Tulsiramji Gaikwad-Patil College of Engineering & Technology, Nagpur

(An Autonomous Institution Affiliated to RTM Nagpur University, Nagpur)

SCHEME OF INSTRUCTION & SYLLABI

Programme: Mechanical Engineering

Scheme of Instructions: Third Year B.Tech. In Mechanical Engineering Semester–VI (As Per NEP 2020)

Sr. No.	Course Category	Course Code	Course Title	T/P	Contact Hrs / Wk			Credits	Exam Scheme				
					L	P	Hrs		CT-1	CT-2	CA	ESE	TOTAL
1	PCC	BME33601	Internal Combustion Engine	T	3	-	3	3	15	15	10	60	100
2	PCC	BME33602	Mechatronics & Robotics	T	3	-	3	3	15	15	10	60	100
3	HSSM	BME33603	Principles of Industrial Management	T	2	-	2	2	7	8	5	30	50
4	VSEC	BME33604	Modelling And Simulation On Software	P	-	4	4	2	-	-	25	25	50
5	PEC	BME33605-08	Programme Elective–II	T	4	-	4	4	15	15	10	60	100
6	PEC	BME33609-12	Programme Elective–III	T	4	-	4	4	15	15	10	60	100
7	MDM	BCS33601	Artificial Intelligence	T	2	-	2	2	7	8	5	30	50
8	PCC	BME33613	Internal Combustion Engine Lab	P	-	2	2	1	-	-	25	25	50
9	PCC	BME33614	Mechatronics & Robotics Lab	P	-	2	2	1	-	-	25	25	50
			Total		**18**	**8**	**26**	**22**	**74**	**76**	**125**	**375**	**650**

L-Lecture SL-Self Learning P-Practical NHL-Notional Hrs/Wk(Total Notional Hrs)
CT1-ClassTest1 TA/CA-Teacher Assessment Continuous Assessment
CT2-ClassTest2 ESE-End Semester Examination (For Laboratory End Semester Performance)

Course Category	PCC (Programme Core Courses)	PEC (Programme Elective Courses)	(MDM) Multidisciplinary Minor	OEC (Open Elective courses from other discipline)	VSEC (Vocational and Skill Enhancement Course)	HSSM (Humanities Social Science and management) (VEC/IKS/AEC)	FP/CP/OJT/RM/ Project (Experimental Learning Courses)
Credits	8	8	2	-	2	2	-
Cumulative Sum	40	12	11	8	8	14	2

PROGRESSIVE TOTAL CREDITS: 106+22=128

Chairperson	Dean Academics	Vice Principal	Principal	May,2025	1.00	Applicable for AY2025-26 Onwards
				Date of Release	Version	

Dean Academics
Tulsiramji Gaikwad-Patil College of Engineering & Technology, Nagpur

Dr. Pragati Patil
Vice-Principal
Tulsiramji Gaikwad-Patil College of Engineering & Technology, Nagpur

Dr. Premanand Naktode
Principal
TGPCET, Nagpur

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Programme: Mechanical Engineering

List of **Program Electives** offered By Mechanical Department (NBA Accredited)

Program Elective-I	Program Elective-II	Program Elective-III	Program Elective-IV	Program Elective-V
Semester V	**Semester VI**	**Semester VI**	**Semester VII**	**Semester VIII**
BME33504: Industrial Economics and Management	BME33605: Hydraulic and Pneumatic Systems	BME33609: Finite Element Method	BME34704: Total Quality Management	BME34803: Material Handling System
BME33505: Computer Aided Design	BME33606: Mechanical Measurement and Metrology	BME33610: Advanced Manufacturing Techniques	BME34705: Finite Element Analysis	BME34804: Computer Integrated Manufacturing
BME33506: Automotive System	BME33607: Automotive maintenance and Industrial Safety	BME33611: Operation Research	BME34706: Design of Mechanical drives	BME34805: Renewable Energy System
BME33507: Smart Manufacturing	BME33608: Control System Engineering	BME33612: Industrial Robotics	BME34707: Advanced Mechanical Vibration	BME34706: Composite and Nano Materials

				May, 2025	1.00	Applicable for AY 2025-26 Onwards
Chairperson	**Dean Academics**	**Vice Principal**	**Principal**	**Date of Release**	**Version**	

Chairperson, Department of Mechanical Engineering (NBA Accredited)
Yeshwantrao Chavan College of Engineering, Nagpur

Dean Academics
Yeshwantrao Chavan College Of Engineering

Dr. Prashanti Patil
Vice-Principal
Yeshwantrao Chavan College of Engineering & Technology, Nagpur

Dr. Premanand Naktode
Principal
TGPCET, Nagpur

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Third Year (Semester-VI) B. Tech. Mechanical Engineering

BME33601: Internal Combustion Engine

Teaching Scheme	
Lectures	3Hr/Week
Tutorials	-
Total Credits	3

Examination Scheme	
CT	30 Marks
CA	10 Marks
ESE	60 Marks
Total	100 Marks
Duration of ESE:03Hrs	

Course Objectives:

1	To learn the concept of IC Engine
2	To understand the concept of fuel supply and engine lubrication
3	To apply the basic knowledge of ignition in IC engine
4	To analyze the testing and performance of IC engine
5	To understand recent advances in IC engine

	Course Contents	Hours
UnitI	**Introduction:** Introduction, Engine Classification, components of I. C. Engines, Two stroke SI and CI engines, Four stroke SI and CI engines, Comparison of SI and CI Engines, valve and port timing diagram. Advantages and disadvantages, applications.	(9)
UnitII	**Fuels and its supply system for IC Engines:** Important qualities of IC engine fuels, rating of fuels, Carburetion, mixture requirement for different loads and speeds, simple carburetor and its working, types of carburetors, MPFI, types of injection systems in CI engine, fuel pumps and injectors, types of nozzles, spray formation. **Engine cooling and lubrication:** Necessity of engine cooling, disadvantages of overcooling, Cooling systems and their comparison, Air cooling, Liquid cooling, types of lubricants and their properties, SAE rating of lubricants, Types of lubrication systems, Supercharging/Turbo-charging: Objectives, Limitations, Methods and Types, Different arrangements of turbochargers and superchargers	(9)
Unit III	**Ignition and Combustion in IC Engines:** Function of Ignition system, Battery and Magneto Ignition system, Electronic Ignition system, Spark plug and its types, Firing order, Types of combustion chambers in SI and CI engines, Stages of combustion in SI engines, abnormal combustion and knocking in SI engines, factors affecting knocking, effects of knocking, control of knocking, combustion chambers for SI engines, Stages of combustion in CI engines, detonation in C.I. engines, factors affecting detonation, controlling detonation, engine emission	(9)
UnitIV	**Testing and Performance of IC Engine:** Measurement of Indicated power, brake power, Friction Power, Willan's Line Method, Morse Test, Motoring Test, Dynamometers, indicated thermal efficiency, brake thermal efficiency and volumetric efficiencies, performance maps, Engine testing standards, heat	(9)

	balance sheet.	
UnitV	**Recent Trends in IC Engines:** LHR engines, lean burn engines, stratified charge spark ignition engine, homogeneous charge compression ignition, reactivity-controlled compression ignition, six stroke engine concept, Electric Vehicle, hybrid engine vehicle, Hydrogen Internal Combustion Engine.	**(9)**
Text Books		
T.1	Internal Combustion Engine by V Ganeshan, McGraw Hill Education Pvt. Ltd.	
T.2	Internal Combustion Engine by R. K. Rajput, Laxmi Publication	
Reference Books		
R.1	Internal Combustion Engines, E. Obert, Intex educational publication.	
R.2	Internal Combustion Engine fundamental by John Heywood, Tata MCGraw Hill Publication	

