASICS OF AI	9

Introduction to AI - Future of AI – Applications of AI – History of AI- Types of AI- Intelligent Agent: Types of Agents- Characteristics of Intelligent Agents - Structure of Agents – Agents and Environments- Examples of AI.

UNIT-II	GEN AI MODELS	9

Introduction of Gen Ai- Sub Sets of Gen Ai- Model Creation - Types of Generative Ai transformer Based Architecture -LLM- GAN architecture - Training GANs and challenges) - Variants of GANs- VAE : Encoder, Decoder, and Latent space- Applications of VAEs

UNIT-III	OPEN SOURCE GEN AI	9

Gen AI in open source - Benefits of Open source AI -Open source tools for generative AI - Deep learning frameworks for generative AI- Advantages and Disadvantages of these frameworks

UNIT-IV	PROMPT ENGINEERING & CHATBOT DEVELOPMENT	9

Basics of Prompt Engineering- Few-shot - Zero-shot prompting - Prompt tuning vs Fine-tuning - Building a chatbot using: Lang Chain -RAG (Retrieval-Augmented Generation)

UNIT-V	USE CASES OF GEN AI IN OPEN SOURCE	9

Open-Source Generative AI Models-generative ai use cases in open source- visual content- audio generation- Text generation- Manufacturing- Supply chain and logistics- Retail & e-commerce- Automotive.

Approved By BoS Chairman

Total Instructional hours: 45

Course Outcomes: Students will be able to	
CO1	Explain Intelligent agents, and their interaction with environments.
CO2	Identify the structure and working principles of various Generative AI models
CO3	Apply open-source tools, frameworks, and platforms
CO4	Discover prompt engineering techniques
CO5	Examine use cases of Generative AI across various domains
TextBooks	
1.	Stuart Russell, Peter Norvig, "Artificial Intelligence: A Modern Approach", Pearson, 2021.
2.	Goodfellow I, Bengio Y and Courville, "A Deep Learning", MIT Press. Foster, D, 2022
Reference Books	
1.	Chollet, F. "Deep Learning with Python", Manning Publications, 2018
2.	Martin Musiol, "Generative Ai: Navigating the Course to the Artificial General Intelligence Future", John Wiley Sons, 2024

Approved By BoS Chairman

B.E / B.Tech	B23AMO501 – PRINCIPLES OF MACHINE LEARNING	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the concepts of Machine Learning.
2.	To study the Supervised Learning with Classifications.
3.	To analyse Random Forest methods and Backpropagation.
4.	To identify the Clustering Techniques for Data Analysis.
5.	To infer the applications of Machine Learning and Dimensionality Analysis.

UNIT - I	INTRODUCTION	9
Introduction to Machine Learning – Need of Machine Learning – Machine Learning Applications – Types of Machine Learning Systems – Challenges – Machine Learning Process – Data Collection – Exploration – Preparation – Training – Optimization – Performance Measures.		

UNIT - II	SUPERVISED LEARNING	9
Classification and Regression Technique – Linear Regression – Polynomial Regression – Logistic Regression – Generalization – Overfitting – Underfitting – Support Vector Machine – Kernels – KNN – Naïve Bayes Classifiers – Decision Tree.		

UNIT - III	ENSEMBLE LEARNING TECHNIQUES	9
Random Forest – Ensemble Learning – Bagging – Boosting – Ada Boost – Gradient Boosting – Neural Networks – ANN Perceptron – MLP's and Backpropagation – Hyperparameter Optimization – Dimensionality Reduction.		

UNIT - IV	UNSUPERVISED LEARNING	9
Clustering – Techniques – K-Means Clustering – AGNES – DIANA – Density Based Clustering (DBSCAN) – Grid Based Clustering – Gaussian Mixtures – Clustering High Dimensionality Data – Outlier Analysis.		

UNIT - V	APPLICATIONS OF ENSEMBLE LEARNING	9
Dimensionality Reduction Applications – Factor Analysis – Model Selection & Evaluation – Visualization of Results – Applications of ML : Medical Science, Fraud Detection, Traffic Prediction, Personal Assist, Stock Prediction.		

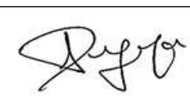
Total Instructional hours: 45

Approved by BoS Chairman

Text Books	
1.	Muller, Andreas C., and Sarah Guido. “Introduction to Machine Learning with Python : A Guide for Data Scientists.” 3rd Edition, “O’Reilly Media, Inc.”, 2016.
2.	Geron, Aurelien. Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow : Concepts, Tools, and Techniques to build intelligent systems. 1st Edition, “O’Reilly Media, Inc.”,

Reference Books	
1.	Himanshu Singh, Yunis Ahmed Lone, Deep Neuro-Fuzzy Systems with Python : With Case Studies and Applications from the Industry, 3rd Edition, 2019.
2	Leonardo De Marchi, Hands-On Neural Networks : Learn how to Build and Train Your First Neural Network Model using Python Book, 1st Edition, 2019.
3	James Loy, Neural Network Projects with Python : The Ultimate Guide to using Python to explore the true power of neural networks through six projects. 1st Edition, Kindle Edition,

Course Outcomes : Students will be able to	
CO1	Recall the basics of Machine Learning
CO2	Illustrate the Classification and Regressions
CO3	Identify the Concepts of Neural Networks and Ensemble Learning
CO4	Analyze the features of unsupervised Learning
CO5	Explain the applications of Machine Learning



Approved by BoS Chairman

B.E / B.Tech	BM23BMO501- PRINCIPLES OF BIOSENSORS	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To study the basic structural ,functional elements, the gaseous exchange and fluid maintenance of the human body.
2.	To learn the organs and structures involved in system formation and functions.
3.	To understand the functions of physiological system
4.	To Know the activity of sensory and motor nerves
5.	To analyse Different Physiological Conditions in the Human Body.

UNIT - I	INTRODUCTION TO BIOSENSOR	9
Biosensors- Advantages and limitations, various components of biosensors, Classification of Biosensors Based on Type of Transduction - Electrochemical, Optical, Acoustic, Calorimetric. Classification of Biosensors Based on Biological Element - Enzyme Sensor, Immunosensors, Cell-based Sensors		

UNIT - II	DESIGN OF BIOSENSOR	9
Introduction, Assay format, Immobilisation-Ligand Activity, Regeneration, Analysis of regeneration data, Signal correction, Buffer scouting, Extracting kinetic affinity constant, Extracting kinetic rate constant, Sensor Surfaces and Receptor Depth, Molecular Interaction.		

UNIT - III	OPTICAL AND BIOCHEMICAL BIOSENSORS	9
Principles of Optical biosensing, Immobilization of bio-recognition elements, Types of optical biosensor: Fiber optic, planar waveguide, Evanescent, Interferometric, and Surface plasmon resonance-biosensor-Applications. Chemical and other sensors - Biocatalysis based biosensors, Bio affinity based biosensors & Microorganisms based biosensors, Biologically active material and analyte. Types of membranes used		

Program Coordinator

Approved by BOS Chairman

in biosensor constructions.

UNIT - IV	IMMUNOSENSOR	9
introduction to Immuno biosensor- Enzyme Biosensor, Bio Affinity Biosensor, Labelled Immuno sensors, Non-Labelled Immuno sensors. Transducer Aspects of Immuno sensor Optical Immunosensor, Piezoelectric Crystal Immunosensors, Electrochemical Immunosensors. Biological Aspects of biosensor- Antibody Development, Immunosensor based Assay Development.		
UNIT - V	**DIAGNOSTIC APPLICATION OF BIOSENSOR**	**9**
Preparation of Doped Sol-Gel Glasses, Application of Sol-Gel Glasses in Biosensors- Glucose Biosensor, Urea Biosensor, Cholesterol Biosensor, Lactate Biosensor. Application of enzymes in analysis; design of enzyme electrodes and their application as biosensors in healthcare.		
		Total Instructional hours : 45

Course Outcomes: Students will be able to	
CO1	Apply principles and concepts of biology and engineering to design biosensors.
CO2	Apply principles and concepts of electronics and electrochemistry to design electrochemical biosensors.
CO3	Recognize different types of transducers, and their application in biosensor design.
CO4	Apply principles and concepts of sensing and engineering to design biosensors for detection of markers in biofluids.
CO5	Apply engineering tools to evaluate parameters needed for point-of-care devices.

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Text book	
1.	Bansi D Malhotra, Anthony, Advances in Biosensors, Volume 5, 2003, Elsevier, Oxford.
2.	Brian R Eggins - Biosensors an Introduction, First edition, John Wiley & Sons Publishers, 1996
3.	Loic J Blum, Pierre R Coulet - Biosensors Principles and Applications, First edition, Marcel Dekker,Inc, 1991.
4.	Donald G. Buerk - Biosensors Theory and Applications, First Edition Technomic Publishing. Co, Inc, 1993.

Reference Books	
1.	Elizabeth A Hall - Biosensors, First Edition, Open University, Milton Keynes, 1990.
2.	Graham Ramsay - Commercial Biosensors, First edition, John Wiley & Sons, Inc. 1998.
3.	Tran Minh Canh - Sensor Physics & Technology – Biosensors, First Edition, Champan & Hall, 1993.
4.	Mathew A.Cooper, Label free Biosensors Techniques and Applications, Cambridge, 2009.

Program Coordinator

Approved by BOS Chairman

B. TECH.	B23BTO501 – BIOFERTILIZER PRODUCTION AND MUSHROOM CULTIVATION	L	T	P	C
		3	0	0	3

Course Objectives

1.	To provide a comprehensive understanding of the principles and practices of biofertilizer production and mushroom cultivation.
2.	To equip students with knowledge of microbial inoculants and their applications in sustainable agriculture.
3.	To explore the cultivation techniques and nutritional aspects of various edible mushrooms.
4.	To enable students to understand industrial mushroom processing, value addition, and quality control, including nutraceuticals and waste management.
5.	To familiarize students with the quality control and commercial aspects of biofertilizers and mushroom production.

UNIT - I	INTRODUCTION TO BIOFERTILIZERS AND MICROBIAL INOCULANTS	9

Introduction to biofertilizers: Significance and scope. Types of biofertilizers: Nitrogen-fixing, phosphate-solubilizing, potassium-mobilizing, and mycorrhizal biofertilizers. Microbial inoculants: *Rhizobium, Azotobacter, Azospirillum, Pseudomonas, Bacillus, Trichoderma*, and mycorrhizal fungi. Mechanisms of action of biofertilizers: Nitrogen fixation, phosphate solubilization, plant growth promotion. Carrier materials and their properties. Quality control of biofertilizers: Viability, purity, and efficacy testing.

UNIT - II	PRODUCTION TECHNOLOGY OF BIOFERTILIZERS	9

Isolation and characterization of effective microbial strains. Fermentation technology for biofertilizer production: Batch, fed-batch, and continuous fermentation. Scale-up and optimization of biofertilizer production. Formulation and packaging of biofertilizers. Storage and shelf-life of biofertilizers. Quality standards and FCO.

UNIT - III	MUSHROOM CULTIVATION: PRINCIPLES AND PRACTICES	9

Introduction to edible mushrooms: Nutritional and medicinal value. Cultivation techniques for various mushrooms: Oyster, button, shiitake, and milky mushrooms. Substrate preparation and sterilization. Spawn production and inoculation. Environmental control in mushroom cultivation: Temperature, humidity, and ventilation. Pest and disease management in mushroom cultivation.

UNIT - IV	MUSHROOM PROCESSING AND VALUE ADDITION	9

Post-harvest handling and preservation of mushrooms. Processing of mushrooms: Drying, canning, and pickling. Value-added products from mushrooms: Mushroom powder, extracts, and nutraceuticals. Mushroom waste utilization. Quality assessment of mushrooms: Sensory, chemical, and microbiological analysis.

