Jabalpur Engineering College, Jabalpur

(Declared Autonomous by MP Govt., Affiliated to RGPV, Bhopal)

(AICTE Model Curriculum Based Scheme)

Bachelor of Technology (B.Tech.) IV Semester (Mechatronics Engineering)

w.e.f. July 2023

S.No.	Subject Code	Category Code	Subject Name	Maximum Marks Allotted					Total Marks	Contact Hours Per Week			Total Credits
				Theory			Practical						
				End. Sem.	Mid Sem. Exam.	Quiz/ Assignment	End Sem.	Lab Work		L	T	P	
1	MT41	PCC	Manufacturing Process	70	20	10	-	-	100	3	1	-	4
2	MT42	PCC	Electronic Devices & Circuits	70	20	10	30	20	150	3	-	2	4
3	MT43	PCC	Theory of Machines	70	20	10	30	20	150	3	-	2	4
4	MT44	PCC	Microprocessor & Embedded Systems	70	20	10	30	20	150	3	-	2	4
5	MT45	PCC	Linear Control Theory	70	20	10	-	-	100	3	1	-	4
6	MT46	ESC	CAD & Kinematics Simulation Lab	-	-	-	30	20	50	-	-	4	2
Total				**350**	**100**	**50**	**120**	**80**	**700**	**15**	2	**10**	**22**
7	MT47	DLC	Self-Learning Presentation (SWAYAM/NPTEL/MOOC)	-	-	-	-	-	-	-	-	-	8
8	MT48	MC	NSS/NCC/Swatchhata Abhiyan/Rural Outreach	Qualifier									
Additional Course for Honours or Minor Specialization				Permitted to opt for maximum 8 credits against additional MOOC courses in subject code MT47 for the award of Honours (Minor Specialization).									

Note: MOOC/NPTEL subjects shall be taken with permission of HOD/Coordinator.

1 hour lecture (L) = 1 credit	1 hour Tutorial (T) = 1 credit	2 hour Practical (P) = 1 credit

PCC: Professional Core Course, ESC: Engineering Science Course, DLC: Distance Learning Course, MC: Mandatory Course

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COURSE CONTENTS **w.e.f. July 2023**

Subject Code	Subject Name	Maximum Marks Allotted					Total Marks	Contact Hours Per Week			Total Credits
		Theory			Practical			L	T	P	
		End. Sem.	Mid Sem. Exam.	Quiz/ Assignment	End Sem.	Lab Work					
MT-41	Manufacturing Process	70	20	10	-	-	100	3	1	-	4

Module-I: Pattern Making: Types of pattern, Pattern and pattern making, pattern allowances; pattern design considerations, core and core boxes.
Casting: Types of casting process. Molding and Foundry core sands and their properties, gating, runners, risers, solidification, defects and elimination, molding machines, centrifugal casting, dye casting, shell molding, Lost wax molding; continuous casting, cupola description and operation.

Module-II: Welding: Types of welding, Gas welding method, flames, gas cutting, Electric arc welding, AC and DC welding machines and their characteristics, flux, electrodes, submerged arc welding, TIG & MIG welding, pressure welding, electric resistance welding spot, seam and butt welding; Consumable estimation for weld length and size, Thermit chemical welding, brazing and soldering, welding defects & remedies. Safety precautions.

Module-III: Forging: Types of forging operations. Theory and application of forging processes, description of drop and horizontal forging machines.

Module-IV: Press working: Description and operation of processes, process of shearing, punching, piercing blanking, trimming, perfecting, notching, lancing, embossing, coining, bending, forging and drawing; press, types of presses, tool dies, die punch clearance, auxiliary equipment, safety devices, stock feeders, scrap cutters, forces, pressure and power requirements..

Module-V: Rolling: Types of Rolling operations, stages of rolling for formation, General description of machines and process; rolling of structural section plates and sheets; hot and cold rolling techniques.

