

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

Sr. No.	Course Code	Course Category	Course Title	L	T	P	Contact Hrs./Wk	Credits	EXAM SCHEME				
									CT1	CT2	TA/CA	ESE	TOTAL
1	PCC	BME3601	Mechatronics	3	-	-	3	3	15	15	10	60	100
2	PCC	BME3602	Energy Conversion	3	-	-	3	3	15	15	10	60	100
3	PCC	BME3603	Lab- Mechatronics	-	-	2	2	1	-	-	25	25	50
4	PCC	BME3604	Lab- Energy Conversion	-	-	2	2	1	-	-	25	25	50
5	PCC	BME3605	Mini Project	-	-	2	2	1+1	-	-	25	25	50
6	PEC	BME3606-09	Professional Elective-III	4	-	-	4	4	15	15	10	60	100
7	PEC	BME3610-13	Professional Elective-IV	3	-	-	3	3	15	15	10	60	100
8	OEC	B\$\$\$X01-14	Open Elective-II	4	-	-	4	4	15	15	10	60	100
9	MCC	BAU3606	Social Awareness	2	-	-	2	Audit	-	-	-	-	-
			Total	19		6	25	21	75	75	125	375	650

#Every Student will undergo Industrial Training/Internship of Two weeks in summer vacation after B. Tech. VI Sem. Examinations, upon successful completion of industrial training/internship 01 credit will be awarded after submission of the report in prescribed format.

L-Lecture

CT1-ClassTest1

CT2-ClassTest2

T-Tutorial

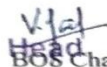
TA/CA-Teacher Assessment/Continuous Assessment

ESE-End Semester Examination (For Laboratory End Semester performance)

P-Practical

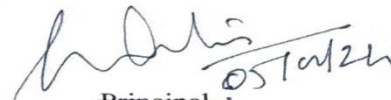
Course Category	HSMC (Hum., Soc.Sc, Mgmt.)	BSC (Basic Sc.)	ESC (Engg. Sc.)	PCC (Professional Core Courses)	PEC (Professional Elective Courses)	OEC (Open Elective courses from other discipline)	Project / Seminar /Industrial Training	MCC (Mandatory Courses)
Credits	--	--	--	8	7	4	2	Yes
Cumulative Sum	11	25	24	39	14	8	3	--

PROGRESSIVE TOTAL CREDITS:103+21=124


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Program: Mechanical Engineering

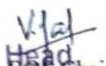
List of Electives offered by Mechanical Engineering Professional Elective

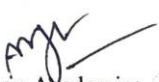
Professional Elective-I	Professional Elective- II	Professional Elective-III	Professional Elective-IV	Professional Elective-V
Semester V BME3507	Semester V BME3511	Semester VI BME3606	Semester VI BME3610	Semester VII BME4705
BME3507:Power Plant Engineering	BME3511:Renewable Energy System	BME3606: Mechanical Measurement and metrology	BME3610:Industrial Fluid Power	BME4705:Stress Analysis
BME3508:Computer Aided Designing	BME3512:Control System Engineering	BME3607:Mechanical Vibrations	BME3611:Finite Element Analysis	BME4706:Material Handling System
BME3509:Advance Manufacturing Techniques	BME3513:Tool Design	BME3608:Industrial Robotics	BME3612:Automotive System	BME4707:Composite Material
BME3510:Production Management	BME3514:Industrial Engineering	BME3609:Operation Research	BME3613:Product Design and Development	BME4708:Total Quality Management

Open Elective

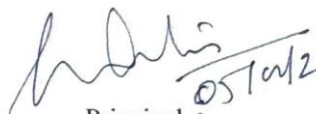
List of Open Elective

Sr. No.	Course Code	Course Title	Sr. No.	Course Code	Course Title
1	BCSXX01	Cyber Law and Ethics	9	BMEXX09	Additive Manufacturing Techniques
2	BCSXX02	Block chain Technology	10	BMEXX10	Automobile Engineering
3	BITXX03	Cyber Security	11	BEEXX11	Power Plant Engineering
4	BITXX04	Artificial Intelligence	12	BEEXX12	Electrical Materials
5	BECXX05	Internet of Things	13	BAEXX13	Avionics
6	BECXX06	Embedded Systems	14	BAEXX14	Unmanned Aerial Vehicles
7	BCEXX07	Introduction to Art and Aesthetics	15	BBTXX15	Biomaterials
8	BCEXX08	Metro Systems and Engineering	16	BBTXX16	Food and Nutrition Technology