UNIT - V	COMMERCIAL ASPECTS AND ENTREPRENEURSHIP	9

Market potential and demand for biofertilizers and mushrooms. Economic analysis of biofertilizer and mushroom production. Entrepreneurial opportunities in biofertilizer and mushroom industries. Marketing and distribution strategies. Intellectual property rights (IPR) and patenting. Government schemes and subsidies.

Total Instructional hours : 45

Approved by BoS Chairman

Course Outcomes After the successful completion of the course, the students will be able to,		Knowledge Level
CO1	Illustrate the principles of microbial inoculant production and application.	K2
CO2	Classify the different types of biofertilizers and their impact on soil fertility.	K2
CO3	Explain the cultivation techniques and nutritional value of various edible mushrooms.	K2
CO4	Demonstrate the quality and safety parameters of biofertilizers and mushroom products.	K2
CO5	Identify the commercial aspects and entrepreneurial opportunities in biofertilizer and mushroom industries.	K3

Text Books	
1.	Subba Rao N.S., "Soil Microbiology", Oxford & IBH Publishing Company, New Delhi, 2002.
2.	Himadri Panda H., "Manufacture of Biofertilizer and Organic Farming", Asia Pacific Business Press Inc., 2024.
3.	Tewari R.P., "Mushrooms: Cultivation, Marketing and Consumption", Daya Publishing House, Delhi, 2005.
4.	Chang S.T., Miles P.G., "Mushrooms: Cultivation, Nutritional Value, Medicinal Effect, and Environmental Impact", CRC Press, Boca Raton, 2004.

References Books	
1.	Alexander M., "Introduction to Soil Microbiology", John Wiley & Sons, New York, 1977.
2.	Stamets P., "Mycelium Running: How Mushrooms Can Help Save the World", Ten Speed Press, Berkeley, 2005.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	2	2	-	-	2	3	3
CO2	2	1	-	-	-	-	-	2	2	-	-	2	3	3
CO3	2	2	-	-	-	-	-	2	2	-	-	2	3	3
CO4	2	2	-	-	-	-	-	2	2	-	-	2	3	3
CO5	2	2	-	-	-	-	-	2	2	-	-	2	3	3
Wt. Avg.	2	2	-	-	-	-	-	2	2	-	-	2	3	3

Approved by BoS Chairman

B.E.	B23CSO501- FOUNDATIONS OF DBMS (Except CSE)	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To learn the fundamentals of data models, relational algebra and SQL.
2.	To represent a database system using ER diagrams and to learn normalization techniques.
3.	To understand the concepts of transaction, concurrency and recovery processing.
4.	To understand the internal storage structures using different file and indexing techniques
5.	To have basic knowledge about the Distributed databases, NOSQL and DB security

UNIT - I	RELATIONAL DATABASES	9
Purpose of Database System – Views of data – Data Models – Database System Architecture – Introduction to relational databases – Relational Model – Keys – Relational Algebra – SQL fundamentals – Advanced SQL features – Embedded SQL– Dynamic SQL		
UNIT - II	**DATABASE DESIGN**	**9**
Entity-Relationship model – ER Diagrams – Enhanced-ER Model – ER to Relational Mapping – Functional Dependencies – Non-loss Decomposition – First, Second, Third Normal Forms, Dependency Preservation – Boyce/Codd Normal Form – Multi-valued Dependencies and Fourth Normal Form – Join Dependencies and Fifth Normal Form		
UNIT - III	**TRANSACTIONS**	**9**
Transaction Concepts – ACID Properties – Schedules – Serializability – Transaction support in SQL – Need for Concurrency – Concurrency control –Two Phase Locking- Timestamp – Multiversion – Validation and Snapshot isolation– Multiple Granularity locking – Deadlock Handling – Recovery Concepts – Recovery based on deferred and immediate update – Shadow paging – ARIES Algorithm.		
UNIT - IV	**IMPLEMENTATION TECHNIQUES**	**9**
RAID – File Organization – Organization of Records in Files – Data dictionary Storage – Column Oriented Storage– Indexing and Hashing –Ordered Indices – B+ tree Index Files – B tree Index Files – Static Hashing – Dynamic Hashing – Query Processing Overview – Algorithms for Selection, Sorting and join operations – Query optimization using Heuristics - Cost Estimation.		

UNIT - V	ADVANCED TOPICS	9
Distributed Databases: Architecture, Data Storage, Transaction Processing, Query processing and optimization – NOSQL Databases: Introduction – CAP Theorem – Document Based systems – Key value Stores – Column Based Systems – Graph Databases. Database Security: Security issues – Access control based on privileges – Role Based access control – SQL Injection – Statistical Database security – Flow control – Encryption and Public Key infrastructures – Challenges.		
		Total Instructional hours: 45

Course Outcomes: Students will be able to	
CO1	Construct basic SQL Queries using relational algebra
CO2	Build database using ER model and normalize the database
CO3	Organize transaction-related queries while ensuring consistency and concurrency control
CO4	Evaluate various indexing and file organization strategies to optimize query performance
CO5	Analyze relational DB and NoSQL DB

Text Books	
1.	Abraham Silberschatz, Henry F. Korth, S. Sudharshan, “Database System Concepts”, Seventh Edition, McGraw Hill, 2020.
2.	Ramez Elmasri, Shamkant B. Navathe, “Fundamentals of Database Systems”, Seventh Edition, Pearson Education, 2017.

Reference Books	
1.	C.J.Date, A.Kannan, S.Swamynathan, “An Introduction to Database Systems”, Eighth Edition, Pearson Education, 2006.

Approved by BoS Chairman

CO Mapping with PO & PSO

CO/PO & PSO		PO1 (K3)	PO2 (K4)	PO3 (K5)	PO4 (K5)	PO5 (K6)	PO6 (K3) (A3)	PO7 (K2) (A3)	PO8 (K3) (A3)	PO9 (A3)	PO10 (A3)	PO11 (K3) (A3)	PO12 (A3)	PSO1 (K4) (A3)	PSO2 (K3) (A3)
CO1	K3														
CO2	K3														
CO3	K3														
CO4	K5														
CO5	K4														
Weighted Average															

3 – Substantial **2- Moderate** **1- Low** **'-' – No Correlation**

Approved by BoS Chairman

B.E / B. TECH	B23ECO501 COMMUNICATION ENGINEERING (Common to All Except ECE)	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the concepts of modulation techniques in generation of amplitude modulation and angle modulation.
2.	To impart knowledge in random process
3.	To familiarize students' optimum receivers for binary digital modulation schemes
4.	To examine digital modulation formats and their power spectral
5.	To understand the properties of spread spectrum techniques to design robust and efficient communication systems

UNIT – I FUNDAMENTALS OF ANALOG COMMUNICATION	9
Basics of communication systems; Fundamentals of Principles of amplitude modulation; AM envelope; frequency spectrum and bandwidth; modulation index and percent modulation; AM Voltage distribution; AM power distribution; Angle modulation; FM and PM waveforms; phase deviation and modulation index; frequency deviation and percent modulation; Frequency analysis of angle modulated waves; Bandwidth requirements for Angle modulated wave.	

UNIT–II RANDOM PROCESS AND SAMPLING	9
Review of probability and random process; Gaussian and white noise characteristics; Noise in amplitude modulation systems; Noise in Frequency modulation systems; Pre-emphasis and Deemphasis; Threshold effect in angle modulation; Low pass sampling; Aliasing; Signal Reconstruction; Quantization; Uniform & non-uniform quantization; quantization noise; Nyquist criterion; Logarithmic Companding; PAM; PPM; PWM; PCM; TDM; FDM.	

UNIT – III DIGITAL TRANSMISSION	9
Optimum Receiver for Binary Digital Modulation Schemes; Description of Binary ASK; PSK; and FSK Schemes; Binary PSK Signaling Schemes; M-ary Signaling Schemes; Synchronization Methods.	

UNIT – IV DIGITAL MODULATION TECHNIQUES	9
Digital modulation formats; Coherent Binary Modulation Techniques: BFSK and BPSK; QPSK; MSK; M-ary QAM; Power spectra of BFSK; BPSK; QPSK and MSK.	
UNIT – V SPREAD SPECTRUM AND MULTIPLE ACCESS	**9**

Approved by BOS Chairman

PN sequences: properties; m-sequence; DSSS; Processing gain; Jamming; FHSS; Synchronization and tracking; Multiple Access: FDMA; TDMA; CDMA.	
	Total Instructional hours:45

Course Outcomes: Students will be able to	
CO1	Apply principles of basic communication systems to design basic modulation schemes for efficient signal transmission.
CO2	Apply probability and random process principles to analyze noise in communication systems
CO3	Apply knowledge to design and assess optimum receivers for binary digital modulation schemes like ASK, PSK, FSK, and M-ary systems.
CO4	Analyze and differentiate between digital modulation formats and their power spectral.
CO5	Apply and evaluate concepts of PN sequences, DSSS, FHSS, and multiple access techniques

Text Books	
1.	K Sam Shanmugam, Digital and Analog Communication Systems, Wiley, 2019.
2.	Wayne Tomasi, “Advanced Electronic Communication Systems”, 6th Edition, Pearson Education, 2018.
3.	Simon Haykin, “Communication Systems”, Wiley India, 4th edition, 2014.

Reference Books	
1.	H.Taub, D L Schilling and G Saha, “Principles of Communication”, 4th Edition, Pearson Education, 2017.
2.	B.P.Lathi, Zhi Ding, Hari Mohan Gupta “Modern Analog and Digital Communication Systems”, 4th Edition, Oxford University Press, 2017.
3.	Sanjay Sharma, “Communication Systems (Analog and Digital)”, S.K. Kataria & Sons; Reprint 2013.
4.	B.Sklar, “Digital communications: Fundamentals and Applications”, 2nd Edition, Pearson Education, 2012.

<table>
<tr><th colspan="5">Evaluation Pattern:</th></tr>
<tr><th colspan="4">Continuous Internal Assessment</th><th>End Semester Examinations</th></tr>
<tr><td colspan="2">CIA I (Theory)
(100 Marks)</td><td colspan="2">CIA II (Theory)
(100 Marks)</td><td rowspan="3">Theory End Semester Examinations
(Examinations will be conducted for 100 Marks)</td></tr>
<tr><td>* Alternate Assessment Tool (AAT)</td><td>Written Test</td><td>* Alternate Assessment Tool (AAT)</td><td>Written Test</td></tr>
<tr><td>40 Marks</td><td>60 Marks</td><td>40 Marks</td><td>60 Marks</td></tr>
<tr><td colspan="4">40 Marks</td><td>60 Marks</td></tr>
<tr><th colspan="5">Total: 100 Marks</th></tr>
</table>

* AAT - Individual Assignment/ Case Study/ Seminar/ Mini project/ MCQ/ Role Play/ Group Discussion/ Debates/ Oral Presentations/ Poster Presentations/ Technical Presentations can also be provided course coordinator can choose any one/two components based on the nature of the course.

Approved by BOS Chairman

B.E	B23EEO501- ELECTRIC VEHICLE TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the basics of electric vehicle history and components.
2.	To understand properties of batteries.
3.	To understand the electrical machine properties and classifications.
4.	To understand the properties of electric vehicle drive systems.
5.	To understand the concepts of hybrid electric vehicles.

UNIT-I	INTRODUCTION TO ELECTRIC VEHICLES	9
Present scenario of electric vehicles, Need of electric vehicles, economics, environmental impacts of using electric vehicles, challenges faced by electric vehicles in replacing ICE, major requirements of electric vehicles.		

UNIT-II	TYPES OF ELECTRIC VEHICLES AND THE CHALLENGES	9
Types of electric vehicles: Plug-in Electric Vehicle (PEV), Battery Electric vehicle (BEV), Fuel Cell electric vehicle (FCEV), Hybrid electric vehicle (HEV), Challenges of battery electric vehicle, hybrid electric vehicle and fuel cell electric vehicle.		