Text & Reference Books:

1. Anderson and Tetro; Shop Theory, Mc Graw Hills.
2. Kaushish JP; Manufacturing Processes; PHI Learning.
3. Kalpakjian Producting Engineering, PEARSON Education.
4. Chapman; Workshop Technology.
5. Philip F Ostwald; Manufacturing Process &systems: John Wiley.
6. Raghuvanshi; Workshop Technology, Dhanpat Rai.
7. HajraChoudhary; Workshop Technology: Vol L..

COURSE OUTCOMES: At the completion of this course, students should be able to

CO1	Define the general production processes like casting, forging, press working, welding and spinning.
CO2	Illustrate working principle of metrology instruments used in production shop.
CO3	Explain metal cutting process on lathe with machining economics.
CO4	Compare various welding processes.
CO5	Understand the processing of different materials in the lab.

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		End. Sem.	Mid Sem. Exam.	Quiz/ Assignment	End Sem.	Lab Work					
MT- 42	Electronic Devices & Circuits	70	20	10	30	20	150	3	-	2	4

Module-1 Semiconductor materials, PN junction, Ideal and Practical diode, Tunnel diodes, Varactor diodes, Schottky diode, Photo diodes, Photodetector, LED, solar cell, Clipper, Clamper, Half wave rectifier, Full wave rectifier, Bridge rectifier, filter circuits, Voltage regulation using shunt & series regulator circuits, Voltage regulation using IC.

Module-2 Fundamentals of BJT, basic operation, current components and equations, CB, CE and CC configuration, BJT as an amplifier, Transistor biasing circuits, DC analysis and AC analysis, Transistor as a switch.

Module-3 Introduction to MOSFET, principle, working, types and configurations. Concept of feedback and their types, Introduction to Oscillators and types, RC Phase Shift, Wien Bridge Oscillators. LC Oscillators: Hartley, Colpitts's, Clapp and Crystal oscillator.

Module-4 Introduction of OPAMP, Configurations, Virtual ground, CMRR, Slew rate, SVRR etc., Applications of OPAMP as Comparator, Adder, Subtractor, Averaging, Integrator, Differentiator, Voltage Follower, Triangular/Rectangular wave generator.

Module-5 Linear Applications of OPAMP: Instrumentation Amplifier, Analog Multiplier and Divider, VCO, Zero Crossing Detector, Schmitt Trigger, Log/ Antilog amplifier, Voltage limiters, Clipper and Clampers circuits, Peak detector, Sample and hold Circuit, Precision rectifiers, Voltage-to-Current converter, Current-to-voltage converter, Filters, Regulators.

Text/Reference Books:

1. Millman & Halkias, "Electronic Devices And Circuits", TMH.
2. Salivahanan, Kumar & Vallavaraj, "Electronic Devices And Circuits", TMH.
3. Boylestad & Neshelsky, "Electronic Devices & Circuits", PHI.
4. Schilling & Belove, "Electronic Circuits , Discrete & Integrated", TMH.
5. Chattopadhyay & Rakhshit, "Electronic Fundamentals & Applications", New Age
6. Adel S. Sedra & Kenneth C. Smith, "Microelectronic Circuits", OUP.
7. R. A. Gayakwad, "Op-Amps And Linear Integrated Circuits", PHI
8. Theodore F. Bogart, Jeffrey S. Beasley, "Guillermo Rico Electronic Devices & Circuits".
9. Allen Mottershead, "Electronic Devices & Circuits".

List of Experiments:

1. To design and verify Clipper and Clamper circuits using diodes.
2. To design a circuit performing rectification using diode / OPAMP.
3. To study DC and load line analysis using BJT.
4. To verify MOSFET drain and transfer Characteristics.
5. To design RC Phase Shift Oscillator / Wien Bridge Oscillators.
6. To design Hartley, Colpitts's, Clapp and Crystal oscillators.
7. To design circuits for Triangular/Rectangular waves generation using OPAMP.
8. To design adder, subtractor, multiplier circuits using OPAMP.
9. To design a circuit using OPAMP for comparison.
10. To design Zero Crossing Detector, Schmitt Trigger using OPAMP.

COURSE OUTCOMES: At the end of the course the student will be able to:

CO1 Understand basics of diode and its applications.

CO2 Learn the BJT working and practical aspects.