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	Tulsiramji Gaikwad-Patil College of Engineering and Technology Wardha Road, Nagpur-441 108 NAAC Accredited (A+Grade)			
Third Year (Semester-VI) B.Tech. Mechanical Engineering				
BME3601: Mechatronics				
Teaching Scheme			Examination Scheme	
Lectures	3 Hrs/week		CT-1	15 Marks
Tutorial	-		CT-2	15 Marks
Total Credit	3		TA	10 Marks
			ESE	60 Marks
		Total	100 Marks	
		Duration of ESE: 03Hrs.		
Course Objectives				
1	To learn the basic concept of Mechatronics system			
2	To acquaint 3 phase and single phase Induction motors			
3	To Develop the ability to understand the working of various electronically and computer control devices.			
4	To Concept development to bridge the existing gap between machines, Automation and Computer control system o Solve lumped parameter transient heat transfer problems.			
Course Contents				
Unit I	Introduction: Scope and elements of mechatronics, mechatronics design process, sensors, actuators, modeling of systems. measurement system, requirements and types of control systems, feedback principle, Basic elements of feedback control systems, Classification of feedback control system. Examples of Mechatronics Systems such as Boat Autopilot, High-Speed Tilting trains, Automatic Car Park system, Coin counter, Engine management system, Antilock braking system (ABS) control, traffic controller, temperature controller, weigh-bridge, weather prediction.			
Unit II	Basic principles, working and specific applications of armature and field controlled D.C. Motors, Variable voltage and variable frequency control of 3 phase and single phase Induction motors, speed control of synchronous motors, Different types of stepper motors- Constriction, working and application. Position control of stepper motors			
Unit III	Common and commercial I.Cs used for amplification, timing and digital indication. Different types of actuators, working of synchro-transmitter and receiver set, Pressure to current (P/I) and I/P conversion. Electrical and hydraulic servomotors. Design of solenoid plungers and pressure and force amplification devices			
Unit IV	Programmable Logic Controller: Introduction to PLCs, Basic structure of PLC, Principle of operation, input and output processing, PLC programming language, ladder diagram, ladder diagrams circuits, timer counters, internal relays, master control, jump control, shift registers, data handling, and manipulations, analogue input and output, selection of PLC for application. Application of PLC control: Extending and retracting a pneumatic piston using latches, control of two pneumatic pistons, control of process motor, control of vibrating			

	machine, control of process tank, control of conveyer motor etc.
Unit V	Data acquisition and Virtual Instrumentation: Data Acquisition and analysis Tools, Programming for virtual Instrumentation, signal generation and its processing for the Fourier transform. Real time monitoring and Control, Solutions for real time applications, Various tools for real time data acquisition and control. Real time data acquisition and control.
Text Books	
1	Mechatronics Borole, Rajesh P; Angal, Yogesh S; Patil, Varsha K., Nirali Prakashan, 4th Edition, 2005
2	Mechatronics Integrated Mechanical Ramachandran K.P., Willey.
3	Boltan W, Mechatronics : Pearson Education, 11th Edition, 2005
Reference Books	
1	Introduction to Mechatronics and Measurement Systems , David Alciators & Michael B. Histan, Tata McGraw Hills, India
2	Mechatronics : HMT LTD, McGraw-Hill
Useful Links	
1	https://nptel.ac.in/courses/112/103/112103174/
2	https://nptel.ac.in/courses/112/106/112106300/
3	https://nptel.ac.in/courses/112/107/112107298/