UNIT-III	BATTERY ELECTRIC VEHICLE	9
Components of BEV drive train: electric propulsion subsystem - power converter, driving wheels, suspension system, driveshaft, mechanical transmission, electric Motor, power electronics converters (DC-AC/DC-DC), electronic control unit, energy source subsystem, battery pack with battery management system, On board charger, auxiliary subsystem, power steering unit, common parts between ICE drive train and EV drive train.		

UNIT-IV	HYBRID AND FUEL CELL ELECTRIC VEHICLE	9
Basic architecture of hybrid drive trains, components of HEV drive train system, classification of HEV: conventional HEV (Micro, Mild and Full hybrid- series hybrid, parallel hybrid, series-parallel hybrid, complex hybrid), Basic architecture of FCEV, components of FCEV drive train system.		

Approved by BoS Chairman

UNIT-V	ENERGY STORAGE	9
Battery-based energy storage, Overview of batteries, Battery parameters, battery charging, regenerative braking, alternative novel energy sources: solar photovoltaic cells, fuel cells, super capacitors, and flywheels.		
		Total Instructional hours:45

Course Outcomes: Students will be able to	
CO1	Illustrate the basics of electric vehicle history and components.
CO2	Classify the different types of electric vehicles.
CO3	Apply the battery properties in an electric vehicle.
CO4	Develop the hybrid and fuel cell electric vehicle.
CO5	Illustrate the concept of energy storage devices.

Text Books	
1.	Electric & Hybrid Vehicles – A.K. Babu, Khanna Publishing House, New Delhi, 2018.
2.	Electric & Hybrid Vehicles – Design Fundamentals – Iqbal Hussain, Second Edition, CRC Press, 2011.
3.	Electric Vehicle Battery Systems – Sandeep Dhameja, Newnes, 2000.
4.	Husain, I. (2021). Electric and Hybrid Vehicles: Design Fundamentals (3rd Edition). CRC Press.

Reference Books	
1.	Electric Vehicle Technology Explained - James Larminie, John Wiley & Sons, 2003
2.	Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals – Mehrdad Ehsani,Yimin Gao, Ali Emadi, CRC Press, 2010.
3.	Chan, C. C., & Chau, K. T. (2001). Modern Electric Vehicle Technology. Oxford University Press.
4.	Larminie, J., & Lowry, J. (2023). Electric Vehicle Technology Explained (3rd Edition). Wiley.

Approved by BoS Chairman

B.E.	B23MEO501 - ROBOTICS	L	P	TU	C
		3	0	0	3

Course Objectives	
1.	To understand the concepts of the basic components of a robot
2.	To apply the distinct drive systems and end effectors to control the robot actuation
3.	To study the role and application of various types of sensors and machine vision system
4.	To make use of the knowledge in the robot kinematics and to write Robot Programs
5.	To identify the social and economic challenges while implementing the robot systems

UNIT - I	FUNDAMENTALS OF ROBOT	9

Robot - Definition - Robot Anatomy - Coordinate Systems, Work Envelope Types and Classification - Specifications - Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load - Robot Parts and their Functions- Different Applications - A view on Global and Indian manufacturers of Robots - Need for Robots in Indian environment.

UNIT - II	ROBOT DRIVE SYSTEMS AND END EFFECTORS	9

Drives - hydraulic, pneumatic, mechanical, electrical, Servo motors, Stepper motors - salient features, application; End effectors – types; Grippers - mechanical, pneumatic, hydraulic, magnetic, vacuum - limitations, Multiple grippers.

UNIT - III	SENSORS AND MACHINE VISION	9

Requirements of sensors, principles, types and applications of Proximity (Inductive, Hall effect, Capacitive, Ultrasonic and Optical); – Range (Triangulation, Structured light approach); Speed, Position (resolvers, optical encoders); – Force – Torque – Touch sensors (binary, analog sensor). Introduction to Machine Vision; applications, functions; image processing and analysis; training the vision system.

UNIT - IV	ROBOT KINEMATICS AND ROBOT PROGRAMMING	9

Forward kinematics and Reverse kinematics of manipulators; two, three degrees of freedom, homogeneous transformation matrix; introduction to manipulator dynamics, trajectory generator, manipulator mechanism, Degeneracy and Dexterity; Lead through programming, Robot programming languages; VAL programming, motion commands, sensor commands, end effecter commands, simple programs (for loading, unloading and palletizing operations), introduction to advances in Robot Programming.

Approved by BoS Chairman

UNIT - V	APPLICATION, IMPLEMENTATION AND ROBOT ECONOMICS	9
Robot cell design; types, application of robots in processing, assembly, inspection, material handling in automobile, medical, Nuclear Industries, RGV, AGV; Implementation of Robots in Industries; Safety considerations for robot operations, safety codes, Economic analysis of robots.		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Explain the concepts of industrial robots, classification, specifications and coordinate systems.
CO2	Illustrate the different types of robot drive systems as well as robot end effectors.
CO3	Apply the different sensors and image processing techniques in robotics to improve the ability of robots.
CO4	Develop robotic programs for different operations and familiarize with the kinematics motions of robot.
CO5	Examine the implementation of robots in various industrial sectors and interpolate the economic analysis of robots.

Text Books	
1.	Groover M.P., “Industrial Robotics - Technology Programming and Applications”, McGraw Hill, 2012.
2.	Deb S R and Deb S, Robotics Technology and Flexible Automation, Tata McGraw Hill Education Pvt. Ltd, 2010.
3.	Saha S K, Introduction to Robotics, Tata McGraw Hill Education Pvt. Ltd, 2010, 2nd Ed, 2014.

Reference Books	
1.	Craig J.J., “Introduction to Robotics Mechanics and Control”, Pearson Education, Global Edition, 3rd Edition, 2014.
2.	Deb S.R., “Robotics Technology and Flexible Automation” Tata McGraw Hill Book Co., 2013.
3.	Ashitava Ghoshal, Robotics-Fundamental Concepts and Analysis, Oxford University Press, Sixth impression, 2010.

Approved by BoS Chairman

B.E / B.TECH	B23CBO501 FRONT END DEVELOPMENT	T	P	TU	C
		3	0	1	3

Course Objectives	
1.	To interpret the basics of front end development and modern development tools.
2.	To device a front end design with HTML Tags.
3.	To work with HTML Forms and Implement Layouts Using Frames and iFrames
4.	To design a dynamic webpage using CSS.
5.	To articulate client side activities on a web site using Javascript.

UNIT- I INTRODUCTION TO FRONT END DEVELOPMENT	9
Introduction to web - WWW - Web server and client, URL, URI,URN-Internet addresses and IP classes Web protocols -TCP/IP,UDP, MIME.SMTP,POP3,HTTP & HTTPS-MVC-Model, View, Controller of Web design-Role of front end developer and Modern Front end Tools.	

UNIT-II HTML (HYPERTEXT MARKUP LANGUAGE)	9
Introduction to HT ML - HTML s HTML5 - Basic HTML Structure - HTML Elements, Attributes and properties - Formatting tags - Lists & symbols -Ordered Lists -Unordered Lists-Descriptive Lists - Hyperlinks- Multimedia: Images, Audio, Video tags	

UNIT- III HTML TABLES & FORMS	9
HTML table :Table border, row, column header, rowspan & colspan, cell spacing and cell padding HTML forms: Form elements- Text, Textarea, Password field, Label-Checkbox, Radio Button. Selection List - Button -Frames & iFrames	

UNIT- IV CSS (Cascading style sheets)	9
Introduction to style sheets: Cascading style sheets-CSS properties - CSS selectors - Pseudo classes and elements - Types of CSS: Inline, Embedded, External style sheet-Case study Talwind CSS	

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UNIT- V CLIENT SIDE SCRIPTING	9
Introduction to Javascript, Javascript features -Datatypes, Variables , Literals & Operators – Control structures -Arrays - Predefine functions & User defined functions – Javascript - DOM objects - Case study- npm, NodeJs.	
Total Instructional hours: 45	

Course Outcomes: Students will be able to	
CO1	**Interpret the working of web sites, web servers and modern front-end**
CO2	Build web pages of a website with HTML
CO3	Develop web site for process and Implement Layouts Using Frames and
CO4	Construct dynamic styles using CSS.
CO5	Build client side activities with Javascript.

Text Books:
1.Uttam K.Roy,"Web Technologies" by, Oxford University Press 2010, First edition, eight impression 2014.

Reference Books :
1.Thomas Powell , "HTML& css: The Complete Reference", Fifth Edition Paperback - 1, Tata McGrawHill, July 2017.
2.. Laurence Lars Svekis , Maaike Van Putten , Rob Percival ," JavaScript from Beginner to Professional: Leam JavaScript quickly by building fun, interactive, and dynamic web apps. games, and pages", Packt, December 2021.

Approved by BoS Chairman

Open Elective - II

B.E.	B23AEO601 – UNMANNED AIRCRAFT SYSTEMS OPERATION AND MRO (Common to all Except AERO)	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To know the working principles of aircraft engine and fuel systems.
2.	To understand the lighting technologies and pressurization system of the aircraft cabin.
3.	To realize the warning and protection systems of the aircraft.
4.	To expose on terrain warning systems of the safety of the aircraft.
5.	To gain knowledge on FDR and anti-fire protection system.

UNIT - I	DRONE RULES & BASIC PRINCIPLES OF FLIGHT	9
International Rules- Regulations, Standards & Practices, Dos and Do not, Civil Aviation Requirements- AIPs, NOTAM, Classification & Categorization of drones, Type Certification of Drones, Registration, Sale & De-Registration of Drones, Operations of Drones, Dos and Donts, Remote Pilot Licensing, Drone Insurance Fundamentals of flight, Aerodynamics, Take-off, flight, and landing. Maneuvers, turns and circuit pattern.		

UNIT - II	ATC PROCEDURES & RADIO TELEPHONY (NON FRTOL) WEATHER AND METEOROLOGY	9
Understanding ATC operations, Airspace structure and Airspace, Restrictions with knowledge of no drone zones, RT Phraseology & Communicating with ATC including Position and Altitude Reporting. Flight Planning Procedures including Altimeter setting procedures. Collision avoidance. Radio Telephony (RT) techniques, The standard atmosphere, Measuring air pressure, Heat and temperature, Wind. Moisture, cloud formation, icing and its effects. Effect of atmosphere on RPAS operation & hazardous weather avoidance, Met Terminal Aviation Routine Weather Report (METAR).		

UNIT - III	FIXED-WING & ROTORCRAFT OPERATIONS AND AERODYNAMICS	9
Types of fixed wing drones, make, parts, terminology, Operation and maneuvers of fixed wing drones, Flight Performance. Intro to Mission Planning, Instrument Flying & Navigation (GCS). Applications of fixed-wing UAVs. Pros and Cons of Fixed Wing Drones Rotorcraft- Basic drone terminology & parts,		

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Types of drones, material used and size of drones, Drone Anatomy: Different parts of drones, Avionics & C2 Link, Intro to Mission Planning, Instrument Flying & Navigation (GCS). Applications and operations of Multirotor, Flight Performance. Pros and Cons of Rotorcraft Drones.

UNIT - IV	HYBRID OPERATIONS, AERODYNAMICS & EQUIPMENT MAINTENANCE	9
Principles of Aerodynamics, Types of Hybrid Drones & Parts, Intro to Mission Planning, Instrument Flying & Navigation (GCS), Applications of Hybrid UAVs, Comparison with Rotorcraft & Aeroplane Drone Equipment Maintenance- Maintenance of drone, flight control box, ground station, Maintenance of ground equipment, batteries and payloads, Scheduled servicing, Repair of equipment, Fault finding and rectification.		