	UsefulLinks
1	https://nptel.ac.in/courses/112104033
2	https://nptel.ac.in/courses/112103262

	Course Outcomes	**CL**
BME33601.1	**Interpret** the principles of IC engines, including valve and port timing diagrams, to know advantages, disadvantages, and applications.	3
BME33601.2	**Apply** the concepts of engine cooling and lubrication systems to enhance the performance and reliability of internal combustion engines.	3
BME33601.3	**Explain** the function of ignition systems in SI and CI engines, including factors that influence knocking and abnormal combustion.	4
BME33601.4	**Calculate** SI and CI engine performance, including emission factors affecting knocking and detonation.	3
BME33601.5	**Illustrate** recent trends in IC engines to gain advantages, disadvantages, and challenges.	3

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Third Year (Semester-VI) B. Tech. Mechanical Engineering

BME33602: Mechatronics & Robotics

Teaching Scheme	
Lectures	3Hr/Week
Tutorials	-
Total Credits	3

Examination Scheme	
CT	30
CA	10
ESE	60
Total	100 Marks
Duration of ESE: 03 Hrs	

Course Objectives:

1	To introduce students to the fundamental concepts of Mechatronics systems and its interdisciplinary nature
2	To develop programming skills for automation using PLCs and design ladder logic diagrams for real-time systems.
3	To familiarize students with Supervisory controlled Data acquisition system along with virtual instrumentation as a tool for real-time monitoring and control in modern industries.
4	To develop foundational knowledge for robot hardware, design and integration
5	To Understand different methods used for programming robots.

	Course Contents	Hours
Unit I	Introduction to Mechatronics Systems, Scope and Elements of Mechatronics, Mechatronics Design Process, Sensors, Integrated Circuits and Actuators, Control Systems, Close loop and open loop control system, **Case Studies on Mechatronics Systems** such as Temperature Controller, High-Speed Tilting Trains, Antilock Braking System (ABS), Engine Management System, Smart Irrigation System for Drought-Prone Regions, Smart HVAC (Heating, Ventilation, and Air Conditioning) System.	**(9)**
Unit II	**Programmable Logic Controller (PLCs)**, Basic structure of PLC, Principle of operation of PLC, PLC programming languages, ladder diagram, latching, timer, counters, Selection criteria of PLC. **Application of PLC:** Extending and retracting a pneumatic piston using latches, control of two pneumatic pistons, Smart Elevator Control, Conveyor Belt with Object Sorting, Automatic Water Tank Level Controller.	**(9)**
Unit III	**Data Acquisition Systems (DAQ)**, Components of DAQ, Role of DAQ in real-time control and monitoring. **Virtual Instrumentation (VI):** Its need, Tools use for Virtual Instrumentation, Software use for Virtual Displays (e.g. LabView, MATLAB etc), Real-Time Monitoring and Control, Traditional methods of monitoring and control, Cloud-based Monitoring Systems, Edge-based Real-Time Systems. **Supervisory Control and Data Acquisition (SCADA):** As an Extension of DAQ, SCADA functions (Data visualization, alarm management, logging, and supervisory control), Stand alone DAQ vs SCADA, Communication Protocol of SCADA (e.g. MODBUS, OPC, Ethernet/IP)	**(9)**

Unit IV	**Introduction to Robotics and Robotic Components:** **Types of Robots**: Cartesian, Cylindrical, Articulated, SCARA, Delta, Mobile Robots. **Basic Components of a Robot**: Manipulator/Arm, End-effector (grippers, tools), Actuators (Electric, Pneumatic, Hydraulic), Sensors (Proximity, Vision, Force, IR, Ultrasonic), Controller (Microcontroller/PLC-based). **Robot Drive Systems**: Servo, Stepper, DC drives	**(9)**
Unit V	**Robot Programming and Applications:** **Robot Programming Methods**: Manual Teach, Lead-through, Offline programming, PLC programming (intro to simulation tools like RoboDK or MATLAB Robotics Toolbox). **Safety in Robotics**: Safety sensors, emergency stops, safety standards (ISO 10218). **Robotics Applications: Industrial:** Welding, Painting, Pick and Place, Assembly, Inspection. **Emerging:** Agriculture, Medical Surgery, Defense, Warehouse Automation	**(9)**

Text Books	
T.1	Mechatronics Borole,Rajesh P;Angal,Yogesh S;Patil,Varsha K., Nirali Prakashan, 4th Edition, 2005
T.2.	Mechatronics Integrated Mechanical Ramachandran K.P., Willey.
T.3	Boltan W, Mechatronics : Pearson Education, 11th Edition, 2005
Reference Books	
R.1	Introduction to Mechatronics and Measurement Systems , David Alciators & Michael B. Histand, Tata McGraw Hills, India
R.2	Mechatronics : HMT LTD, McGraw-Hill

	Useful Links
1	https://nptel.ac.in/courses/112103174
2	https://nptel.ac.in/courses/112107298

	Course Outcomes	**CL**
BME33602.1	**Explain** feedback control in Mechatronics systems to determine real-time case studies.	4
BME33602.2	**Summarize** ladder logic programs using timers for recent applications in Programmable Logic Controllers.	5
BME33602.3	**Interpret** data acquisition and SCADA systems for real-time industrial monitoring.	3
BME33602.4	**Classify** robots based on configuration to find requirements in specific applications.	4
BME33602.5	**Differentiate** robot programming methods to know safety protocols, design, and robot programming techniques.	4

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Third Year (Semester-VI) B. Tech. Mechanical Engineering

BME33603: Principles of Industrial Management

Teaching Scheme		Examination Scheme	
Lectures	2 Hr/Week	CT	15 Marks
Tutorials	-	CA	5 Marks
Total Credits	2	ESE	30 Marks
		Total	50 Marks
		Duration of ESE: 02Hrs	

Course Objectives:

1	To understand the significance of various management skills in different organizational contexts.
2	To understand the different types of plant layouts.
3	To understand comprehension of material requirement planning (MRP) and storekeeping procedures by explaining their underlying principles, processes, and objectives