Course Code BME3601	Course Outcomes	CL	Class Sessions
BME3601.1	Understand Scope and elements of Mechatronics	2	9
BME3601.2	Understand the working of various motors used in mechatronic systems	2	9
BME3601.3	Analyze the characteristics and use various IC's.	4	9
BME3601.4	Understand Programmable, PLC programming language	2	9
BME3601.5	Analyze Data acquisition Mechatronics Systems.	4	9


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Third Year (Semester-VI) B.Tech. Mechanical Engineering				
BME3602: Energy Conversion				
Teaching Scheme			Examination Scheme	
Lectures	3 Hrs/week		CT-1	15 Marks
Tutorial	-		CT-2	15 Marks
Total Credit	3		TA	10 Marks
			ESE	60 Marks
		Total	100 Marks	
		Duration of ESE: 03Hrs.		
Course Objectives				
1	Students will learn the concept of steam generation			
2	To understand the concept of boiler draught			
3	To apply the basic knowledge of Different types of compressor			
4	To analyze essential elements of internal combustion engine			
5	To utilize open cycle & closed cycle gas turbine plants cogenerations			
Course Contents				
Unit I	Introduction to layout of thermal power plant: principle of steam generation, fuel for steam generators, necessity of water treatment, classification of steam generators, fire tube and water tube boilers, high pressure boilers, low pressure boiler, boiler mountings and accessories.			
Unit II	Draught and its classification: calculations for chimney height, chimney diameter & efficiency. Condition for maximum discharge. Performance of steam generators: Evaporation capacity, equivalent evaporation, boiler efficiency.			
Unit III	Air Compressors: Introduction, classification, applications. Positive displacement Compressors:- Reciprocating compressors: - Construction and working, isothermal, polytropic & adiabatic compression process, work done with and without clearance, P-V diagram, volumetric efficiency, effect of clearance, isothermal efficiency, methods for improving isothermal efficiency, volumetric efficiency, mechanical efficiency, multistage compression, intercooling, condition for minimum work input.			
Unit IV	Internal Combustion Engines: Introduction, classification, components of I.C. Engines, working of two stroke and four stroke S.I. and C.I. Engines, valve and port timing diagram. Advantages and disadvantages, applications. Combustion in I. C. Engines: Combustion in S. I. Engine, stages of combustion, ignition lag, detonation. Combustion in C. I. Engine, stages of combustion, delay period, diesel knock, abnormal combustion in S.I. and C.I. engines, detonation and knocking.			

Unit V	Gas Turbine: Introduction to Gas Turbine, Classification of Gas turbine, Open cycle and closed cycle gas turbine, effect of inter-cooling, reheating & regeneration, fuel-air ratio, combustion efficiency, performance calculation. (Analytical treatment needed) Jet Propulsion: Principles & working of turbojet, turbo-prop, Ramjet & pulse jet, simple turbojet cycle.
Text Books	
1	Gas Turbine & Jet Propulsion, Dubey & Khajuriya, Dhanpat Rai & Sons.
2	Power Plant Engineering: P.K.Nag/ II Edition /TMH.
3	Thermal Engineering, P.L. Ballaney, Khanna Publications.
Reference Books	
1	Gas Turbine Theory, Cohen and Rogers, Pearson.
2	IC Engine V. Ganeshan, MC Graw Hill education
	Power Plant Engineering, M. M. EI- Wakil, McGraw Hill International.
Useful Links	
1	https://nptel.ac.in/courses/112/107/112107291/
2	https://nptel.ac.in/courses/112/106/112106166/
3	https://nptel.ac.in/courses/112/106/112106300/

Course Code BME3602	Course Outcomes	CL	Class Sessions
BME3602.1	Compare the high pressure and low pressure boiler, and components of thermal power plant	2	9
BME3602.2	Analyze performance of chimney and compare draught	3	9
BME3602.3	Describe various types of reciprocating and rotary compressors with performance calculations of positive displacement compressors	3	9
BME3602.4	Describe construction and working of various I. C. Engine systems	2	9
BME3602.5	Compare open cycle & closed cycle gas turbine plants cogenerations & combined	3	9