UNIT - V	SAFETY MANAGEMENT, PAYLOAD, & DATA & ANALYSIS	9
Drothe Emergency & Handling, Loss of C2-link, Fly-aways (Straying), Loss of power, Other Emergencies, Control surface failures, Human Performance & Pilot Incapacitation, Fail-Safe Features, Types of payloads - What to carry, what not to carry, Parts of payloads, Installation, Features of payloads, Utilization, Principles of Observation, Elements of Image & Video Interpretation, Introduction to Photogrammetry, Types of Image & Video Data, Analysis.		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Explain the Basics of Ignition and Fuel System of an Aircraft. (K2)
CO2	Illustrate the Flight Compartment Lighting Technologies and Cabin Air Conditioning system. (K2)
CO3	Identify the Warning and Protection Systems for the Ice Formation and Rain in the Airframe of the Aircraft During Flight. (K3)
CO4	Apply the Terrain Warning Systems to avoid the Terrain Collision of an Aircraft. (K3)
CO5	Examine the FDR and Fire Protection System to Monitor the Flying Performance of the Aircraft. (K4)

Text Books	
1.	"Aircraft Electrical and Electronic Systems", Principles, operation and maintenance by Mike Tooley and David Wyatt.

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Reference Books	
1.	Pallet.E.H.J., "Aircraft Instruments and Integrated Systems", Pearsons, Indian edition 2011.
2.	Spitzer, C.R. "Digital Avionics Systems", Prentice-Hall, Englewood Cliffs, N.J., U.S.A. 1993.
3.	Spitzer. C.R. "The Avionics Hand Book", CRC Press, 2000.

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B.Tech.	B23AGO601 - Environmental Management in Agriculture	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To provide knowledge on natural resource use and environmental sustainability in agriculture.
2.	To understand the causes and impacts of pollution from agricultural activities.
3.	To explore the principles and methods of environmental impact assessment (EIA).
4.	To study the role of waste management and resource recycling in agriculture.
5.	To introduce climate-smart agriculture and mitigation strategies for sustainable development.

UNIT I	NATURAL RESOURCES AND SUSTAINABILITY	9
Natural resources – classification and utilization in agriculture – Sustainable use of soil, water, biodiversity – Ecological footprint – Concept of carrying capacity – Environmental indicators – Role of agriculture in environmental degradation – Policies for sustainable agriculture – SDGs related to environment and agriculture.		

UNIT II	AGRICULTURE AND POLLUTION	9
Agricultural pollution – causes and effects – Soil pollution due to fertilizers, pesticides and heavy metals – Water pollution: runoff, eutrophication, groundwater contamination – Air pollution: burning of residues, methane, ammonia emissions – Noise pollution from farm machinery – Agrochemical residues and food chain contamination – Preventive strategies.		

UNIT III	ENVIRONMENTAL IMPACT ASSESSMENT (EIA)	9
Concept and need for EIA – Components and stages of EIA – Screening, scoping, impact prediction, mitigation – EIA methods (checklist, matrix, network) – Public participation – Environmental Management Plan (EMP) – Environmental audit – Case studies of agricultural projects (dams, irrigation, fertilizer units).		

UNIT IV	AGRICULTURAL WASTE AND RESOURCE MANAGEMENT	9
Types of agricultural waste – crop residues, livestock waste, agro-industrial waste – Collection, handling and disposal – Waste minimization – Composting, vermicomposting, biogas production – Biomass energy – Circular economy in agriculture – Integrated farming and nutrient recycling – Wastewater reuse in agriculture.		

UNIT V	CLIMATE CHANGE AND SUSTAINABLE FARMING	9
Climate change: causes and impact on agriculture – GHG emissions from agriculture – Carbon sequestration – Climate-smart agriculture – Conservation agriculture – Precision farming – Agroforestry and carbon farming – Green technologies in agriculture – Institutional frameworks (UNFCCC, IPCC, ICAR).		
		Total Instructional Hours: 45

COURSE OUTCOMES: Students will be able to

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CO1	Understand the sustainable use of natural resources in agriculture.
CO2	Identify environmental pollution sources and their impact from agriculture.
CO3	Apply EIA techniques for environmental planning in agricultural projects.
CO4	Utilize waste management techniques for environmental protection.
CO5	Implement climate-resilient and sustainable agricultural practices.

Text Books	
1.	Rattan Lal and B.A. Stewart, *Soil and Environmental Management*, CRC Press, 2020.
2.	N.T. Kumbhar, *Environmental Management in Agriculture*, Himalaya Publishing House, 2018.
3.	G.N. Tiwari and R.K. Mishra, *Environmental Pollution and Management*, Narosa Publishing House, 2015.

References	
1.	D.W. Sims, *Agricultural Waste Management*, FAO Publications.
2.	Shukla, S.K. & Pandey, P., *Climate Smart Agriculture*, Springer, 2021.
3.	EIA Guidelines – Ministry of Environment, Forest and Climate Change (MoEF&CC), Government of India.
4.	NPTEL: https://nptel.ac.in/courses/120108004

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B.E/ B.TECH	B23ADO601-HUMAN COMPUTER COMMUNICATION	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To outline the basic knowledge of HCI.
2.	To classify the design process and rules.
3.	To apply the evaluation techniques and HCI models.
4.	To make use of communications and human factors.
5.	To develop the understanding of user interface.

UNIT - I	INTRODUCTION TO HCI	9

Introduction to HCI - A discipline involved in HCI- Importance of HCI - The psychology of everyday things - Principles of HCI - Input–output channels - Human memory -Thinking: reasoning and problem solving - Conceptual Models – Interface Metaphors – Interaction Types – Paradigms and Frameworks. Cognitive Aspects: Cognition – Cognitive Framework. Social Interaction – Emotional Interaction.

UNIT - II	HCI DESIGN PROCESS AND DESIGN RULES	9

The software design process - User focus – Scenarios - Navigation Design - Screen Design - Prototyping techniques - Wire-Framing - Understanding the UI Layer and Its Execution Framework, Model-View-Controller(MVC) Framework - Principles that support usability, Design standards, Design Guidelines, Golden rules and heuristics, User interface management system (UIMS).

UNIT - III	EVALUATION TECHNIQUES AND HCI MODELS	9

Goals of evaluation - Evaluation Criteria - Evaluation through expert analysis - Evaluation through user participation - Choosing an Evaluation Method - Goal and task hierarchy model - Linguistic model - Physical and device models - Cognitive architectures - Hierarchical task analysis (HTA) - Uses of task analysis - Diagrammatic dialog design notations - Computer mediated communication - Ubiquitous Computing.

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UNIT - IV	COMMUNICATION AND HUMAN FACTORS	9
Face-to-face Communication - Conversation - Text-based Communication - Group working - Dialog design notations - Diagrammatic notations - Textual dialog notations - Dialog semantics - Dialog analysis and design – Groupware - Meeting and decision support systems - Shared applications and artifacts - Frameworks for groupware Implementing synchronous groupware - Mixed - Augmented and Virtual Reality.		

UNIT - V	FUTURE OF HCI AND USER INTERFACE	9
The future of HCI - perceptual interfaces, context-awareness and perception –User centered design - Interfaces: Types – Natural User Interfaces, Importance of user Interface and good design - Principles of user interface. - The graphical user interface – popularity of graphics, the concept of direct manipulation - graphical system - Characteristics - Web user – Interface popularity.		
		Total Instructional hours: 45

Course Outcomes: Students will be able to	
CO1	Illustrate the importance of human computer interaction.
CO2	Explain the design process and design rules.
CO3	Develop the understanding of evaluation techniques and HCI models.
CO4	Demonstrate the concept of communication and human factors.
CO5	Apply the user centered deign methods.
	Text Books
1.	A Dix, Janet Finlay, G D Abowd, R Beale., Human-Computer Interaction, 3rd Edition, Pearson Publishers,2018
2.	Wilbert O. Galitz, "The Essential Guide to User Interface Design: An Introduction to Gui Design Principles and Techniques", Third Edition, John Wiley Sons, 2017..
Reference Books	
1.	Sharp, H., Rogers, Y., and Preece, J, "Interaction Design: Beyond Human – Computer Interaction", Third Edition, John Wiley & Sons, Inc., 2021.
2.	Shneiderman, Plaisant, Cohen and Jacobs, Designing the User Interface: Strategies for Effective Human Computer Interaction, 5th Edition, Pearson Publishers, 2020.

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B.E / B.Tech	B23AMO601 - AI FOR SMART SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To recall the different types of AI based on capabilities and functionality
2.	To discuss the ethical implications of AI and how they affect societal impact
3.	To analyze a case study of AI-enhanced weather forecasting and evaluate its effectiveness in agricultural applications
4.	To evaluate the potential future trends and ethical dilemmas in the integration of AI in healthcare and autonomous systems
5.	To design a functional interactive AI system, such as a food delivery app, integrating AI technologies like voice recognition and user interaction design

UNIT - I	INTRODUCTION TO ARTIFICIAL INTELLIGENCE	9
Basics of AI: Definition and origins - Intelligence and its measurement - History and evolution of AI technologies - Overview of AI applications in smart systems - Types of AI: Based on Capabilities and Functionality - The Role of Ethics in AI Governance - Symbolic AI vs. Connectionist AI - Autonomous Vehicles and Intelligent Transportation Systems		

UNIT – II	AI METHODOLOGIES AND TECHNIQUES	9
Introduction to Robotics and AI – Ethics of AI – Machine learning basics – Supervised learning - Unsupervised learning – AI in smart homes - Impact of AI in society		

UNIT – III	ADVANCED AI TOPICS	9
Soft Computing: Overview and applications - Chat Bots and Conversational AI: Design and development - AI in Cyber-Physical Systems: Integration and challenges - AI-enabled IoT: Concepts – Case study : Agriculture: AI-Enhanced Weather Forecasting		

UNIT – IV	APPLICATIONS OF AI IN SMART SYSTEMS	9
AI in Healthcare: Diagnostics and personalized medicine - AI in Automotive Systems: Autonomous vehicles - AI in Robotics: Intelligent control and navigation - Ethical considerations and future trends in AI		

UNIT – V	INTERACTIVE AI SYSTEM DESIGN	9
Fundamentals of Human-AI Interaction - Role of AI in personal assistants – Interactive AI in customer service – AI in Education – Voice recognition systems - Future Trends in Interactive AI Design - Case Study: Designing an Interactive Food Delivery App		

Total Instructional hours: 45

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Course Outcomes : Students will be able to	
CO1	Recall the definition and origins of AI, including its historical evolution and types based on capabilities and functionality.
CO2	Apply AI methodologies, such as machine learning, to analyze and solve problems in smart home systems.
CO3	Evaluate the effectiveness of AI in solving real-world problems.
CO4	Discuss the ethical considerations and predict future trends in the development of AI technologies.
CO5	Analyze trends in the future of interactive AI design, including advancements in voice recognition systems and their potential impact on different sectors.

Text Books	
1.	Khan, I. U., Ouaissa, M., Ouaissa, M., Fayaz, M., & Ullah, R., Artificial Intelligence for Intelligent Systems: Fundamentals, Challenges, and Applications, CRC Press, 1st Edition, 2024.
2.	Ramana, T. V., Ghantasala, G. S. P., Sathiyaraj, R., & Khan, M., Artificial Intelligence and Machine Learning for Smart Community, CRC Press, 1st Edition, 2023.

Reference Books	
1.	P, M., Kumar, M. V., & Umamaheswari, R., Machine Learning and IoT for Intelligent Systems and Smart Applications, CRC Press, 1st Edition, 2022.
2.	Venkatesh, C., Rengarajan, N., Ponmurugan, P., & Balamurugan, S., Smart Systems for Industrial Applications, Scrivener Publishing, 1st Edition, 2022.
3.	Tanwar, R., Bhatia, S., Sapra, V., & Ahuja, N. J. (Eds.). (2024). Artificial Intelligence and Machine Learning: An Intelligent Perspective of Emerging Technologies. CRC Press.
4.	Kose, U., Prasath, V. B., Mondal, M., Podder, P., & Bharati, S. (Eds.). (2022). Artificial Intelligence and Smart Agriculture Technology. *Auerbach Publications.*

B.E / B.Tech	BM23BMO601- MEDICAL INSTRUMENTATION	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the electrode behavior and amplifiers
2.	To gain knowledge of various biopotential measurement
3.	To familiarize various electrical and non-electrical physiological parameters.
4.	To learn biochemical measurement
5.	To learn recent trends for biomedical applications

UNIT - I	BIOPOTENTIAL ELECTRODES AND AMPLIFIERS	9
Cell potential- Resting and Action potential, Electrode Electrolyte Interface, Types of electrodes, Bio signal characteristics– frequency and amplitude ranges, Bioamplifier, isolation amplifiers – transformer and optical isolation, Artifacts and removal.		