	Course Contents	Hours
UnitI	**Basics of industrial Management** Management - Definition–Administration-Definition–Henry-Fayol's principles of management- Business Organisation- Types- Proprietorship- Partnership- Joint stock-Cooperative Society-Advantages and disadvantages -Functions of Management – Planning Definition-Functions- Organisation- Definition- types of organisation –Line-Functional-Line &staff-advantages and disadvantages- Leadership -Types –Quality of good leader Motivation - Maslow's Theory of Motivation -Hierarchy of needs-Communication - Process of Communication – Barriers for effective communication.	(9)
UnitII	**Production management** Concept of project work - Project planning -Market survey- Project capacity- selection of site for project- Plant layout-Types of Plant layout- Product design- Stages in product design drawing-Specifications-Material requirement-operation- Planning-Production-definition-Job, Batch & Mass production with their advantages and disadvantages-Productivity-definition factors to improve productivity- Production planning and Control (PPC)-definition-Functions of PPC- planning, routing, scheduling, dispatching and Inspection-Introduction to CPM and PERT –Comparision.	(9)
Unit III	**Materials management** Material management - definition, functions- Purchase - Objectives, different methods of purchasing -Purchase procedure-Comparative statement-purchase order-Tender-Types of tender- Store keeping- classification of stores - Functions of store keeper. Store management Bin Card - Material Issue Requisition-Material Returned Note- Store ledgers -Codification of stores-Inventory Management- Definition - functions of Inventory Control- Advantages of Inventory Control Enterprise resource planning - concept, features and applications.- Material Requirement Planning (MRP)-concept, applications -Justin Time (JIT)-concept and benefits-Supply chain management-concept and benefits –FIFO(first in first out) concept-definition.	(9)

Text Books	
T.1	IndustrialOrganizationandEngineeringEconomicsT.R.Banga&SCSharmaKhanna.Publishers
T.2	Industrialmanagementandengineeringeconomics O.P.khannaKhanna.Publishers
Reference Books	
R.1	Industrial management and organizational behavior K.K.Ahuja

	Useful Links
1	www.youtube.com/watch?v=SF53ZZsP4ik
2	www.youtube.com/watch?v=iPZlQ3Zx5zc

	Course Outcomes	CL
BME33603.1	**Explain** the importance of management functions in industrial settings to gain knowledge of their impact on organizational performance.	4
BME33603.2	**Apply** knowledge of plant layouts to determine product design stages to real-world production scenarios.	3
BME33603.3	**Interpret** materials management principles to optimize resource allocation and streamline production processes.	3

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Third Year (Semester-VI) B. Tech. Mechanical Engineering

BME33604: Modelling And Simulation On Software

Teaching Scheme	
Lectures	4 Hr/Week
Tutorials	-
Total Credits	2

Examination Scheme	
CT	-
CA	25 Marks
ESE	25 Marks
Total	50 Marks
Duration of ESE : 02 Hrs	

Course Objectives:

1	Understand the fundamentals of 3D modeling and simulation software (CREO and ANSYS).
2	Apply design tools in CREO to create detailed part and assembly models.
3	Simulate and analyze real-world mechanical problems using ANSYS.
4	Integrate CAD and FEA tools for product development and testing.
5	Develop skills for industry-based design validation and optimization.

Sr. No.	List of Experiment	CO
1	Introduction to CREO: Sketching and Part Modeling of a Mechanical Component	CO1
2	Advanced 3D Modeling in CREO: Gear, Coupling, or Crankshaft	CO1
3	CREO Assembly Modeling: Assemble a Shaft-Bearing-Housing System	CO2
4	Drafting and Detailing in CREO: 2D Drawing Extraction from 3D Model	CO2
5	Introduction to ANSYS: Geometry Import and Meshing Techniques	CO3
6	Static Structural Analysis in ANSYS: Cantilever Beam under Load	CO3
7	Thermal Analysis in ANSYS: Heat Transfer through Fin	CO3
8	Modal Analysis in ANSYS: Natural Frequency of a Bracket	CO4
9	Stress Analysis of Assembly Model: Imported from CREO to ANSYS	CO4
10	Mini-Project: Design and Analysis of a Mechanical Part/Assembly (e.g., Chassis Frame or Connecting Rod)	CO5

Text Books

T.1	"Creo Parametric 10.0 for Engineers and Designers" – Sham Tickoo
T.2	"PTC Creo Parametric 10.0 Tutorial" – Kristin Eckstein, Roger Toogood
T.3	"Learning Creo Parametric 10.0" – Randy Shih

T.4	"Introduction to Finite Element Analysis Using ANSYS" – Saeed Moaveni
Reference Books	
R.1	Practical Finite Element Analysis Author: Nitin S. Gokhale et al. Publisher: Finite to Infinite
R.2	ANSYS Workbench 2023 R1: A Tutorial Approach Author: Prof. Sham Tickoo Publisher: CADCIM Technologies

Useful Links	
1	https://nptel.ac.in/courses/112104193
2	https://nptel.ac.in/courses/112102101

	Course Outcomes	CL
BME33604.1	**Demonstrate** the ability to model complex mechanical components using CREO, to enhance knowledge of advanced features.	3
BME33604.2	**Analyze** the assembly modeling and drafting capabilities of CREO by creating complex assemblies for learning practical skills.	3
BME33604.3	**Construct** 3D models and assemblies using CREO to perform static analysis using ANSYS.	3
BME33604.4	**Differentiate** material behavior under various load conditions to find simulation results.	4
BME33604.5	**Summarize** engineering components through integrated use of CAD and FEA tools to determine optimization of Assembly model.	5

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Third Year (Semester-VI)B. Tech. Mechanical Engineering

BME33605: (PE-II) Hydraulic And Pneumatic Systems

Teaching Scheme	
Lectures	4 Hr/Week
Tutorials	-
Total Credits	4

Examination Scheme	
CT	30 Marks
CA	10 Marks
ESE	60 Marks
Total	100 Marks
Duration of ESE:03Hrs	

Course Objectives:

1	Students will understand the Fundamentals of fluid power
2	Students will analyze and design Systems of hydraulic system
3	Students will apply Practical Skills Pneumatic system

	Course Contents	Hours
UnitI	**Fluid Power Priniciples And Hydraulic Pumps** Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids– Properties of fluids and selection – Basics of Hydraulics – Pascal's Law – Principles of flow – Friction loss – Work, Power and Torque Problems, Sources of Hydraulic power : Pumping Theory – Pump Classification – Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criteria of Linear and Rotary – Fixed and Variable displacement pumps – Problems.	(9)
UnitII	**Hydraulic Actuators And Control Components** Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning – Hydraulic motors – Control Components: Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Servo and Proportional valves – Applications – Accessories: Reservoirs, Pressure Switches – Applications – Fluid Power ANSI Symbols – Problems.	(9)
Unit III	**Hydraulic Circuits And Systems** Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double-Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical hydraulic servo systems.	(9)
UnitIV	**Pneumatic And Electro Pneumatic Systems** Properties of air – Perfect Gas Laws – Compressor – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit – Cascade method – Electro Pneumatic System – Elements – Ladder diagram – Problems, Introduction to fluidics and pneumatic logic circuits.	(9)
UnitV	**Trouble Shooting And Applications** Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for Pick and Place applications and tool handling	(9)

	in CNC Machine tools – Low cost Automation – Hydraulic and Pneumatic power packs.	
Text Books		
T.1	Majumdar S.R., "Pneumatic systems – Principles and maintenance", Tata McGraw Hill, 1995	
T.2	Anthony Lal, "Oil hydraulics in the service of industry", Allied publishers, 1982.	
T.3	Anthony Esposito, "Fluid Power with Applications", Pearson Education 2000.	
Reference Books		
R.1	Harry L. Stevart D.B, "Practical guide to fluid power", Taraoeala sons and Port Ltd. Broadey, 1976.	
R.2	Majumdar S.R., "Oil Hydraulics", Tata McGraw-Hill, 2000.	
R.3	Dudelyt, A. Pease and John T. Pippenger, "Basic Fluid Power", Prentice Hall, 1987.	