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Third Year (Semester-VI) B. Tech. Mechanical Engineering					
BME3603: Mechatronics Lab					
Teaching Scheme				Examination Scheme	
Practical	2 Hrs/week			CA	25 Marks
				ESE	25 Marks
Total Credit	1			Total	50 Marks
				Duration of Exam: 03 Hrs .	
Course Objectives					
1	Determine the solid state electronics devices.				
2	Identify different sensors and actuators.				
3	Demonstrate the working of various digital to analog to digital converters.				
4	Illustrate the ladder diagram, programming using PLC for various sensors and controllers.				
5	Interpret the working of electro pneumatic system and hydraulic system.				
Experiment No.	Name of Experiment				CO
1	Identification of solid state electronic devices.				CO1
2	Identification of different types of sensors and actuators with its application				CO2
3	Application of AND ,OR and NOT GATE for converting ADC to DAC and vice versa				CO3
4	Illustration of Mechatronics system with development of ladder diagram and PLC programming for bottle filling plant				CO4
5	Illustration of Mechatronics system with development of ladder diagram and PLC programming for Lift Control System				CO4
6	Illustration of Mechatronics system with development of ladder diagram and PLC programming for Water Level Controller				CO4
7	Illustration of Mechatronics system with development of ladder diagram and PLC programming for Traffic Light Control System				CO4
8	Demonstration of Electro Pneumatic Systems				CO5
9	Interpretation of working of Electro Hydraulic Systems				CO5
Text Books					
1	Mechatronics - Integrated Mechanical Electronics System, K.P. Ramachandran, Wiley India Pvt. Ltd. New Delhi				
2	Mechatronics & Microprocessors, K.P. Ramachandran, Wiley India Pvt. Ltd., New Delhi.				
3	Mechatronics, Bolton W, Pearson Education, Second Edition, 1999.				
Reference Books					

1	Pneumatic Tips, Festo K G, Festo, Germany, 1987.
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 Code BME3603	Course Outcomes	CL	Class Sessions
BME3603.1	Determine the solid state electronics devices.	3	2
BME3603.2	Identify different sensors and actuators.	3	2
BME3603.3	Demonstrate the working of various digital to analog to digital converters.	4	2
BME3603.4	Illustrate the ladder diagram, programming using PLC for various sensors and controllers.	3	2
BME3603.5	Interpret the working of electro pneumatic system and hydraulic system.	3	2


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Third Year (Semester-VI) B. Tech. Mechanical Engineering				
BME3604 : Lab- Energy Conversion				
Teaching Scheme			Examination Scheme	
Practical	2Hrs/week		CA	25 Marks
Total Credit	1		ESE	25 Marks
			Total	50 Marks
		Duration of ESE: 02 Hrs 00 Min.		
Course Outcomes (CO)				
After completion of the course, Students will be able to				
1	Compare the high pressure and low pressure boiler			
2	Evaluate various characteristics of air compressor			
3	Interpret the component of Internal Combustion Engine			
4	Evaluate the performance of Internal Combustion Engine			
5	Explore the importance of Gas Turbine.			
Sr. No.	List of Experiment			CO
1	To study and sketch about the Locomotive Boiler.			CO1
2	To study and sketch about the model of Babcock Wilcox Boiler			CO1
3	Perform test on two stage reciprocating air compressor test rig to find volumetric efficiency and isothermal efficiency.			CO2
4	Assemble/ Dismantle Multi cylinder Petrol Engine			CO3
5	Assemble/ Dismantle Multi cylinder Diesel Engine			CO3
6	Perform load test on Petrol Engine Test Rig to prepare heat balance sheet And plot performance curve			CO4
7	Perform load test on Diesel Engine Test Rig to prepare heat balance sheet And plot performance curve			CO4
8	Perform Morse Test on Petrol Engine			CO4
9	To study of Gas Turbine Power Plant			CO5
10	To study open cycle constant pressure combustion gas turbine with inter cooler, regenerator and reheater			CO5
Text Books				
1	Thermal Engineering, P.L. Ballaney, Khanna Publications			
2	Thermal Engineering, R. K. Rajput, Laxmi publications.			
3	Gas Turbine& Jet Propulsion, Dubey & Khajuriya, Dhanpat Rai & Sons			
Reference Books				
1	Power Plant Engineering, M. M. EI- Wakil, McGraw Hill International.			
2	Gas Turbine Theory, Cohen and Rogers, Pearson.			