UNIT - II	BIOPOTENTIAL MEASUREMENT	9
ECG – Einthoven 's triangle, standard 12 lead system, block diagram. Measurement of heart sounds - PCG. EEG – 10-20 electrode system, unipolar, bipolar and average mode, Functional block diagram. EMG – unipolar and bipolar mode, block diagram, EOG and ERG		

UNIT - III	PHYSIOLOGICAL PARAMETER MEASUREMENT	9
Temperature, Respiration rate and pulse rate measurements, Plethysmography, Pulse oximetry, Blood Pressure measurement-direct and indirect method. Blood flow - Ultrasound blood flow measurement. Cardiac output measurement- Indicator dilution, dye dilution and thermodilution method, GSR Measurement, Patient Monitoring system		

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UNIT - IV	BIOCHEMICAL MEASUREMENT	9
Blood gas Analyzer, Blood Glucose measurement, colorimeter, flame photometer, spectrophotometer, blood cell counter, auto analyser.		
UNIT - V	**RECENT TRENDS**	**9**
Point of care devices, Endoscopy unit, Radio pill, laproscopy, Applications of Laser in medicine, cryogenic application. Biotelemetry, Telemedicine, m-health.		
		Total Instructional hours : 45

Course Outcomes: Students will be able to	
CO1	Understand the electrode behavior
CO2	Comprehend the fundamentals of Bio potential recording.
CO3	Design various bio amplifiers
CO4	Measure various electrical and non-electrical physiological parameters.
CO5	Understand different monitoring system

Text book	
1.	Joseph J. Carr and John M. Brown, "Introduction to Biomedical equipment technology",Pearson Education, 4th Edition, 2014.
	John G.Webster, "Medical Instrumentation Application and Design", John Wiley and and Sons,New York, 4th Edition, 2009.

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Reference Books	
1.	Khandpur R.S, “Handbook of Biomedical Instrumentation”, Tata McGraw Hill, New Delhi,3 rd Edition, 2014.
2.	Richard Aston, “Principles of Biomedical Instrumentation and Measurement” Merril PublishingCompany, 1990.
3.	L.A Geddes and L.E.Baker, “Principles of Applied Biomedical Instrumentation”, 3 rd Edition,John Wiley and Sons, Reprint 2008.

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B. Tech.	B23BTO601 – BIOINFORMATICS	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To know the knowledge of databases and its maintenance.
2.	To provide the basic concept of various algorithms
3.	To deliver the knowledge on protein designing and its interactions.

Pre-requisite (if any)
Biochemistry, Molecular Biology, Protein Engineering

UNIT 1	**INTRODUCTION TO BIOINFORMATICS**	**9**
Scope of Bioinformatics, Databases- DBMS, Biological databases-classification-importance, Sequence Databases- GenBank, NCBI, DDBJ, EMBL, UniProt, SWISS-PROT, PIR, TrEMBL, Structural Databases-PDB, SCOP, CATH, pfam.		
UNIT 2	**SEQUENCE ANALYSIS**	**9**
Sequence Alignment- Sequence Homology Vs Sequence Identity Vs Sequence Similarity, Types of Sequence alignment methods- PSA, MSA, Scoring Function and Substitution Matrices-PAM & BLOSUM, Algorithms-Needleman-Wunch & Smith-Watermann, BLAST and its types, FASTA.		
UNIT 3	**PHYLOGENETIC RELATIONSHIPS**	**9**
Introduction to Phylogenetics-Parts of Phylogenetic Tree-Types of trees, Molecular Clock Theory, Distance Based Method- UPGMA, NJ, Character Based Method- Maximum Parsimony Method, Maximum Likelihood Method, Method of evaluating phylogenetic tree- Bootstrapping, Jackknife resampling, Data perturbation.		
UNIT 4	**STRUCTURAL ANALYSIS**	**9**
Protein Structure Visualization, Structural Prediction- Primary structure & Secondary Structure, tertiary Structure-Homology Modelling, Hidden Markov Model, Threading, Ab-initio method, Validation by Ramachandran plot.		
UNIT 5	**APPLICATIONS**	**9**
System Biology-Introduction and its importance, Microarray Data analysis, Approaches to drug designing and discovery.		
		Total Instructional Hours: 45

Course Outcomes After the successful completion of the course, the students will be able to,		**Knowledge Level**
CO1	Examine various biological databases.	K4
CO2	Compare genomic and proteomic sequences using various bioinformatics tools.	K5
CO3	Measure the evolutionary relationship using phylogenetic methods	K5
CO4	Compare vast genomic and proteomic dataset.	K5
CO5	Develop basic bioinformatics scripts with Perl programming.	K6

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Text Books	
1.	Introduction to Bioinformatics by Arthur K. Lesk, Oxford University Press. ,4th edition 2014
2.	Algorithms on Strings, Trees and Sequences by Dan Gusfield, Cambridge University Press. 1999
3.	Biological Sequence Analysis Probabilistic Models of proteins and nucleic acids by R.Durbin, S.Eddy, A.Krogh, G.Mitchison, Cambridge University Press. 2013
4.	Bioinformatics Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor Laboratory Press. 2^{nd} edition, 2004.

Reference Books	
1.	Next Generation Sequencing Data Analysis, by Xinkun Wang CRC Press 2016

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	3	2	3	3	3	2	3	3	2	3
CO2	3	2	3	3	2	2	2	3	1	3	3	3	3	2
CO3	3	3	2	2	3	3	2	2	2	3	2	2	3	3
CO4	2	3	2	3	3	3	3	3	2	2	2	3	2	3
CO5	3	3	3	2	2	3	2	3	3	3	3	3	2	2
Wt. Avg.	**2.8**	**2.6**	**2.6**	**2.4**	**2.6**	**2.6**	**2.4**	**2.8**	**2.2**	**2.6**	**2.6**	**2.8**	**2.4**	**2.6**

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B.E.	B23CSO601- FOUNDATIONS OF WEB DEVELOPMENT (Except CSE)	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To introduce the structure of websites and fundamental web technologies such as HTML5 and CSS3.
2.	To understand basic programming concepts using Java for web development.
3.	To explore dynamic client-side functionalities using JavaScript and DHTML.
4.	To identify the role of server-side programming and databases in web applications.
5.	To apply web development knowledge for building basic interactive applications.

UNIT - I	BASICS OF WEB	9
Basics of Internet – Web Clients and Servers – HTTP Protocol – Web Communication. HTML5: Tags, Forms, Tables, Lists, Multimedia Integration (Audio, Video). CSS3: Styling Text and Layout – Inline, Embedded, External Style Sheets – Responsive Layout		
UNIT - II	**PROGRAMMING CONCEPTS**	**9**
Need for Programming in Web Development – Java Overview – Simple Java Program Structure – Variables, Data Types, Operators, Control Structures – Arrays – Methods – Introduction to Classes and Objects (no inheritance). Use of Java in Web and GUI Applications		
UNIT - III	**JAVASCRIPT AND DYNAMIC WEB PAGES**	**9**
JavaScript Basics: Variables, Operators, Conditional Statements, Loops – Functions. Working with Forms – Validations – DOM Manipulation – Popups and Events. DHTML: Combining HTML, CSS, JavaScript for Simple Interactions.		
UNIT - IV	**SERVER-SIDE PROGRAMMING BASICS**	**9**
Overview of Server-Side Scripting – Introduction to Java Servlets – Servlet Lifecycle – Handling Form Data using GET and POST – Session Management – Basics of Cookies. Web Server Setup: Apache Tomcat (Overview and Setup).		

UNIT - V	DB CONNECTIVITY AND APPLICATIONS	9
Basics of Database for Web – Introduction to JDBC – Connecting Java Applications to Databases – Sample Data Insertion and Retrieval – Use Cases in Industry and Healthcare Systems. Mini Case Study: Simple Web Application with Form Input and Database Storage.		
		Total Instructional hours: 45

Course Outcomes: Students will be able to	
CO1	Outline core components of web applications including HTML5 and CSS3.
CO2	Apply basic Java programming for developing interactive functionalities
CO3	Develop dynamic client-side interactions using JavaScript and DHTML
CO4	Explain the workflow of server-side programs and sessions using Java servlets
CO5	Construct a simple web application integrating frontend, server-side logic, and database

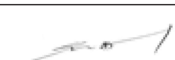
Text Books	
1.	Kogent Learning Solutions Inc., Web Technologies Black Book, Dreamtech Press, 2018.
2.	Budi Kurniawan, Servlet & JSP: A Tutorial, 2nd Edition, Brainy Software Inc., 2015.

Reference Books	
1.	Deitel P.J. & Deitel H.M., Internet and World Wide Web How to Program, Pearson Education, 2020.
2.	Jeffrey C. Jackson, Web Technologies: A Computer Science Perspective, Pearson Education, 2011.
3.	Herbert Schildt, Java: A Beginner's Guide, McGraw-Hill, 2018.

CO Mapping with PO & PSO

CO/PO & PSO		PO1 (K3)	PO2 (K4)	PO3 (K5)	PO4 (K5)	PO5 (K6)	PO6 (K3) (A3)	PO7 (K2) (A3)	PO8 (K3) (A3)	PO9 (A3)	PO10 (A3)	PO11 (K3) (A3)	PO12 (A3)	PSO1 (K4) (A3)	PSO2 (K3) (A3)
CO1	K2														
CO2	K3														
CO3	K3														
CO4	K2														
CO5	K3														
Weighted Average															

3 – Substantial **2- Moderate** **1- Low** **'-' – No Correlation**



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B.E / B. TECH	B23ECO601 - WIRELESS TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives	
1.	Understand Introduction about wireless Communication.
2.	Study the basic concepts of channel modeling.
3.	Learn the access schemes in wireless communication.
4.	Understand channel capacity in wireless communication system.
5.	Learn evolution of wireless technologies.

UNIT I INTRODUCTION	9
Introduction to wireless communication systems-Cellular concept – system design fundamentals Handoff Strategies- Interference and system capacity, Improving Coverage and Capacity	

UNIT II CHANNEL MODELING	9
Free space propagation model, Reflection- Diffraction — Scattering - Log-normal shadowing. Small-scale multipath propagation, Types of small-scale fading, Rayleigh and Ricean distribution, Input /output model of the wireless channel-Time and frequency coherence-Statistical channel models	
UNIT III ACCESS SCHEMES AND DIVERSITY	**9**
FDMA, TDMA, CDMA, SDMA and CSMA, OFDMA. Diversity Techniques—Frequency diversity, Time diversity, Code diversity, Antenna diversity–RAKE Receiver-SIMO, MISO, MIMO, MIMO-OFDM Technique	
UNIT IV CAPACITY OF WIRELESS CHANNELS	**9**
AWGN channel capacity — capacity of flat fading channels, Frequency-selective fading channels, Multiuser capacity, Downlink channel capacity, Uplink channel capacity, Outage capacity	
UNIT V EVOLUTION OF WIRELESS TECHNOLOGIES	**9**
Mobile Technologies - GSM, 3G, 4G (LTE) and 5G technologies, Wireless LAN Technologies and WLL.	
	Total Instructional hours: 45

Approved by BOS Chairman

Course Outcomes: Students will be able to	
CO1	Learn fundamentals of wireless communication.
CO2	Understand the concepts of channel modeling.
CO3	Study various access schemes in wireless communication.
CO4	Understand channel capacity in wireless networks.
CO5	Learn evolution of wireless technologies.

Text Books	
1.	Andrea Gold smith, " Wireless Communications", Cambridge University Press, 2012.
2.	DavidTse, Pramod Viswanath, "Fundamentals of Wireless Communication", Cambridge University Press, 2015.