	Useful Links
1	https://archive.nptel.ac.in/courses/112/106/112106300/
2	https://archive.nptel.ac.in/courses/112/105/112105047/

	Course Outcomes	**CL**
BME33605.1	**Summarize** the fundamentals of fluid power to determine hydraulic system design requirements.	4
BME33605.2	**Select** appropriate hydraulic control components, to achieve desired system performance	4
BME33605.3	**Analyze** hydraulic system designs, to determine performance, stability, and control.	4
BME33605.4	**Apply** pneumatic and electro-pneumatic principles to find out troubleshoot circuits using air control valves,	3
BME33605.5	**Explain** troubleshooting techniques and remedies for common issues in hydraulic and pneumatic systems,	4

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Third Year (Semester-VI) B. Tech. Mechanical Engineering

BME33606: (PE-II) Mechanical Measurement and Metrology

Teaching Scheme	
Lectures	4 Hr/Week
Tutorials	-
Total Credits	4

Examination Scheme	
CT	30 Marks
CA	10 Marks
ESE	60 Marks
Total	100 Marks
Duration of ESE:03Hrs	

Course Objectives:

1	Understand the basic structure and principles of measuring system
2	Explore various sensing and signal conditioning elements used in measurement systems
3	Familiarize students with the instruments used for measuring pressure, displacement, force, torque and power
4	To understand standards of measurement, linear and angular measurement methods, and precision tools.
5	Provide knowledge on limits and fits, gauges and advanced inspection tools for precision engineering

	Course Contents	Hours
UnitI	Purpose, structure and elements of measuring system. Static characteristics of measurement system, elements including systematic, statistical characteristics, generalized model of system elements and calibration. Error measurement, error probability density function, error reduction. Introduction to dynamic characteristics of measurement system. Introduction to noise in measurement system.	**(9)**
UnitII	Classification, Principle, Sensing elements, Signal conditioning elements, Construction, Range and working of instruments for measurement of Linear and Angular Displacement, Speed, Load, Strain, Force, Torque and Power. (Analytical treatment not included)	**(9)**
Unit III	Classification, Principle, Sensing elements, Signal conditioning elements, Construction, Range and working of instruments for measurement of Pressure, Vacuum, Sound, Light and Temperature. (Analytical treatment not included)	**(9)**
UnitIV	Standards of Measurement, Line, End and Wavelength standard, Working standards, Requirement of interchangeability, Allowance and Tolerance, Selective assembly, Measurement of Straightness and Flatness. Instruments for Linear and Angular Measurement. (Vernier, Angle gauge, Sine bar, Level indicator, Clinometers and Taper gauge)	**(9)**
UnitV	Limits and Fits, Tolerance analysis of Limits and Fits, Types of limit gauges, Types of fit, Shaft and Hole basis system, Design of Limit gauge and Process planning sheet (Numerical treatment is expected). Comparators: Mechanical, Optical, Electrical, Electronic, Pneumatic. Study and use of Optical profile projectors, Tool maker's microscope and Autocollimator. Measurement of	**(9)**

	Screw thread and Gear tooth.	
Text Books		
T.1	Mechanical Measurement and Control, D.S. Kumar, Metropolitan Book Co	
T.2	Metrology, R. K. Jain, Khanna Publishers	
T.3	Instrumentation Measurement and Analysis, B.C. Nakra, K.K. Choudhary, TMH	
Reference Books		
R.1	Principles of Measurement Systems, John P. Bentley, Pearson	
R.2	Metrology and Measurement, Anand K. Bewoor, Vinay A. Kulkarni, TMH	

	Useful Links
1	https://nptel.ac.in/courses/112104250
2	https://nptel.ac.in/courses/112106139

	Course Outcomes	**CL**
BME33606.1	**Explain** the fundamental principles of measurement systems, to ensure accurate and reliable measurements.	4
BME33606.2	**Interpret** the principles of measurement instruments for linear and angular displacement.	3
BME33606.3	**Summarize** the operation of measurement instruments for pressure, temperature,	5
BME33606.4	**Apply** measurement standards and techniques, to ensure interchangeability and specify tolerances for precise engineering applications.	4
BME33606.5	**Evaluate** the use of advanced measurement instruments, to inspect complex parts.	5

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Third Year (Semester-VI) B. Tech. Mechanical Engineering

BME33607: (PE-II) Automotive Maintenance and Industrial Safety

Teaching Scheme	
Lectures	4 Hr/Week
Tutorials	-
Total Credits	4

Examination Scheme	
CT	30 Marks
CA	10 Marks
ESE	60 Marks
Total	100 Marks
Duration of ESE:03Hrs	

Course Objectives:

1	Equip students with knowledge on accident causes, prevention methods, industrial hazards, and safety requirements.
2	Provide a comprehensive understanding of maintenance engineering principles, types, and equipment life-cycle management.
3	Study wear and corrosion prevention, and lubrication methods for enhancing system reliability.
4	Develop skills to systematically trace, analyze, and diagnose faults in various equipment using structured techniques.
5	Equip students with skills for periodic and preventive maintenance of mechanical and electrical equipment.

	Course Contents	Hours
UnitI	**Industrial Safety** Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/ procedure, describe salient points of factories act1948 for health and safety, washrooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc., Safety color codes. Fire prevention and firefighting, equipment and methods.	(9)
UnitII	**Maintenance Engineering** Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.	(9)
Unit III	**Wear and corrosion and their prevention** Wear-types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii.Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.	(9)
UnitIV	**Fault Tracing** Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like ,i. Anyone machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi.	(9)

	Electrical motors, Types of faults in machine tools and their general causes.	
UnitV	**Periodic and preventive maintenance** Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: i. Machine tools, ii. Pumps, iii.Airc ompressors, iv. Dieselgenerating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, Advantages of preventive maintenance. Repair cycle concept and importance.	**(9)**

Text Books	
T.1	L M Deshmukh, Industrial Safety Management,Tata Mc Graw-Hill Education,2005.
T.2	Charles D.Reese,Occupational Health and Safety Management:A Practical Approach,C R C Press
Reference Books	
R.1	**Edward Ghali, V. S. Sastri, M. Elboujdaini**, *Corrosion Prevention and Protection: Practical Solutions*, John Wiley & Sons, 2007.
R.2	**H. P. Garg**, Maintenance Engineering, S. Chand Publishing.