3	Internal combustion engine fundamentals, by: John Heywood, pub.: McGraw- Hill .
4	Elements of Gas Turbine Propulsion, Jack D. Mattingly McGraw-Hill, Inc., 1996.
Useful Links	
1	https://nptel.ac.in/courses/108/104/108104139/
2	http://nptel.ac.in/courses/117107095


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Third Year (Semester-VI) B. Tech. Mechanical Engineering				
BME3608:PE-III- Industrial Robotics				
Teaching Scheme			Examination Scheme	
Lectures	4 Hrs/week		CT-1	15 Marks
Tutorial	-		CT-2	15 Marks
Total Credit	4		TA	10 Marks
			ESE	60 Marks
			Total	100 Marks
		Duration of ESE: 03 Hrs .		
Course Objectives				
1	To introduce the functional elements of Robotics.			
2	To impart knowledge on robot end effectors and grippers.			
3	To introduce the dynamics and control of manipulators in robotics.			
4	To understand basic concept of robotics sensors in robotics industries			
5	To understand the cell layouts of robots and its interface.			
Course Contents				
Unit I	Basic concepts: - Brief history-Types of Robot–Technology-Robot classifications and specifications-Design and control issues- Various manipulators – Sensors - work cell - Programming languages.			
Unit II	Robots end-effectors-classification of end-effectors, mechanical grippers, hooking or lifting grippers, grippers for molten metal's, plastics, vacuum cups, magnetic grippers, electrostatic grippers, multiple grippers, internal & external grippers, drive systems for grippers, active & Passive grippers.			
Unit III	Direct and inverse kinematics :- Mathematical representation of Robots - Position and orientation -Homogeneous transformation Various joints- Representation using the Denavit Hatten berg parameters -Degrees of freedom-Direct kinematics-Inverse kinematics- SCARA robots- Solvability – Solution methods-Closed form solution.			
Unit IV	Robot Sensors: Scheme of robotic sensors, contact type sensors, force, torque, touch, position, 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.			
Unit V	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.			
Text Books				
1	R.K.Mittal and I.J.Nagrath, Robotics and Control, Tata McGraw Hill, New Delhi,4th Reprint,			

	2005.
2	M.P.Groover, M.Weiss, R.N. Nageland N. G.Odrej, Industrial Robotics, McGraw-Hill Singapore, 1996.
3	JohnJ.Craig ,Introduction to Robotics Mechanics and Control, Third edition, Pearson Education
Reference Books	
1	Ashitava Ghoshal, Robotics-Fundamental Concepts and Analysis', Oxford University Press, Sixth impression,2010.
2	K. K.Appu Kuttan, Robotics, I K International, 2007.Edwin Wise, Applied Robotics, Cengage Learning.
3	R.D.Klafter, T.A.Chimielewski and M.Negin, Robotic Engineering–An Integrated Approach, Prentice Hall of India,New Delhi, 1994.
4	B.K.Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai, 1998.
5	S.Ghoshal, “Embedded Systems & Robotics” – Projects using the 8051 Microcontroller”, 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 Code BME3608	Course Outcomes	CL	Class Sessions
BME3608.1	Discuss history and classification of robots.	3	9
BME3608.2	Explain robot end effectors and grippers.	4	9
BME3608.3	Explain direct and inverse kinematics.	4	9
BME3608.4	Discuss the types of robot sensors and its applications.	3	9
BME3608.5	Explain the cell layouts of robots and its interface.	4	9


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Third Year (Semester-VI) B. Tech. Mechanical Engineering					
BME3609: PE III-(Operation Research)					
Teaching Scheme				Examination Scheme	
Lectures	4 Hrs/week			CT-1	15 Marks
Tutorial	-			CT-2	15 Marks
Total Credit	4			TA	10 Marks
				ESE	60 Marks
				Total	100 Marks
			Duration of ESE: 03 Hrs.		
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					
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.				
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				
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.				
Unit IV	Drawing of Network, CPM & PERT, probability of completion of project, Cost Analysis of Project, and Concept of Crashing. Allocation & updating of Network.				
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)				