Reference Books	
1.	Kamilo Feher,"Wireless Digital Communications, Modulation & Spread Spectrum Applications", PHI, 2015.
2.	William C.Y.Lee, "Mobile Communication Engineering", McGraw Hill, 2014.
3.	Theodore S.Rappaport, "Wireless Communications", Pearson Education,2017
4.	Andreas F.Molisch,"Wireless Communications", Wiley, 2011.
5.	Learn evolution of wireless technologies.

<table>
<tr><th colspan="5">Evaluation Pattern:</th></tr>
<tr><th colspan="4">Continuous Internal Assessment</th><th>End Semester Examinations</th></tr>
<tr><td colspan="2">CIA I (Theory)
(100 Marks)</td><td colspan="2">CIA II (Theory)
(100 Marks)</td><td rowspan="3">Theory End Semester Examinations
(Examinations will be conducted for 100 Marks)</td></tr>
<tr><td>* Alternate Assessment Tool (AAT)</td><td>Written Test</td><td>* Alternate Assessment Tool (AAT)</td><td>Written Test</td></tr>
<tr><td>40 Marks</td><td>60 Marks</td><td>40 Marks</td><td>60 Marks</td></tr>
<tr><td colspan="4">40 Marks</td><td>60 Marks</td></tr>
<tr><th colspan="5">Total: 100 Marks</th></tr>
</table>

- AAT - Individual Assignment/ Case Study/ Seminar/ Mini project/ MCQ/ Role Play/ Group Discussion/ Debates/ Oral Presentations/ Poster Presentations/ Technical Presentations can also be provided course coordinator can choose any one/two components based on the nature of the course.

Approved by BOS Chairman

B.E	B23EEO601 – GREEN ELECTRONICS AND SUSTAINABLE TECHNOLOGIES	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the fundamentals of Green Electronics.
2.	To explain sustainable materials and design practices.
3.	To reveal the renewable energy in Electronics.
4.	To understand the E-Waste management and recycling strategies.
5.	To explain the emerging trends in sustainable technologies.

UNIT-I	Introduction to Green Electronics	9

Overview of Green Electronics and Sustainability-Environmental Impact of Electronic Waste (E-Waste)- Energy Consumption in Electronics Manufacturing-Green Engineering Principles-Life Cycle Assessment (LCA) of Electronic Devices.

UNIT-II	Sustainable Materials and Design	9

Eco-friendly and Biodegradable Electronic Materials-Sustainable Circuit Design Techniques-Low-power and Energy-efficient Semiconductor Technologies-Flexible and Organic Electronics-Sustainable PCB (Printed Circuit Board) Manufacturing.

UNIT-III	Renewable Energy for Electronics	9

Solar Energy: Photovoltaics in Electronics-Energy Harvesting Techniques (Piezoelectric, Thermoelectric, etc.)- Battery Technologies and Green Energy Storage Solutions- Supercapacitors and Fuel Cells for Sustainable Electronics-Smart Grid and IoT for Energy Efficiency.

UNIT-IV	Waste Management and Recycling of Electronics	9

E-Waste Recycling Techniques and Challenges-Circular Economy in Electronics-Regulations and Policies for Electronic Waste Management-Extended Producer Responsibility (EPR)- Case Studies on Successful E-Waste Management.

UNIT-V	Emerging Trends and Future of Green Electronics	9

AI and IoT for Energy-efficient Systems-Sustainable Computing and Cloud Technologies-Green 5G and Communication Technologies-Carbon Footprint Reduction in Semiconductor Industries-Future Innovations in Sustainable Electronics.

Total Instructional hours:45

Approved by BoS Chairman

Course Outcomes: **Students will be able to**	
CO1	Illustrate the concept of green electronics and sustainability.
CO2	Explain the Sustainable Materials and Design with low-power and energy-efficient semiconductor technologies.
CO3	Demonstrate green energy storage solutions such as batteries, supercapacitors, and fuel cells.
CO4	Interpret the principles of e-waste recycling and the circular economy.
CO5	Infer the advancements in green computing, energy-efficient communication, and semiconductor technologies.

Text Books	
1.	John Lamb, “Green Electronics/Green Bottom Line: A Commonsense Guide to Environmentally Responsible Engineering and Management”, CRC Press, 2007.
2.	Santosh K. Kurinec, Krzysztof Iniewski, “Energy-Efficient Computing and Electronics: Devices to Systems”, CRC Press, 2019.
3.	Sunil Kumar, Vineet Kumar, “Electronic Waste Management: Policies, Processes, Technologies, and Impact”, Wiley Publications, 2023.
4.	Wayne C. W. Chan, Alan C. L. Wong, “Sustainable Electronics and Photonics”, Wiley publications, 2021.

Reference Books	
1.	Mohammad S. Obaidat, Alagan Anpalagan, Isaac Woungang, “Handbook of Green Information and Communication Systems”, Academic Press, 2013.
2.	Kaka Ma, “Sustainable Materials and Green Processing for Energy Conversion”, Trans Tech Publications, Elsevier, 2021
3.	Muhammad Zaffar Hashmi, Ajit Varma, “Environmental Impact of Electronic Waste and Sustainable Recycling Methods”, Springer, 2019.

Approved by BoS Chairman

B.E. / B.Tech	B23MEO601 - 3D PRINTING AND TOOLING	T	P	TU	C
		3	0	0	3

Course Objectives	
1.	To explore the technology used in additive manufacturing.
2.	To develop CAD models for 3D printing.
3.	To acquire knowledge, techniques and skills to select relevant additive manufacturing process.
4.	To select a 3D printing process for an application.
5.	To produce a product using 3D Printing or Additive Manufacturing (AM).

UNIT - I	INTRODUCTION TO ADDITIVE MANUFACTURING (AM)	9

Overview – History – Need – classification - Additive Manufacturing Technology in product development – Materials for Additive Manufacturing.

UNIT - II	CAD AND REVERSE ENGINEERING	9

Basic concept – 3D scanning – digitization techniques – Model reconstruction – data processing for reverse engineering - Additive Manufacturing Technology : CAD model preparation – Part orientation and support generation – Model slicing – Tool path generation.

UNIT - III	LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING	9

Classification – liquid based system – stereo lithography apparatus (SLA) – principle, process, advantages and applications – solid based system – Fused Deposition Modeling – principle, process, advantages.

UNIT - IV	LASER BASED ADDITIVE MANUFACTURING SYSTEMS	9

Selective laser sintering – principles of SLS process – process, advantages and applications, 3D Printing - principle, process, advantages - Laser Engineered Net Shaping (LENS).

Approved by BoS Chairman

UNIT - V	RAPID TOOLING AND APPLICATIONS OF ADDITIVE MANUFACTURING	9
Principles and typical process for quick batch production of plastic and metal parts through quick tooling – applications for Aerospace, defence, automobile, Bio-medical and general engineering industries		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Understand the importance of Additive Manufacturing.
CO2	Apply technique of CAD and reverse engineering for geometry transformation in Additive Manufacturing.
CO3	Define the various process used in Additive Manufacturing.
CO4	Identify and select suitable process used in Additive Manufacturing.
CO5	Understand the basic concept of quick tooling and additive manufacturing application.

Text Books	
1.	Lan Gibson, David W. Rosen and Brent Stucker, “Additive Manufacturing Technologies : Rapid Prototyping to Direct Digital Manufacturing”, Springer, 2010.
2.	Andreas Gebhardt, “Understanding Additive Manufacturing : Rapid Prototyping, Rapid Tooling, Rapid Manufacturing”, Hanser Publisher, 2011.
3.	Khanna Editorial, “3D Printing and Design”, Khanna Publishing House, Delhi.

Reference Books	
1.	J.D. Majumdar and I. Manna, “Laser-Assisted Fabrication of Materials”, Springer Series in Material Science, 2013.
2.	Dougles Bryden, “CAD and Prototyping for Product Design”, 2014.
3.	CK Chua, Kah Fai Leong, “3D Printing and Rapid Prototyping- Principles and Applications”, World Scientific, 2017.

Approved by BoS Chairman

B.E / B.TECH	B23CBO601 DATA SCIENCE FOR BUSINESS ANALYTICS	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To introduce the basic concepts of Data Science.
2.	To understand the Analytics Life Cycle.
3.	To understand the process of acquiring Business Intelligence & various types of analytics for Business Forecasting
4.	To model the supply chain management for Analytics.
5.	To apply analytics for different functions of a business

UNIT- I Introduction to Data Science	9
Need for Data Science – Benefits and uses – Facets of data – Types of data- Organization of data - Data Science process- Data Science life cycle- Role of Data Science - Big Data – sources and characteristics of Big Data	

UNIT-II Introduction to Business Analytics	9
Analytics and Data Science – Analytics Life Cycle – Types of Analytics – Business Problem Definition – Data Collection – Data Preparation – Hypothesis Generation – Modeling – Validation and Evaluation – Interpretation – Deployment and Iteration	

UNIT- III Business Intelligence & Forecasting	9
Data Warehouses and Data Mart – Knowledge Management –Types of Decisions – Decision-Making Process – Decision Support Systems – Business Intelligence –OLAP – Analytic functions - Introduction to Business Forecasting and Predictive analytics – Logic and Data-Driven Models – Data Mining and Predictive Analysis Modeling –Machine Learning for Predictive analytics.	

Approved by BoS Chairman

UNIT- IV HR & Supply Chain Analytics	**9**
Human Resources – Planning and Recruitment – Training and Development – Supply chain network – Planning Demand, Inventory and Supply – Logistics – Analytics applications in HR & Supply Chain. Apply HR Analytics to make a prediction of the demand for hourly employees for a year.	

UNIT- V Marketing & Sales Analytics	**9**
Marketing Strategy, Marketing Mix, Customer Behaviour –selling Process – Sales Planning – Analytics applications in Marketing and Sales. Do predictive analytics for customers' behaviour in marketing and sales.	
Total Instructional hours: 45	

Course Outcomes: Students will be able to	
CO1	Understand the data science basics and its life cycle.
CO2	Understand the role of data science in business decision-making and strategy formulation.
CO3	Apply business intelligence tools and analytic functions.
CO4	Apply analytics in various HR functions such as recruitment, planning, and training.
CO5	Use predictive analytics to interpret and forecast customer behavior in marketing and sales contexts.

Text Books:
1. David Cielen, Arno D. B. Meysman, and Mohamed Ali, "Introducing Data Science", Manning Publications, 2016.
2. Efrain Turban, Jay E.Aronson, Teng-Peng Liang, Ramesh Sharada "Decision Support Systems and Intelligent Systems" 8th Edition, Pearson Education, 2007.

Reference Books :
1. R. Evans James, Business Analytics, 2017.
2. Joel Grus, "Data Science from Scratch: First Principles with Python", O'Reilly Media, 2017.
3. R N Prasad, Seema Acharya, Fundamentals of Business Analytics, 2016.

Approved by BoS Chairman

MANDATORY COURSE I

B.E / B.Tech	B23MCT501- Environmental Sustainability (Common to ALL)	L	T	P	C
		2	0	0	0

Course Objectives	
1.	To understand ecosystems and the environment, including how they work and their importance.
2.	To learn about biodiversity and ways to protect endangered species.
3.	To Identify causes and solutions for pollution and waste management.
4.	To explore natural resources and how human activities affect them.
5.	To discuss global issues like climate change, population growth, and sustainable living.

SYLLABUS:

UNIT - I	ENVIRONMENT AND ECOSYSTEM	6
Scope and importance of environment - concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers –energy flow in the ecosystem - food chains and food webs – structure and function of the (a) forest ecosystem (b) desert ecosystem (c) aquatic ecosystems (pond & marine).		

UNIT - II	BIODIVERSITY	6
Introduction to Biodiversity: Genetic, species and ecosystem diversity. Value of biodiversity - hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.		