CO3 Knowledge of MOSFET devices and concept of feedback amplifier, Oscillators.

CO4 Understand the basics of OPAMP.

CO5 Analyse various applications of OPAMP.

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Subject Code	Subject Name	Maximum Marks Allotted					Total Marks	Contact Hours Per Week			Total Credits
		Theory			Practical			L	T	P	
		End. Sem.	Mid Sem. Exam.	Quiz/ Assignment	End Sem.	Lab Work					
MT- 43	Theory of Machines	70	20	10	30	20	150	3	-	2	4

Module 1. Mechanisms and Machines: Links, Pairs, Chains, Structure, Mechanism, Machine, Equivalent linkage, Degrees of freedom, Gruebler's & Kutzback's criterion, Inversions of four bar chain, Mechanism with lower pairs Pantograph, Straight line motion mechanisms, Davis and Ackermann's steering mechanisms, Hooke's joint, Numerical problems based on above topics.

Module 2. Motion: Plane motion, Absolute & Relative motion, Displacement, Velocity and Acceleration of a point, Velocity and Acceleration Analysis by Graphical & Analytical methods, Velocity of rubbing, Kennedy's Theorem, Acceleration polygon, Coriolis acceleration component, Klein's construction, Numerical problems based on above topics.

Module 3. Gears: Classification of gears, Helical, Spiral, Bevel and Spur Gear, Spur Gear Terminology, Law of gearing, Tooth profiles, velocity of sliding, Path of contact, Arc of contact, Contact Ratio, Interference and Undercutting, Conjugate action, Numerical problems based on above topics.
Gear Trains: Simple, compound, reverted and epi-cyclic gear trains. Velocity ratio and torque calculation in gear trains.

Module 4. Cams: Classification of Cams and Followers, Radial Cam Terminology, Analysis of Follower motion (uniform, modified uniform, simple harmonic, parabolic, cycloidal), Pressure Angle, Radius of Curvature, Cam Profile for radial and offset followers Synthesis of Cam Profile by Graphical Approach, Cams with Specified Contours.
Gyroscope: Gyroscopic Action in Machines, Angular Velocity and Acceleration, Gyroscopic torque/ couple, gyroscopic effect on Naval Ships, Stability of Two and Four Wheel Vehicles, Rigid disc at an angle fixed to a rotating shaft.

Module 5. Belt Rope & Chain Drive: Types of Belts, Velocity ratio of a belt drive, Slip in belts, Length of open belt and crossed belt, Limiting ratio of belt-Tensions, Power transmitted by a belt, Centrifugal tension, Maximum tension in a belt, Condition for maximum power transmitted, Initial tension in a belt, Creep in belt, Applications of V-Belt, Rope and Chain drives.

Text & Reference Books:

1. Thomas Bevan; Theory of Machines; Pearson Education.
2. Rattan SS; Theory of machines; MC Graw Hills.
3. Ambekar AG; Mechanism and Machine Theory; PHI. Eastern Economy Edition 2015.
4. Uicker&Shigley, Theory of machines & Mechanism Second Edition Oxford University Press.
5. Rao JS and Dukkipati; Mechanism and Machine Theory; New Age Delhi.
6. Abdulla Shariff, Theory of Machines.
7. Theory of machines by R.K.Bansal.

List of Experiments:

1. To finds out gyroscopic couple.
2. To find out velocity & acceleration of slider crank mechanism by Klin"s Construction.
3. To find out velocity ratio of various gear trains.
4. To study of various types of belt drives & find out the velocity ratio of the drive.
5. To draw the cam profile.
6. Study of working models of various popular mechanisms like quick return mechanism etc.
7. To draw Involute profile of a gear by generating method.

Course Outcomes: At the completion of this course, students should be able to :

CO1	Explain the kinematics of mechanism and their inversions.
CO2	Analyze velocity and acceleration of different links of mechanisms using different methods.
C03	Design different types of gears and gear trains.
C04	Draw cam profile for different follower motions.
CO5	Analyze Gyroscopic effect on Naval ship and Stability of Two and Four Wheel Vehicles.