Text Books	
1	Operation Research, Heera & Gupta, S Chand Publications
2	Operation Research, JK Sharma, Mc Millian Publications
3	Operation Research , S D Sharma, Kedarnath Ramnath & Co.
Reference Books	
1	Operation Research, Hamdy Taha, Prentice Hall
2	Operation Research, Liberman, McGraw Hill Publications
Useful Links	
1	https://nptel.ac.in/courses/110/106/110106062/
2	https://examupdates.in/operation-research-notes/

Course Code BME3609	Course Outcomes	CL	Class Sessions
BME3609.1	Solve linear programming problems using simplex method, Big M method and Duality.	3	9
BME3609.2	Determine the optimal solution for Transportation problems and Assignment problems.	4	9
BME3609.3	Apply an optimal replacement period of equipment or machine and Determine the value of the given Inventory Model.	3	9
BME3609.4	Draw project networks for quantitative analysis of projects.	5	9
BME3609.5	Determine the value of the given Sequencing Model, Simulation and Queuing models.	3	9


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Third Year (Semester-VI) B. Tech. Mechanical Engineering				
BME3610:PE-IV-Industrial Fluid Power				
Teaching Scheme			Examination Scheme	
Lectures	3 Hrs/week		CT-1	15 Marks
Tutorial	-		CT-2	15 Marks
Total Credit	3		TA	10 Marks
			ESE	60 Marks
			Total	100 Marks
			Duration of ESE: 03 Hrs .	
Course Objectives				
1	To understand various Hydraulics and Pneumatic techniques used in various applications & industries			
2	To Explain the operation of the main elements of an industrial hydraulic and pneumatic system			
3	To understand automation concept of industry			
Course Contents				
Unit I	Oil Hydraulic System : Hydraulic power generator- selection and specification of pumps, pump characteristics. Hydraulic Actuators: Hydraulic and rotary actuators - Selection, Specification and characteristics.			
Unit II	Hydraulic valves actuators and accessories: Construction, principle of working and symbols of pressure control valves - pressure relief valve direct, pilot operated , pressure reducing pressure unloading. Sequence valve. Counter balancing. Direction control valve 2/2,3/2,4/2,5/3. Flow control valves, actuators.			
Unit III	Hydraulic Circuits: Draw layout of simple hydraulic circuits, reciprocating, quick return, sequencing circuits, meter in meter out circuit, synchronizing circuit, regenerative circuit industrial circuit (hydraulic milling machine shaper machine).			
Unit IV	Introduction To Component of Pneumatic System: Applications of pneumatic system, general layout merits and limitation of pneumatic system, selection of air compressor, valves (pressure regulating, directional control and flow control valves, actuators (rotary and linear)			
Unit V	Pneumatic Circuit: Draw layout of simple pneumatic circuits, speed control circuit for double acting cylinder and bi directional air motor, sequencing circuit- position based sequencing circuit and time delay circuit			
Text Books				
1	Andrew parr, Hydraulic and pneumatics, (HB), Jaico Publishing House			
2	Industrial Hydraulics, John J. Pippenger, Tata McGraw Hill.			
3	Pneumatic Systems, S. R. Mujumdar, Tata McGraw Hill.			
Reference Books				

1	Antony Esposito, “Fluid Powe with application”, prentice Hall
2	DudleytA. Pease and JohnJ pippenger, “ Basic Fluid power”” Prentice Hall
Useful Links	
1	http://www.pneumatics.com
2	http://www.fluidpower.com.tw

Course Code BME3610	Course Outcomes	CL	Class Sessions
BME3610.1	Identify various components of hydraulic and pneumatic system	2	9
BME3610.2	Select appropriate control valve for given hydraulic system	2	9
BME3610.3	Design hydraulic circuits for various hydraulic system.	4	9
BME3610.4	Apply appropriate control valve for given pneumatic system	3	9
BME3610.5	Design pneumatics circuits for various pneuatics system.	4	9