	Useful Links
1	https://nptel.ac.in/courses/112103264
2	https://www.osha.gov/industrial-safety

	Course Outcomes	**CL**
BME33607.1	**Explain** the causes, types, and consequences of industrial accidents, and describe measures to control mechanical and electrical hazards,	4
BME33607.2	**Interpret** the role and responsibilities of maintenance engineering, to optimize equipment performance and minimize downtime.	3
BME33607.3	**Analyze** the types, causes, and effects of wear and corrosion on equipment, and to determine methods for prevention and mitigation.	4
BME33607.4	**Illustrate** the application of decision trees to troubleshoot common problems in machine tools.	3
BME33607.5	**Summarize** the steps and advantages of preventive maintenance for pumps, air compressors, to minimize downtime	5

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Third Year (Semester-VI) B.Tech. Mechanical Engineering

BME33608: (PE-II) Control System Engineering

Teaching Scheme	
Lectures	4Hr/Week
Tutorials	-
Total Credits	4

Examination Scheme	
CT	30 Marks
CA	10 Marks
ESE	60 Marks
Total	100 Marks
Duration of ESE: 03Hrs	

Course Objectives:

1	To study modeling and transfer function of linear time-invariant system
2	To understand the stability, time domain specifications and tools
3	To understand classical controller/compensator design for linear system
4	To study frequency domain analysis of linear system
5	An introduction to state space approach and to understand the theory state transition matrix

	Course Contents	Hours
UnitI	**Introduction to Control System:** Need of control system, Open loop control and closed loop control, Significance of actuators and sensors, Control system Components (DC/AC servomotors, potentiometer, synchro), Mathematical representation of simple mechanical, electrical and electromechanical systems, Transfer function, Block diagram representation and reduction. Signal flow graph.	**(9)**
UnitII	**Time Response Analysis: -** Concept of transient response, steady state response and time response, standard test signals-type and order of system, steady state error analysis, static error constants, Time response of first and second order system, dominant poles, Time response specifications of second order system, Different types of Controllers (PD, PI, PID) Introduction of LAG, LEAD compensation.	**(9)**
Unit III	**Stability analysis & Root locus:** Stability of control systems, condition of stability, characteristics equation, Routh Hurwitz criterion, special cases for determining relative stability. Root location and its effect on time response, elementary idea of root locus, effect of addition of pole and zero on proximity of imaginary axis.	**(9)**
UnitIV	**Frequency Domain Analysis**: - Concept of frequency response of a dynamical system. Construction of Bode plot, the stability margin on Bode plot and assessing close-loop stability. Construction of polar plot for a system. Nyquist stability criterion and stability margin. Effect of gain variation and addition of poles and zeroes on the frequency response plots.	**(9)**
UnitV	**State Variable Analysis: -** Concept of state, state variable and state model, Systems state model with physical variable, phase variable and canonical variables with state diagram, Transfer function from state model, Stability of state space model.	**(9)**

Text Books

T.1	Modern control system Engineering by K.Ogata , Publisher – Prentice Hall,India
T.2	Control System Analysis by Nagrath /Gopal , Publisher- Newage International
T.3	Automatic Control Systems by B.C. Kuo, Publisher – Prentice Hall,India

T.4	Control System Engineering by S.K. Bhattacharya, Publisher - Pearson
Reference Books	
R.1	Linear System Design by D'azzoand Houpis, Publisher- McGraw Hill
R.2	Control Systems, Principles & Design by M. Gopal Publisher – TMH (Tata Mc Graw Hill)
R.3	Control Systems Engineering by Samarajit Ghosh Publisher - Pearson

	Useful Links
1	https://www.youtube.com/watch?v=7LZSjgZz Qw&list=PLxn52v8fxX5l5tGzU1NAxRDkgqxK0k5UZ
2	https://www.youtube.com/watch?v=39Ggoj2fQ2c&list=PLxn52v8fxX5l5tGzU1NAxRDkgqxK0k5UZ&index=2

	Course Outcomes	**CL**
BME33608.1	**Apply** block diagram reduction and signal flow graph techniques to simplify complex control systems	3
BME33608.2	**Explain** the time response characteristics of first and second-order systems, to determine system performance	4
BME33608.3	**Analyze** the stability of control systems using Routh-Hurwitz criterion to determine relative stability.	4
BME33608.4	**Summarize** the key concepts of frequency response analysis, and the use of Nyquist criterion to evaluate system stability	4
BME33608.5	**Apply** the state variable approach to model to determine the behavior of dynamic systems.	3

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Third Year (Semester-VI)B. Tech. Mechanical Engineering

BME33609: (PE-III) Finite Element Method

Teaching Scheme	
Lectures	4 Hr/Week
Tutorials	-
Total Credits	4

Examination Scheme	
CT	30 Marks
CA	10 Marks
ESE	60 Marks
Total	100 Marks
Duration of ESE:03Hrs	

Course Objectives:

1	Understand the Fundamental Principles
2	Apply FEM to Solve Engineering Problems
3	Develop Computational Skills
4	Analyze and Interpret FEM Results
5	Enhance Problem-Solving and Research Skills

	Course Contents	Hours
UnitI	Introduction to Engineering Analysis tool FEA and its application in Linear static Analysis and 2D problems, Study of Finite Element modeling and simulation Techniques, Use of FEA in structural vibration and thermal Analysis.	(9)
UnitII	Basics of FEM – Review of finite difference method, Initial value and boundary value problems Solution of Boundary Value problems: - weighted residual, Galerk in and Raleigh Ritz methods, Variational Method, Least square Methods. Introduction to meshless FEM, FEA and Linking mechanical design with FEA	(9)
Unit III	Two Dimensional Elements: Linear Triangular Elements, Rectangular Elements, Two Dimensional Fielde quations: Coordinate Systems, Isoparametric elements and numerical integration, Integral equations for the element Matrices, Heat transfer by conduction: One dimensional fins, two dimensional fins, and Long and convection Two Dimensional bodies.	(9)
UnitIV	FEA applications in Solid Mechanics:The axial force members, potential energy formulations. The Truss Element, Beam element, plane frame element, modeling of bolts for assembly,3Dproblems.	(9)
UnitV	Two dimensional Elasticity: The displacement functions, Element matrices, Element Shape Functions: Evaluating shape functions FEM Computations Solution Methods, FEMModelingandPreprocessingFEMHardwareandPostprocessingSurveyofsomeFE Software Systems.	(9)

Text Books

T.1	Reddy, Junuthula Narasimha. An introduction to the finite element method.Vol.2,no.2.2. New York: Mc Graw-Hill, 1993.
T.2	Chandrupatla, Tirupathi R., Ashok D. Belegundu, T. Ramesh, and Chaitali Ray. Introduction to finite elements in engineering. Vol. 2. Upper Saddle River, NJ: Prentice Hall, 2002.
T.3	Desai, Chandrakant S.,and John Fredrick Abel Introduction to the finite element method; a numerical method for engineering analysis. Van Nostrand Reinhold, 1971.