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Subject Code	Subject Name	Maximum Marks Allotted					Total Marks	Contact Hours Per Week			Total Credits
		Theory			Practical						
		End. Sem.	Mid Sem. Exam.	Quiz/ Assignment	End Sem.	Lab Work		L	T	P	
MT- 44	Microprocessor & Embedded Systems	70	20	10	30	20	150	3	-	2	4

Module-I Von Neumann model, CPU, Memory, I/O, System Bus, Memory address register, Memory data register, program Counter, Accumulator, Instruction register, Micro operations, Register Transfer Language, Instruction Cycle, Instruction formats. Control Unit, Control Memory, Micro program sequencer, RAM, ROM, Cache memory and mapping, Virtual memory.

Module-II Introduction to 8085 Microprocessor, Introduction to 8086 microprocessor, architecture, pin functions, Register organization, Instruction Format, Addressing modes of 8086, modes, Instruction set of 8086, Assembler Directives and Operators, Assembly language Programming.

Module-III Memory interfacing, Interfacing I/O devices, Interfacing with RAM and ROM, 8279 programmable Keyboard/Display interface, 8255A programmable Peripheral interface, Interfacing keyboard and seven-segment display using 8255A, 8254 programmable Interval Timer, 8259A programmable Interrupt Controller, 8257 DMA Controller, RS-232C standard, 8251 USART, Stepper motor interfacing.

Module-IV Microcontroller: 8051, its architecture, Counters and Timers, Interrupts and stack of 8051, Addressing modes. AVR, ATMEGA, PIC, Arduino, Raspberry-Pi microcontrollers.

Module-V Introduction to Embedded systems, Classification of embedded systems, Embedded Processors, RISC and CISC, Embedded Software, Application areas, Embedded firmware design, RTOS based embedded system design, ASICs, PLDs.

Reference Books:

1. Morris Mano, "Computer System Architecture" (PHI).
2. William Stalling, "Computer Organization and Architecture" (PHI).
3. Microprocessor architecture, Programming and Applications with the 8085 by Ramesh S.Gaonkar
4. B B Brey, "The Intel Microprocessors, Architecture, Programming and Interfacing"(PHI).
5. K M Bhurchandi and A K Ray,"Advanced Microprocessors and Peripherals"(Mc-Graw Hill Education).
6. Shibu K V, "Introduction to Embedded Systems" (Mc-Graw Hill Education).
7. Microprocessors and Microcontrollers : Architecture, Programming And System Design 8085, 8086, 8051, 8096, by Dr. Krishnakant, PHI Publication.

Course Outcomes:

Upon successful completion of course student will be able to:

CO1	Understand the fundamental concepts of computer system architecture.
CO2	Explain the architecture and working of 8086 microprocessor.
CO3	Illustrate how the different peripherals are interfaced with microprocessor.
CO4	Analyze the architecture and working of 8051 Microcontroller.
CO5	Design various embedded system applications.

List of Experiments:

1. Byte addition, subtraction, multiplication and division
2. Scan string for character
3. If then else implementation.
4. Converting BCD number to binary
5. Addition of series of numbers
6. Largest and smallest number in a list
7. Sorting numbers in ascending order
8. Arranging an array of numbers in descending order & verify
9. Copying bytes of data from source to destination & verify
10. Rotate stepper motor in forward and reverse direction.

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		End. Sem.	Mid Sem. Exam.	Quiz/ Assignment	End Sem.	Lab Work					
MT- 45	Linear Control Theory	70	20	10	-	-	100	3	1	-	4

Module I Basic Control System Introduction and Classification of control System, open and closed loop systems Linear Control System, Mathematical models of physical systems, Transfer function, Block Diagram Representation, Signal flow Graph, MIMO, Mason's gain formula, Linearization.

Module II Error Analysis -Effects of Feedback on gain and time constant, pole location, bandwidth, Sensitivity, Disturbance signal, Control over System Standard Test Signals, Time Response of1st Order System, Design of Higher order system, Steady-State Errors and Error coefficients, Constants, Effects of Additions of Poles and Zeros to Open Loop and Closed Loop System. Design Specification of Dynamic first and higher order system, Performance Indices.