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	Tulsiramji Gaikwad-Patil College of Engineering and Technology Wardha Road, Nagpur-441 108 NAAC Accredited (A+ Grade)			
Third Year (Semester-VI) B. Tech. Mechanical Engineering				
BME3613:PE-IV- Product Design and Development				
Teaching Scheme			Examination Scheme	
Lectures	3 Hrs/week		CT-1	15 Marks
Tutorial	-		CT-2	15 Marks
Total Credit	3		TA	10 Marks
			ESE	60 Marks
			Total	100 Marks
			Duration of ESE: 03 Hrs .	
Course Objectives				
1	To understand product development processes.			
2	To understand and explain the concept of Industrial design and robust design concepts.			
3	To understand the concept of Design for manufacture and assembly.			
4	To understand the legal factors, social issues, engineering ethics related to product design			
5	To understand principles and technologies used for the preparation of prototype.			
Course Contents				
Unit I	Introduction: Characteristics of successful product development, design and development of products, duration, and cost of product development, the challenges of product development. Development Processes and Organizations: Generic development process, concept development: the frontend process, adopting the generic product development process, the AMF development process, product development organizations, the AMF organization.			
Unit II	Product planning: Product planning process, identify opportunities, evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect all the results and the process Identifying customer needs: Gather raw data from customers, interpret raw data in terms of customer needs, organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and The process.			
Unit III	Concept Generation: Activities of concept generation, need for systems level thinking, TRIZ and its comparison with brainstorming and lateral thinking, TRIZ tools Ideality and IFR, problem formulation and functional analysis, use of 40 principles to solve contradiction, use of S-curves and technology evolution trends. Concept selection: Overview of methodology, concept screening, and concept scoring, Pugh matrix and its application. Concept testing: Define the purpose of concept test, choose a survey population, choose a survey format, communicate the concept, measure customer response, interpret the result, reflect on the results and the process, Failure Mode Effect Analysis			

	(DFMEA and PFMEA).
Unit IV	Product architecture: implications of the architecture, establishing the architecture, variety and supply chain considerations, platform planning, related system level design issues. Industrial design: Assessing the need for industrial design, the impact of industrial design, industrial design process, managing the industrial design process, assessing the quality of industrial design.
Unit V	Prototyping: Prototyping basics, principles of prototyping, technologies, planning for prototypes Product development economics: Elements of economic analysis, base case financial mode, sensitive analysis, project trade-offs, influence of qualitative factors on project success, qualitative analysis.
Text Books	
1	A K Chitale and R C Gupta, Product Design and Manufacturing, 6th Edition, PHI, New Delhi, 2003.
2	Karl.T.Ulrich and Steven D Eppinger Irwin, Product Design and Development, 5th Edition, McGraw- Hill, 2011.
3	George E Deiter, Engineering Design, 5th Edition, McGraw-Hill , 2012
Reference Books	
1	Boothroyd G, Dewhurst P and Knight W, Product Design for Manufacture and Assembly, 2nd Edition, Marcel Dekker, New York, 2002.
2	G Altshuller, H Altov, Lev Shulyak, And Suddenly the Inventor Appeared: TRIZ, The theory of Inventive Problem Solving, Technical Innovation Centre, 2nd Edition, May 1996
Useful Links	
1	https://www.youtube.com/watch?v=HN9GtL21rb4
2	https://www.youtube.com/watch?v=9WPZStQp03Q
3	https://onlinecourses.nptel.ac.in/noc21_me83/preview

Course Code	Course Outcomes	CL	Class Sessions
BME3613			
BME3613.1	Describe the characteristics used for product design and development.	3	9
BME3613.2	Assess the customer requirements in product design.	4	9
BME3613.3	Apply structural approach to concept generation, selection and testing	3	9
BME3613.4	Identify various aspects of design such as industrial design, design for manufacture, assembly, service and quality and product architecture.	5	9
BME3613.5	Explain various principles and technologies used for the preparation of prototype.	3	9