T.4	Zienkiewicz,OlekC.,and Robert L.Taylor.The finite element method: Its basis and fundamentals.
Reference Books	
R.1	K.J. Bathe, Finite Element Procedures, Klaus-Jurgen Bathe 6. Singiresu s. Rao . Finite element method in engineering.
R.2	Cook,R.D,"Concepts and application in Finite Element Analysis",3rd Ed,The Wiley & Sons
R.3	Dixit U.S.,"Finite Element Methods for Engineers",Cengage Learning

	Useful Links
1	https://www.youtube.com/watch?v=tH1ygapKG2g&list=PLSGws_74K018SmggufD- pbzG3thPIpF94&index=2
2	https://www.youtube.com/watch?v=UOp6JEiJctA&list=PLSGws_74K018SmggufD- pbzG3thPIpF94

	Course Outcomes	**CL**
BME33609.1	**Apply** FEA modeling and simulation techniques to solve complex engineering problems	3
BME33609.2	**Apply** Different FEM Methods for the Solution of Boundary Value problems.	4
BME33609.3	**Summarize** the numerical methods for solving boundary value problems,	5
BME33609.4	**Apply** FEM Methods for the solution of 3D object	4
BME33609.5	**Evaluate** the effectiveness of FEM modeling and preprocessing techniques for two-dimensional elasticity problems	5

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Third Year (Semester-VI) B. Tech. Mechanical Engineering

BME33610: (PE-III) Advanced Manufacturing Techniques

Teaching Scheme	
Lectures	4 Hr/Week
Tutorials	-
Total Credits	4

Examination Scheme	
CT	30 Marks
CA	10 Marks
ESE	60 Marks
Total	100 Marks
Duration of ESE:03Hrs	

Course Objectives:

1	To understand the evolution and trends of advanced manufacturing and its comparison to traditional methods.
2	To explore additive manufacturing processes, their benefits, and limitations.
3	To learn about subtractive and hybrid manufacturing techniques.
4	To study advanced materials and processing techniques.
5	To explore the applications, quality control, and future trends in manufacturing.

	Course Contents	Hours
UnitI	**Introduction to Advanced Manufacturing;** Overview of Manufacturing Evolution; Need for Advanced Manufacturing Techniques; Comparison with Traditional Manufacturing Processes; Technological Advancements Driving Manufacturing Innovation; Emerging Trends in Advanced Manufacturing; Advantages of Advanced Manufacturing Techniques; Future Scope and Challenges	(9)
UnitII	**Additive Manufacturing and 3D Printing: Introduction to Additive Manufacturing (AM);** Evolution and Technological Improvements; AM Process and Classification; Materials Used in Additive Manufacturing; Advantages of Additive Manufacturing; Limitations of Additive Manufacturing; Additive vs. Conventional Manufacturing Processes	(9)
Unit III	**Subtractive and Hybrid Manufacturing**; Introduction to Subtractive Manufacturing; CNC Machining and Automation; Electric Discharge Machining (EDM); Electrochemical Machining (ECM); Laser Beam Machining; Water Jet Cutting; Hybrid Manufacturing Systems; Applications and Advantages of Subtractive and Hybrid Processes	(9)
UnitIV	**Advanced Processing and Materials;** Introduction to Advanced Material Processing, Advanced Material Forming Techniques, Powder Metallurgy and Sintering, Additive Manufacturing Materials, High-Performance Materials in Manufacturing, Ceramic and Composite Materials, Non-Traditional Welding and Joining Methods, Future Trends in Materials Processing	(9)
UnitV	**Applications, Quality, and Future Trends**; Applications in Aerospace, Automotive, Biomedical, and Electronics, Digital Manufacturing and Industry 4.0, Smart Factories and the Role of IoT, Cyber-Physical Systems and Automation, Quality Control and Inspection Techniques, Process Control and Optimization, Sustainability and Green Manufacturing, Future Trends in Manufacturing Technologies	(9)

Text Books

T.1	**"Introduction to Manufacturing Processes"** by Mikell P. Groover
T.2	**"Additive Manufacturing: Materials, Processes, Quantifications, and Applications"** by Kun Zhou

T.3	**"Modern Machining Technology"** by Chandra Sekhar
Reference Books	
R.1	Understanding Additive Manufacturing Rapid Prototyping · Rapid Tooling · Rapid Manufacturing Andreas Gebhardt, Hanser Publishers, Munich Hanser Publications, Cincinnati
R.2	Additive Manufacturing of Metals: The Technology, Materials, Design and Production , Li Yang Keng Hsu • Brian Baughman Donald Godfrey • Francisco Medina Mamballykalathil Menon SoerenWiener, Springer Series in Advanced Manufacturing

	Useful Links
1	https://onlinecourses.nptel.ac.in/noc21_me115/preview
2	https://onlinecourses.nptel.ac.in/noc20_me50/preview

	Course Outcomes	**CL**
BME33610.1	**Interpret** the differences between traditional and advanced manufacturing processes, to find the benefits of adopting advanced manufacturing techniques.	3
BME33610.2	**Summarize** the key concepts of Additive Manufacturing (AM) and 3D Printing, to find advantages, limitations, and comparison with conventional manufacturing processes.	5
BME33610.3	**Analyze** subtractive manufacturing processes, to determine their applications and advantages.	4
BME33610.4	**Interpret** the properties of advanced materials, for requirement in various manufacturing industries.	3
BME33610.5	**Explain** the concepts of smart factories, in modern manufacturing, for process optimization.	4

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Third Year (Semester-VI) B.Tech. Mechanical Engineering

BME33611: (PE-III) Operation Research

Teaching Scheme	
Lectures	4 Hr/Week
Tutorials	-
Total Credits	4

Examination Scheme	
CT	30 Marks
CA	10 Marks
ESE	60 Marks
Total	100 Marks
DurationofESE:03Hrs	

Course Objectives:

1	To study the various OR tools,
2	To apply appropriate model to the given situation.
3	To Formulate the problem.
4	To Solve and analyze the problem
5	To mathematical models and solve management problems.

Course Contents		Hours
Unit I	Introduction to O.R. & basic O.R. Models, Characteristics, phases & Methodology of O.R., Limitations & Applications. Linear Programming:-Introduction, Linear programming problem formulation, LPP Solution by Graphical Method, Simplex Method, Principle of Duality & Formulation of Model only, Sensitivity Analysis Concept Only.	(9)
Unit II	Formulation of transportation model, Basic feasible solution using different methods (North- West corner, Least Cost, Vogel's Approximation Method) Optimality Methods, Unbalanced transportation problem, Variants in Transportation Problems. Formulation of the Assignment problem, unbalanced assignment problem, typical assignment & travelling salesman problem	(9)
Unit III	Replacement Models-Concept of equivalence, Interest Rate, Present worth, economic evaluations of Alternatives, Group replacement models. Inventory Control Models- Introduction and inventory management concepts, Economic Order Quantity model (EOQ), Economic Production Quantity model (EPQ), model for purchase allowing for shortages, ABC analysis.	(9)
Unit IV	Drawing of Network, CPM & PERT, probability of completion of project, Cost Analysis of Project, and Concept of Crashing. Allocation & updating of Network.	(9)
Unit V	Sequencing Model– Introduction, Sequencing Model n job two machines problem, n job 3 machines problem, 2 jobs m machine problem. Simulations –Concept, applications in waiting line situations, inventory and network. Queuing models– Poisson arrivals and Exponential service times –Single channel models (MM1) and Multi channel models. (No derivation expected)	(9)

Text Books

T.1	Operation Research, Heera & Gupta, S Chand Publications
T.2	Operation Research, J K Sharma, Mc Millian Publications
T.3	Operation Research, S D Sharma, Kedarnath Ramnath &Co.