UNIT - III	ENVIRONMENTAL POLLUTION	6
Causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) soil pollution - solid waste management: causes, effects and control measures of municipal solid wastes.		

Approved by BoS Chairman

UNIT - IV	NATURAL RESOURCES	6
Forest resources: Use and over-exploitation, deforestation - Water resources: Use and over-utilization of surface and ground water - Land as a resource, land degradation, man induced landslides, soil erosion and desertification.		

UNIT - V	HUMAN POPULATION, SOCIAL ISSUES AND THE ENVIRONMENT	6
Population growth, variation among Nations – Population explosion. climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust.		
	TOTAL INSTRUCTIONAL HOURS	30

Course Outcomes: Students will be able to	
CO1	Explain the structure and function of various ecosystems and explain the flow of energy through food chains and food webs.
CO2	Relate the types, values, and threats to biodiversity and differentiate between in-situ and ex-situ conservation methods.
CO3	Summarize the causes and impacts of major types of environmental pollution and suggest appropriate control measures.
CO4	Interpret the usage and over-exploitation of natural resources and analyse their environmental consequences.
CO5	Outline the impact of human population growth and social issues on environmental degradation and global climate phenomena.

Text Books	
1.	Gilbert M. Masters, ‘Introduction to Environmental Engineering and Science’, 2nedition,Pearson Education, 2004.
2.	Benny Joseph, ‘Environmental Science and Engineering’, Tata McGraw-Hill, New Delhi, 2006

Reference Books	
1.	G.Tyler Miller and Scott E. Spoolman, —’Environmental Science’,Cengage LearningIndia Pvt, Ltd, Delhi, 2014
2.	Erach Bharucha, —Textbook of Environmental Studies‖, Universities Press (I) PVT, LTD, Hydrabad, 2015.

Approved by BoS Chairman

B.E / B.Tech	B23MCT502 - ELEMENTS OF LITERATURE (Common to ALL)	L	T	P	C
		2	0	0	0

Course Objectives	
1.	To understand and identify key literary elements in various texts.
2.	To analyze how authors use literary devices to convey themes and messages.
3.	To examine how character, setting, plot, and other elements contribute to the overall meaning of a work.
4.	To appreciate the different forms and genres of literature.
5.	To develop writing and analytical skills through discussions, essays, and presentations.

UNIT-I	INTRODUCTION TO LITERARY ELEMENTS	6

- **Overview of Literary Elements:** Definition and significance of literary elements
- **Introduction to the core components:** plot, setting, character, theme, and conflict
- Understanding literary genres (fiction, poetry, drama, nonfiction)

UNIT-II	PLOT AND STRUCTURE	6

- The five stages: Exposition, Rising Action, Climax, Falling Action, Resolution
- Types of conflict (man vs. man, man vs. self, man vs. nature, etc.)
- Plot devices (foreshadowing, flashbacks, etc.)

UNIT-III	CHARACTERIZATION	6

- **Types of Characters:** Protagonist, antagonist, dynamic, static, round, flat, etc. Direct vs. indirect characterization
- **Character Development:**
- How characters change or grow throughout a story
- Analyzing motivations, conflicts, and relationships

UNIT-IV	SETTING	6

- **Understanding Setting:**
- The time, place, and social environment of a story
- How setting influences plot and character development
- Symbolism and mood created through setting

Approved by BoS Chairman

UNIT-V	ANALYZING LITERARY WORKS	6
• **Close Reading and Analysis:** • Developing analytical skills through in-depth examination of texts • Understanding the role of diction, syntax, and tone in literature • **Comparative Analysis:** • Comparing works of literature across genres or time periods • Drawing connections between themes, characters, and literary devices		
	Total Instructional hours:30	

Course Outcomes: Students will be able to	
CO1	Identify and Interpret Literary Elements. (K2)
CO2	Analyze Literary Devices. (K4)
CO3	Evaluate Narrative Structure. (K5)
CO4	Explore various literary forms and genres. (K3)
CO5	Develop Critical Thinking and Writing Skills. (K6)

Text Books	
1.	Narayan RK, “Malgudi Days”, Indian Thought Publications, New York, 2015
2.	Shaw, George Bernard, “Greatest works of George Bernard Shaw”, Maple Press, 2010
3.	Nair, Anita, “Ladies Coupe-A Novel in Parts”, Penguin Books, 2014

Reference Books	
1.	Abram, “A Glossary of Literary Terms”, Thomson India, 2008
2.	Trivedi, “India’s Shakespeare”, Pearson, 2008
3.	Orwell, George “Animal Farm”, Penguin Books Press, India, March 2011.
4.	Shakespeare, William “As You Like It”, Om Books International published, 2025.
5.	Allan Poe, Edgar, “The Raven”, Penguin Books Press, India, Oct 2013
6.	O. Henry, “The Gift Of The Magi”, Arcadia Publishing, December 2024

B.E / B.Tech	B23MCT503 - FOUNDATIONS OF YOGA	L	T	P	C
		2	0	0	0

Course Objectives	
1.	To introduce the fundamental concepts and philosophy of Yoga and its relevance to modern life.
2.	To develop awareness of the physical, mental, and emotional benefits of Yoga through an understanding of its principles.
3.	To impart knowledge about the ethical and moral foundations of Yoga as described in Patanjali's Yoga Sutras (Yama, Niyama, etc.).
4.	To promote a healthy and disciplined lifestyle by integrating Yogic practices and values into daily routines.
5.	To enable students to manage stress and enhance concentration through the theoretical understanding of pranayama, meditation, and yogic relaxation techniques.

SYLLABUS:

UNIT - I	INTRODUCTION TO YOGA	6

- Definition, origin and evolution of Yoga.
- Aim, objectives, and relevance of Yoga in modern life.
- Different schools of Yoga (Raja Yoga, Karma Yoga, Bhakti Yoga, Jnana Yoga, Hatha Yoga).

UNIT - II	HEALTH AND YOGA	6

- Concept of health in Yoga.
- Holistic approach of Yoga to health and well-being.
- Role of Yoga in stress management.
- Yoga as preventive and therapeutic tool.

UNIT - III	YOGIC LIFESTYLE	6

- Yogic principles of food and diet.
- Importance of discipline (Yama, Niyama) in daily life.
- Daily routine and time management.
- Positive thinking and mental hygiene through Yoga.

Approved by BoS Chairman

UNIT - IV	ASANAS	6

- Standing Asanas: Tadasana, Trikonasana, Vrikshasana.
- Sitting Asanas: Padmasana, Vajrasana, Ardha Matsyendrasana.
- Lying Asanas: Bhujangasana, Shalabhasana, Sarvangasana, Savasana.
- Benefits and precautions.

UNIT - V	MEDITATION AND RELAXATION	6

- Basics of Meditation.
- Guided Meditation Techniques.
- Yoga Nidra / Deep Relaxation Technique (DRT).
- Stress management through meditation.

	TOTAL INSTRUCTIONAL HOURS	30

Course Outcomes: Students will be able to	
CO1	Illustrate the origin, definition, and philosophy of Yoga and its significance in holistic well-being.
CO2	Explain the principles and practices of Ashtanga Yoga as outlined by Patanjali.
CO3	Outline the role of Yoga in promoting physical health, mental clarity, and emotional stability.
CO4	Interpret the ethical and lifestyle principles of Yoga (Yama and Niyama) for personal development.
CO5	summarize how Yogic practices help in stress management and enhancing concentration in daily life.

Text Books	
1.	Light on Yoga – B.K.S. Iyengar. Publisher: HarperCollins,1966
2.	Patanjali Yoga Sutras – Swami Vivekananda commentary, Publisher: Advaita Ashrama, 1896.

Reference Books	
1.	Yoga for Health – Swami Kuvalayananda. *Publisher: Kaivalyadhama, Lonavala 1931.*
2.	Common Yoga Protocol – Ministry of AYUSH, Govt. of India, 2015

Approved by BoS Chairman

B.E /B.Tech	B25MCT504- EXPORT IMPORT MANAGEMENT (Common to ALL)	L	T	P	C
		2	0	0	0

Course Objectives	
1.	To learn the basics of international trade and its importance for businesses.
2.	To understand how goods are transported, paid for, and insured in global trade.
3.	To know how to choose the right products and markets for export.
4.	To get hands-on knowledge of export-import documents and procedures.
5.	To use digital tools and government support to grow your export business.

SYLLABUS:

UNIT - I	Introduction to Export and Import	6
Overview of International Trade, Importance of Export and Import in Business, International Trade Bodies and Local Regulatory Authorities, Export-Import Cycle: Step-by-Step Process, Online IEC (Import Export Code) Application, Myths and Opportunities in Global Trade.		

UNIT - II	Logistics, Transportation & Payment Terms	6
Types of Transportation in International Trade, Containers, Packaging, and Shipment Handling, IncoTerms: Delivery Terms, Costs & Risks, Payment Terms: Modes of Payment & Risk Involved, Insurance and Risk Management in Trade.		

UNIT - III	Product & Market Selection, Buyer Identification	6
Selecting the Right Product for Export, Market Research and Identifying Potential Markets, Importance of Trade Fairs & Exhibitions, Finding Genuine Buyers & Verification Process, Effective Communication with International Buyers.		

UNIT - IV	Export & Import Documentation and Procedures	6
Understanding Proforma Invoice & Letter of Credit (LC), Pre & Post Shipment Documents, GST, Customs Clearance & Compliance Procedures, How to Fill Pre & Post Shipment Documents – Practical Exercise, Import Documentation and Procedures.		

Approved by BoS Chairman

UNIT - V	Marketing, Incentives & Digital Trade Strategies	6
Export Incentives and Government Benefits, Pricing Strategies & Preparing Export Quotations, B2B Listing and Online Marketplaces, Digital Marketing & Social Media for Export Promotion, Buyer Calling, Data Collection & Product Portfolio Development.		

Course Outcomes: Students will be able to	
CO1	Explain the fundamentals of international trade, the role of trade bodies, and the complete export-import process. (K2)
CO2	Outline various transportation methods, Incoterms, packaging, payment terms, and risk management in international trade. (K2)
CO3	Apply knowledge to select suitable products and markets for export, identify genuine buyers, and effectively communicate in global trade. (K3)
CO4	Develop the ability to prepare and process export/import documentation, customs clearance, and GST compliance. (K3)
CO5	Utilize digital marketing, government incentives, and online platforms to develop export strategies and expand business opportunities. (K3)

Text Books	
1.	Thomas E. Johnson & Donna L. Bade, *Export/Import Procedures and Documentation*, 8th Edition, Ashgate Publishing, 2016.
2.	S. Tamer Cavusgil, Gary Knight, John R. Riesenberger, *International Business: The New Realities*, 3rd Edition, Pearson, 2017.
3.	P.K. Khurana, *Export-Import Theory, Practices, and Procedures*, 1st Edition, Atlantic Publishers & Distributors, 2016.
4.	Warren J. Keegan, Mark C. Green, *Global Marketing Management*, 9th Edition, Pearson, 2017.
5.	Francis Cherunilam, *International Trade and Export Management*, 9th Edition, Himalaya Publishing House, 2020

Approved by BoS Chairman

Reference Books	
1.	Anders Grath, *The Handbook of International Trade and Finance*, 3rd Edition, Kogan Page, 2020.
2.	Francis Cherunilam, *International Trade and Export Management*, 9th Edition, Himalaya Publishing House, 2020.
3.	V.K. Bhalla, *International Business: Theories and Practices*, 2nd Edition, Anmol Publications, 2020.
4.	S.K. Bhatia, *Export Management*, 1st Edition, Vikas Publishing House, 2018.
5.	R. Palaniappan, *International Trade and Export Management*, 1st Edition, Oxford University Press, 2019.

Approved by BoS Chairman

MANDATORY COURSE II

B.E / B.Tech	B23MCT601 – EDUCATION PSYCHOLOGY (Common to ALL)	L	T	P	C
		2	0	0	0

Course Objectives	
1.	To enable students to acquire knowledge about various methods of psychology.
2.	To gain knowledge about the concept of learning and its related theories.
3.	To understand motivation and its influence on human behaviour.
4.	To comprehend in-depth concepts of intelligence and creativity.
5.	To explain the concepts and theories of personality.