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Third Year (Semester-VI) B. Tech. Mechanical Engineering				
BMEXX10:Automobile Engineering (Open Elective)				
Teaching Scheme			Examination Scheme	
Lectures	4 Hrs/week		CT-1	15 Marks
Tutorial	-		CT-2	15 Marks
Total Credit	4		TA	10 Marks
			ESE	60 Marks
			Total	100 Marks
Duration of ESE:03Hrs.				
Course Objectives				
1	To recognize the fundamentals and applications of various types of automobiles and its major components.			
2	To illustrate the importance and working of transmission and driveline components.			
3	To explore components and working of steering, braking and suspension system and various types of tyres.			
4	To identify engine components and subsystems; explain working of engine, formation and control of pollutants.			
5	To demonstrate the importance and functioning of various electrical, electronic devices and recent trends in automobiles.			
Course Contents				
Unit I	Introduction: Classification of automobiles, Major components and their functions. Chassis Different vehicle layout. Power train: Engine, Basic Components, Classification, Two Stroke, Four Stroke, Petrol Engine, Diesel Engine, Fuel Supply systems: Necessity, Introduction to Carburetor and Fuel Injection system.			
Unit II	Clutch: Necessity, requirements of a clutch system. Types of Clutches, Gearbox- Necessity of transmission, principle, types of transmission, Automatic Transmission. Transmission system: Propeller shaft, Universal joint, constant velocity joint, Differential, 2 Wheel Drive, 4Wheel drive. Steering systems: Principle of steering, steering geometry and wheel alignment, Power Steering. Under steer, Over steer.			
Unit III	Tyres: Tyres specification, types, factors affecting tyre performance, Special tyres, tyre treads, Hydro planing., tyre Rotation. Suspension systems: Need, Function of spring and shock absorber, conventional suspension, Independent suspension System, Active suspensions. Brakes: Function, Classification, Basic Components. Drum Brakes, Disc Brakes, Hydraulic brakes, Air Brakes,			
Unit IV	Electrical systems: Battery construction, maintenance, testing and charging, cutout, lighting circuit, horn, side indicator, wiper and panel board instruments. Battery, magneto and electronic ignition systems. Automobile air-conditioning. Wheels and Tyres: Types of wheels, wheel dimensions, tyre, desirable tyre properties, types of tyres, comparison of radial and bias-ply tyres, tyre construction, tyre materials, factor affecting tyre life, precautions regarding the tyres and wheel balancing.			

Unit V	Recent Advances in automobile technology: Electric Vehicle, Hybrid Cars, types of hybrids, Traction control, intelligent highway system, Collision avoidance system, Automatic Cruise Control, Navigational aids, Parking Assistance system. Recent advances in automobiles such as ABS, electronic power steering, Active suspension, collision avoidance, intelligent lighting, navigational aids and electronic brake distribution system.
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TextBooks	
1	Automobile Engineering Vol. I & II, Kirpal Singh, Standard Publishers.
2	Automobile Engineering, R. K. Rajput, Laxmi Publications.
3	Automobile Engineering Rajput, R.K. Tata McGraw Hill.
ReferenceBooks	
1	Automotive Mechanics: Principles And Practices Heitner Joseph Publications
2	Automobile Mechanics, Crause, W.H., Tata McGraw Hill
3	Design And Implementation Of Anticipating Mechanism For An Automobile To Reduce The Injuries And Sometime Death Happen In Road Accident
4	Automotive Engines, Srinivasan S., Tata McGraw Hill
5	Automotive Mechanics—Joseph Heitner, Van Nostr and Reinhold
UsefulLinks	
1	www.howacarworks.com/basics
2	https://www.iav.com/us/engineering
3	http://www.sae.org/automotive/

BMEXX10	Course Outcomes	CL	Class Sessions
BMEXX10.1	Identify the components and layout of automobile.	2	9
BMEXX10.2	Analyze the mechanics of transmission system.	4	9
BMEXX10.3	Compute the importance of suspension and braking system.	3	9
BMEXX10.4	Demonstrate the functioning of various electrical, electronic devices.	3	9
BMEXX10.5	Understand the recent advances in automobile.	2	9



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