Reference Books

R.1	Operation Research, Hamdy Taha, Prentice Hall

R.2	Operation Research, Liberman, Mc GrawHillPublications

	Useful Links
1	https://nptel.ac.in/courses/110/106/110106062/
2	https://examupdates.in/operation-research-notes/

	Course Outcomes	CL
BME33611.1	**Solve** linear programming problems using graphical to formulate dual models.	3
BME33611.2	**Determine** the optimal solution to transportation problems using North-West corner method,	4
BME33611.3	**Apply** an optimal replacement period of equipment or machine to determine the value of the given Inventory Model.	3
BME33611.4	**Illustrate** project networks using CPM and PERT techniques, to determine project completion probability.	3
BME33611.5	**Summarize** the key concepts of queuing theory, to solve real-world problems.	5

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Third Year (Semester-VI) B. Tech. Mechanical Engineering

BME33612: (PE-III) Industrial Robotics

Teaching Scheme	
Lectures	4 Hr/Week
Tutorials	-
Total Credits	4

Examination Scheme	
CT	30 Marks
CA	10 Marks
ESE	60 Marks
Total	100 Marks
Duration of ESE:03Hrs	

Course Objectives:

1	To introduce the functional elements of robotics.
2	To impart knowledge on robot end effector and grippers.
3	To introduce the dynamics and control of manipulators in robotics.
4	To understand the basic concepts of robotic sensors used in industries.
5	To understand the cell layouts of robots and their interfaces.

Course Contents		Hours
UnitI	Basic concepts :-Brief history-Types of Robot–Technology-Robot classifications and specifications- Design and control issues-Various manipulators–Sensors- workcell-Programming languages.	(9)
UnitII	Robot send- effectors- classification o fend- effectors, mechanical grippers, hooking or lifting grippers, grippers for molten metal's, plastics, vacuum cups ,magnetic grippers, electrostatic grippers, multiple grippers, internal & external grippers, drives ystems for gripers, active & Passive grippers.	(9)
Unit III	Direct and inverse kinematics:-Mathematical representation of Robots-Position and orientation -Homogeneous transformation Various joints-Representation using the Denavit Hattenberg parameters- Degrees off reedom- Direct kinematics-Inverse kinematics- SCARA robots-Solvability – Solution methods-Closed form solution.	(9)
UnitIV	Robot Sensors: Scheme of robotic sensors, contact type sensors, force, torque, touch, positipn, velocity sensors, non-contact type sensors, electro-optical imaging sensors, proximity sensors, range imaging sensors, robot environment and robot input/ output interfaces, machine intelligence, Safety measures in robots.	(9)
UnitV	Robot cell layouts, multiple robots and machine interface, other considerations in work cell design, work cell control, interlocks, error detection and recovery, Quantitative Techniques for economic performance of robots: Robot investment coats, robot operating expenses. General considerations in robot material handling, material transfer applications, pick and place operations, machine loading and unloading, die casting, plastic molding, forging, machining operations, stamping press operations using robots.	(9)

Text Books

T.1	K. MittalandI. J.Nagrath, Robotics and Control,Tata Mc Graw Hill, New Delhi,4thReprint, 2005
T.2	M.P. Groover, M. Weiss,R. N. Nageland N.G. Odrej, Industrial Robotics, Mc Graw-Hill Singapore, 1996.
T.3	JohnJ.Craig, Introduction to Robotics Mechanics and Control, Third edition, Pears on Education

Reference Books	
R.1	Ashitava Ghoshal, Robotics- Fundamental Concepts and Analysis',Oxford University Press, Sixth impression, 2010.
R.2	K. K. Appu Kuttan, Robotics, I K International, 2007. Edwin Wise, Applied Robotics,Cengage Learning.
R.3	R. D .Klafter,T.A. Chimielewski and M.Negin, Robotic Engineering– An Integrated Approach, Prentice Hall of India,New Delhi,1994.
R.4	B.K. Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai, 1998.
R.5	S. Ghoshal,"Embedded Systems & Robotics"–Projects usingthe8051Microcontroller", Cengage Learning, 2009.

	Useful Links
1	https://onlinecourses.nptel.ac.in/noc23_me143/
2	https://archive.nptel.ac.in/courses/112/105/112105249/
3	https://www.youtube.com/watch?v=OSrMXiaWPZY&list=PLXDsvE7qtfNf_N99hJZbdTEM001mOii6_&index=1

	Course Outcomes	CL
BME33611.1	**Analyze** the design and control issues of robots, to determine their impact on robot performance.	4
BME33611.2	**Interpret** the role of drive systems and control mechanisms in robot end-effectors, to find impact on robotic performance.	4
BME33611.3	**Summarize** the methods for solving direct and inverse kinematics problems in robotics,	4
BME33611.4	**Discuss** the types of robot sensors for its applications.	3
BME33611.5	**Illustrate** the application of robots in material handling, including quantitative techniques for determining economic performance	3

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Third Year (Semester-VI) B. Tech. Mechanical Engineering

BCS33601: Artificial Intelligence

Teaching Scheme	
Lectures	2 Hr/Week
Tutorials	-
Total Credits	2

Examination Scheme	
CT	15 Marks
CA	05 Marks
ESE	30 Marks
Total	50 Marks
Duration of ESE:02Hrs	

Course Objectives:

1	Understand the fundamental concepts and terminologies of AI and Machine Learning.
2	Develop skills to choose, plan, and execute Al projects collaboratively within a team.
3	Recognize the roles and responsibilities of Al team members within organizations.