SYLLABUS:

UNIT - I	EDUCATIONAL PSYCHOLOGY AND HUMAN GROWTH AND DEVELOPMENT	6
Psychology: Meaning - Educational psychology: Meaning, scope and significance - Dimensions of human growth and development: Physical, cognitive, emotional, social, moral and language.		

UNIT - II	ATTENTION AND MEMORY	6
Attention: Meaning, nature and determinants of attention - Memory: Meaning, types of memory and Strategies for improving memory.		

UNIT - III	MOTIVATION AND LEARNING	6
Motivation: Meaning and definitions - Level of aspiration learning: Theories of learning and its educational implications Cognitive Theory: Jean Piajet, Behaviourist Theory- Pavlov's Classical, Conditioning.		

UNIT - IV	INTELLIGENCE AND CREATIVITY	6
Intelligence: Meaning, and types - Theories of Intelligence: Two factor, Thurston's Group factor - Intelligence Quotient (IQ) - Creativity: Concept, factors and process - Strategies for fostering creativity.		

UNIT - V	PERSONALITY	6
Personality: Meaning, definitions, and determinants of personality - Theories of Personality: Type, trait, and psychoanalytic Assessment of personality: Projective and non-projective techniques.		
TOTAL INSTRUCTIONAL HOURS		30

Course Outcomes: Students will be able to	
CO1	Explain various methods of psychology.
CO2	Describe the concept of learning and its related theories.
CO3	Discuss motivation and its influence on human behaviour.
CO4	Summarize the concepts of intelligence and creativity.
CO5	Interpret the concepts and theories of personality.

Text Books	
1.	Bert Laura, E. (2014). Child development. New Delhi: PHI Learning
2.	Chauhan, S. S. (2002). Advanced educational psychology. New Delhi: Vikas Publishing house.
3.	Hurlock, Elizabeth, B. (2015). Child development. New Delhi: McGraw Hill Education.
4.	Mangal, S.K. (2002). Advanced educational psychology. New Delhi: Prentice Hall of India.
5.	Matthews. G., Deary, L. J., & Whiteman, M.C. (2009). (2nd ed.). Personality: Theory and research. New York: Guilford Publications.

Reference Books	
1.	AnithaWoolfolk. (2004). Educational psychology. Singapore: Pearson Education.
2.	Cloninger, S.C. (2008) (5thed.). Theories of personality: Understanding persons. Englewood Cliffs, New Jersey: Prentice Hall.
3.	Schunk, D.H. (2007) (5thed.). Learning theories: An educational perspective. New York: Prentice Hall of India.
4.	Skinner, C.E. (2003) (4thed.). Educational psychology. New Delhi: Prentice Hall of India.
5.	Sprint Hall Norman, A, & Sprint Hall, Richard, C. (1990) (5thed.). Educational psychology: A developmental approach. New Delhi: McGraw Hill.

Approved by BoS Chairman

B.E / B.Tech	B23MCT602- Life Style Education (Common to ALL)	L	T	P	C
		2	0	0	0

Course Objectives	
1.	To understand the importance of a healthy lifestyle and its impact on overall well-being.
2.	To learn about balanced nutrition, the role of essential nutrients, and healthy eating habits.
3.	To explore the benefits of regular exercise and different types of physical activities.
4.	To identify common lifestyle diseases and strategies for their prevention.
5.	To develop mental wellness through stress management, mindfulness, and better sleep habits.

UNIT - I — Introduction to a Healthy Lifestyle — 6

- Definition & importance of a healthy lifestyle
- Nutrition, exercise, sleep, and mental well-being.
- Assessing current lifestyle habits.

UNIT - II — Nutrition & Balanced Diet — 6

- Macronutrients & micronutrients: Their roles and sources.
- Healthy eating habits and meal planning.
- Importance of hydration.
- Harmful effects of processed food and unhealthy eating habits.

UNIT - III — Physical Fitness & Exercise — 6

- Benefits of regular exercise on physical and mental health.
- Types of workouts: Cardio, strength training, yoga, and flexibility exercises.
- Designing a personalized fitness routine.

UNIT - IV — Lifestyle Diseases & Prevention — 6

- Causes and prevention of obesity, diabetes, heart disease, and hypertension.
- Role of diet, exercise, and mental health in disease prevention.
- Importance of regular health check-ups.

UNIT - V — Mental Health & Stress Management — 6

- Understanding stress, anxiety, and depression.
- Techniques for relaxation: Meditation, deep breathing, and mindfulness.
- Importance of sleep for overall health.
- Tips for improving sleep hygiene.

TOTAL INSTRUCTIONAL HOURS	30

Course Outcomes: Students will be able to	
CO1	Explain the importance of a healthy lifestyle and its key aspects like nutrition, exercise, sleep, and mental well-being.
CO2	Describe the role of nutrients, healthy eating habits, and the effects of processed food.
CO3	Summarize different types of exercises and their benefits for physical and mental health.
CO4	Identify common lifestyle diseases, their causes, and ways to prevent them.
CO5	Discuss stress, anxiety, and sleep issues, along with techniques to manage them.

Text Books	
1.	*Francesc García, Héctor,Miralles*, Ikigai: The Japanese Secret to a Long and Happy Life, Penguin Audio, 2017.
2.	Relationship, wellbeing and behaviour, Harry T. Reis, World Library of Psychological series, Reutledge, Taylor and Francis Group, 2018.

Reference Books	
1.	Shawn Achor, The Happiness Advantage: How a Positive Brain Fuels Success in Work and Life, Crown Currency, 2018.
2.	James Clear, Atomic Habits: An Easy & Proven Way to Build Good Habits & Break Bad Ones, Penguin Audio, 2018.

Approved by BoS Chairman

B.E / B.Tech	B25MCT603 STARTUP AND VENTURE FUNDING (Common to ALL)	L	T	P	C
		2	0	0	0

Course Objectives	
1.	To understand new venture creation opportunities, its resources, and requirements for Enterprise Start-up
2.	To understand the legal environment.
3.	To learn about the start-up environment and survival.
4.	To study the various funding availabilities for startups.
5.	To analyse the venture capital funding and its stages.

UNIT - I	Start-up An Overview	6
Introduction to start ups - The rise of startup economy – Ideation- Venture Choices - The Start-up Equation – The Entrepreneurial Ecosystem – Entrepreneurship in India. Government Initiatives.		

UNIT - II	Start-up Capital Requirements and Legal Environment	6
Identifying startup capital requirements - estimating startup cash requirements - Startup financing metrics – Risk mitigation strategies - The legal framework for startups - Incorporation and commencement of businesses and registration of a company.		

UNIT - III	Start-up Survival and Growth	6
Feasibility Study - Stages of growth of start-ups – Reasons for new start up failures- Scaling new ventures – preparing for change - Leadership succession. Support for growth and sustainability of the venture.		

UNIT - IV	Funding of Start Up Ventures	6
Financing Opportunities for startups – Equity investment process – Angel Investors - Funding startups with bootstrapping- crowd funding- strategic alliances.		

UNIT - V	Venture Capital Funding	6
Venture Capital – Meaning and features – Seed capital – Financing various stages of startup ventures – Exit strategy for venture capital funds.		

Course Outcomes: Students will be able to	
CO1	Implement entrepreneurship concepts in a start-up idea. (K3)
CO2	Use budgeting and legal setup processes for the venture. (K3)
CO3	Demonstrate feasibility through market and financial analysis. (K3)
CO4	Execute funding strategies suited for a new business. (K3)
CO5	Apply suitable funding methods for different stages of a new business using basic financial models and strategies. (K3)

Text Books	
1.	Kathleen R Allen, Launching NewVentures, An Entrepreneurial Approach, Cengage Learning, 2016.
2.	AnjanRaichaudhuri, Managing New Ventures Concepts and Cases, Prentice Hall International, 2010.
3.	S. R. Bhowmik& M. Bhowmik, Entrepreneurship, New Age International, 2007.

Reference Books	
1.	Steven Fisher, Ja-nae' Duane, The Startup Equation -A Visual Guidebook for Building Your Startup, Indian Edition, Mc Graw Hill Education India Pvt. Ltd, 2016.
2.	Donald F Kuratko, Jeffrey S. Hornsby, New Venture Management: The Entrepreneur's Road Map, 2e, Routledge, 2017.
3.	Vijay Sathe, Corporate Entrepreneurship, 1e, Cambridge, 2009.

Approved by BoS Chairman

B.E / B.Tech	B23MCT604 – INDIAN KNOWLEDGE SYSTEM	L	T	P	C
		2	0	0	0

Course Objectives	
1.	To introduce the scope and significance of Indian Knowledge Systems in the context of modern education and engineering.
2.	To explore ancient Indian contributions in science, mathematics, technology, and architecture.
3.	To understand core Indian philosophies, ethics, and values and their relevance in personal and professional life.
4.	To connect traditional practices with modern innovations through case studies and project-based learning.
5.	To promote sustainable thinking and design approaches inspired by indigenous knowledge and practices.

SYLLABUS:

UNIT - I	INTRODUCTION TO INDIAN KNOWLEDGE SYSTEM	6

- Meaning and scope of IKS
- Importance of IKS in modern education
- Relevance of IKS to science, technology, and engineering.

UNIT - II	SCIENCE AND TECHNOLOGY IN ANCIENT INDIA	6

- Contributions in mathematics (e.g., zero, decimal system, algebra – Aryabhata, Bhaskara)
- Ancient metallurgy (e.g., Iron Pillar of Delhi, zinc extraction)
- Astronomy and calendar systems (e.g., Surya Siddhanta, Jantar Mantar)
- Ayurveda and traditional health sciences.

UNIT - III	ENGINEERING AND ARCHITECTURE	6

- Vastu Shastra and ancient Indian architecture
- Temple construction and civil engineering marvels
- Water management systems (step wells, tanks, canals)
- Town planning in Harappan civilization.

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UNIT - IV	INDIAN PHILOSOPHY, ETHICS & VALUE SYSTEM	6

- Core concepts of Indian philosophy (Dharma, Karma, Yoga)
- Ethical principles in Indian tradition
- Role of values in professional and personal life
- Indian view on environmental sustainability.

UNIT - V	ARTS, CULTURE, AND LITERATURE	6

- Overview of Indian classical music and dance
- Ancient literature (Vedas, Upanishads, Ramayana, Mahabharata)
- Sanskrit and its scientific relevance
- Cultural practices and their scientific background.

TOTAL INSTRUCTIONAL HOURS	30

Course Outcomes: Students will be able to	
CO1	Explain the meaning, scope, and importance of Indian Knowledge Systems in the context of modern education.
CO2	Outline the key scientific and technological advancements of ancient India in fields like mathematics, metallurgy, and astronomy.
CO3	Interpret traditional Indian architectural and engineering practices, including Vastu Shastra and water management systems.
CO4	Illustrate the ethical values and philosophical principles of Indian traditions and their relevance in contemporary life.
CO5	Summarize the applications of IKS in modern innovation, entrepreneurship, and sustainable engineering practices.

Text Books	
1.	Introduction to Indian Knowledge Systems: Concepts and Applications, B. Mahadevan, Publisher: PHI Learning Pvt. Ltd. 2016.
2.	Science and Technology in Ancient India,: Roshen Dalal,Publisher: Penguin Books.2003
3.	Foundations of Indian Culture, Govind Sadashiv Ghurye, Publisher: Popular Prakashan. 1951

Reference Books	
1.	Indian Knowledge Systems – Volume 1, Kapil Kapoor & Michel Danino Publisher: Central Sanskrit University & Bharatiya Vidya Bhavan, 2021.
2.	The Argumentative Indian, By: Amartya Sen, Publisher: Picador, 2005.

Approved by BoS Chairman