Module III Domain Stability Analysis- Concept of Stability of Linear Systems, Effects of Location of Poles on Stability, Necessary Conditions for Stability, Routh-Hurwitz Stability Criteria, Relative Stability Analysis, Root Locus technique, Experimental determination of transfer function. Frequency Domain Stability Analysis- Performance Specification in Frequency Domain, Co- relation between frequency Domain and Time Domain, Bode Plot, Minimum-Phase and Non- Minimum Phase System, Polar Plots, Inverse Polar Plot, Nyquist Stability Criterion, Assessment of Relative Stability (Phase Margin, Gain Margin and Stability), Constant-M and N Circle, Nichols Chart.

Module IV Approaches to System Design, Types of Compensation, Design of Phase-Lag, Phase

Lead and Phase Lead-Lag Compensators in Time and Frequency Domain, Proportional, Derivative, Integral and PID Compensation. Modeling of discrete -time systems -sampling -mathematical derivations for sampling sample and hold -Z-transforms-properties -solution of difference equations using Z transforms -examples of sampled data systems -mapping between s plane and z plane

Module V State variables Analysis and Design- Concept of State Variables and State Model, State Space Representation of Systems, Solution of State Equation, Transfer Function Decomposition, Discrete time system.

Text & Reference Books:

1. Ziemer R.E., Tranter W.H. & Fannin D.R., "Signals and Systems", Pearson Education Asia

2 Ogata K., "Modern Control Engineering", Prentice Hall India

3. Nagarath I.J. & Gopal M., "Control System Engineering", Wiley Eastern Ltd.

4. Kuo B.C., "Digital Control Systems", Oxford University Press.

5. Computer-Based Industrial Control. Author, Krishna Kant. Publisher, Prentice Hall India.

COURSE OUTCOMES: Upon successful completion of course, students will be able to:

CO1	Describe mathematical model of the electrical and mechanical systems and simplify complex systems using different graphical techniques in closed and open loop systems.
CO2	Apply time domain analysis and steady state response in control systems
CO3	Analyze Time Domain and frequency domain stability Techniques in control systems
CO4	Design control systems with the desired phase and gain performance.
CO5	Demonstrate the concept of state, state variable and state model and apply this knowledge in steady state analysis automation systems.

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		End. Sem.	Mid Sem. Exam.	Quiz/ Assignment	End Sem.	Lab Work					
MT- 46	CAD & Kinematics Simulation Lab	-	-	-	30	20	50	-	-	4	2

List of Experiments:

1. Introduction of AutoCAD & Fusion 360
2. 2D and 3D modeling on CAD software
3. Use of CAM software for writing CNC programs.
4. A case study / tutorial using CAPP Software, writing M & G codes for given operations.
5. Robot and AGV programming
6. Modelling, offline manual part programming and simulation of the operation of 3 axis CNC milling machine
7. Programming and operation of a 5 axis robot Manipulator.
8. To create a 2D view of the diagrams given using AutoCAD.
9. To make an orthographic dimensioned drawing of a connecting rod.
10. To draw the orthographic views of a Cotter joint.
11. To create a spiral by extruding the circle.
12. Draw 3D models by extruding simple 2D designs.

Course Outcomes: At the completion of this course, students should be able to:

CO1	Analyze geometric transformations and CAD models.
CO2	Develop and validate CNC programs to manufacture engineering components.
CO3	Illustrate the elements of group technology in an automated manufacturing environment.

Text & Reference Books:

1. Automation, Production systems & Computer integrated Manufacturing, Groover, P.E.
2. CAD/CAM/CIM, Radhakrishnan and Subramaniah, New Age, 3rd edition, 2008.
3. Principles of Computer Aided Design and Manufacturing, FaridAmirouche, Pearson.
4. CAD/CAM Theory and Practice, R. Sivasubramaniam, TMH.
5. Computer Aided Design and Manufacturing, K.Lalit Narayan, PHI, 2008.
6. Computer Aided Manufacturing, T.C. Chang, Pearson, 3rd edition, 2008.

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