	Course Contents	Hours
UnitI	Introduction: Machine Learning, What is data, The terminology of AI, What makes an Al company, What machine kuming can and cannot do. Non-technical explanation of deep learning, basics of neural networks. Examples of Al. Application domains of Al	(9)
UnitII	Building Al projects Workflow of a machine learning project, Workflow of a data science project, How to use data, How to choose an Al project, Working with an Al team, How to process and visualize nata. Tectitical twats for Al teams, use of python in Al related projects	(9)
Unit III	Building Al in Your Company: Smart speaker, Case study: Self-driving car. Example roles of an Al team, Al protalls to avoid, Survey of major Al application areas Al and Society A realistic view of Al, Discrimination/Bias, Adversarial attacks on Al, Adverse uses of AL, Al and developing economies, Al and jobs	(9)

Text Books

T.1	Artificial Intelligence: A Modern Approach Stuart Russell Peter Norvig 2010 Prentice Hall
T.2	Artificial Intelligence The Basies Kevin Warwick, Routledge 2nd edition Routledge

Reference Books

R.1	Aruficial intelligence for Humans Jeff Heaton 1st edition Independent Publishing

Useful Links

1	https://onlinecourses.nptel.ac.in/noc22_cs56/preview
2	https:// onlinecourses.nptel.ac.in/noc24_ge47/preview

	Course Outcomes	CL
BCS33601.1	**Explain** the fundamentals of machine learning, including data, AI terminology, and the capabilities to enhance knowledge of machine learning.	4
BCS33601.2	**Interpret** the technical tools and methodologies used in AI projects, to determine their effectiveness in project development.	2
BCS33601.3	**Evaluate** the applications and implications of AI in industries, to find potential risks and benefits.	5

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Third Year (Semester-VI) B. Tech. Mechanical Engineering

BME33613: Internal Combustion Engine Lab

Teaching Scheme	
Lectures	2Hr/Week
Tutorials	-
Total Credits	1

Examination Scheme	
CT	-
CA	25 Marks
ESE	25 Marks
Total	50 Marks
Duration of ESE : 02 Hrs	

Course Objectives:

1	To learn the basic concept of I C Engine
2	To enhance the knowledge of IC engine
3	To share complete knowledge of type of fuels used in IC engines and the fuel supply systems
4	To describe combustion phenomena in IC engines
5	To explain the different performance analysis of IC engines

Sr. No.	List of Experiment	CO
1	Assemble/Dismantle Multi cylinder Petrol Engine.	CO1
2	Assemble/Dismantle Multi cylinder Diesel Engine.	CO1
3	Demonstrate The Significance Of Fuel Injection And Ignition Systems Of IC Engine	CO2
4	Demonstrate The Importance of Different types of Carburetor used in Petrol Engine	CO2
5	Demonstrate The Importance Of Engine Cooling And Lubrication System Of IC Engine	CO3
6	To study the Actual valve timing diagram of 4 stroke petrol engine.	CO4
7	Perform Load Test On Petrol Engine Test Rig To Prepare The Heat Balance Sheet And Plot Performance Curve	CO4
8	Perform Morse Test on the Petrol Engine Test Rig	CO4
9	To study the Actual valve timing diagram of 4 stroke diesel engine.	CO5
10	Perform Load Test On Diesel Engine Test Rig To Prepare The Heat Balance Sheet And Plot Performance Curve	CO5

Text Books

T.1	Internal Combustion Engine by V Ganeshan, McGraw Hill Education Pvt. Ltd.
T.2	Internal Combustion Engine by R. K. Rajput, Laxmi Publication
T.3	Internal Combustion Engines by V. M. Domkundwar, Dhanpat Rai Publications (P) Ltd.
T.4	Internal Combustion Engine by M. L. Mathur and R. P. Sharma, Dhanpat Rai Publications (P) Ltd

Reference Books

R.1	Internal Combustion Engines, E. Obert, Intex educational publication.
R.2	Internal Combustion Engine fundamental by John Heywood, Tata MCGraw Hill Publication

Useful Links	
1	https://nptel.ac.in/courses/112104033
2	https://nptel.ac.in/courses/112103262

	Course Outcomes	CL
BME33613.1	**Demonstrate** the ability to safely assemble and dismantle a multi-cylinder petrol engine,	3
BME33613.2	**Demonstrate** knowledge of carburetors used in petrol engines, to aware importance in air-fuel mixture preparation.	3
BME33613.3	**Analyze** the engine cooling and lubrication systems of IC engines, to know their key components, functions,	3
BME33613.4	**Evaluate** the performance of a multi-cylinder petrol engine using the Morse test	3
BME33613.5	**Summarize** the performance characteristics of a diesel engine under varying load conditions, to find heat balance sheet and performance curves	5

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Wardha Road,Nagpur-441108
NAAC Accredited with A+ Grade
(An Autonomous Institute Affiliated to RTM Nagpur University, Nagpur)

Third Year (Semester-VI) B. Tech. Mechanical Engineering

BME33614: Mechatronics & Robotics Lab

Teaching Scheme		Examination Scheme	
Practical	2Hr/Week	-	-
	-	CA	25
Total Credits	1	ESE	25
		Total	50 Marks
		Duration of ESE: 02 Hrs	

Course Objectives:

1	To familiarize students with the identification and application of electronic components, sensors, and actuators used in Mechatronics systems
2	To enhance the understanding of industrial automation by analyzing and executing automation task using standard model
3	To apply PLC programming concepts for automation tasks including bottle filling, lift control, and water level management.
4	To demonstrate the use of electro-pneumatic and hydraulic systems for motion control in industrial automation
5	To develop the ability to compare various industrial robots based on their configuration and degrees of freedom.

Experiment no.	Name of Experiment	CO
1	Interpret the characteristics and functionality of solid-state electronic devices for classification and application in electronic circuits.	CO1
2	Selection of different types of sensors and actuators in mechatronic systems with its application.	CO2
3	Develop a ladder logic program using PLC for a bottle filling plant as part of a Mechatronic system	CO3
4	Construct a ladder logic-based PLC program for a Water Level Controller and demonstrate its integration in a Mechatronic system.	CO3
5	Implementation of ladder logic program using PLC for a Lift Control System in the context of Mechatronic automation.	CO3
6	Demonstration of Electro Pneumatic Systems	CO4
7	Demonstration of Electro Hydraulic Systems	CO4
8	Comparative Study of Industrial Robots Based on Configuration and Degrees of Freedom. (Articulate, SCARA, Cartesian, Cylindrical, Delta)	CO5
9	Study of Articulated Robot Configuration and Degrees of Freedom	CO5
10	Performance of Pick-and-Place Operation Using Articulated Robot	CO5

Text Books

T.1	Mechatronics - Integrated Mechanical Electronics System, K.P. Ramachandran, Wiley India Pvt. Ltd. New Delhi
T.2	Mechatronics & Microprocessors, K.P. Ramachandran, Wiley India Pvt. Ltd., New Delhi
T.3	Mechatronics, Bolton W, Pearson Education, Second Edition, 1999.

Reference Books	
R.1	Pneumatic Tips, Festo K G, Festo, Germany, 1987
R.2	Mechatronics: Introduction, Robert H Bishop, Taylor and Francis, 2006.

	Useful Links
1	https://archive.nptel.ac.in/courses/112/107/112107298/
2	https://nptel.ac.in/courses/112103174

	Course Outcomes	CL
BME33614.1	**Interpret** the characteristics and functionality of solid-state electronic devices, to get classification, and application in electronic circuits.	3
BME33614.2	**Illustrate** the selection and application of sensors to, highlight their functionality and importance in system design.	3
BME33614.3	**Demonstrate** the ladder logic programming using PLC for automation.	3
BME33614.4	**Demonstrate** knowledge of electro-hydraulic systems, to gain knowledge of design and troubleshoot hydraulic circuits.	3
BME33614.5	**Summarize** the performance characteristics of articulated robots in pick-and-place operations, to influence their performance.	5

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