Jabalpur Engineering College, Jabalpur
(Declared Autonomous by MP Govt., Affiliated to RGPV, Bhopal)
(AICTE Model Curriculum Based Scheme)
Bachelor of Technology (B.Tech.) VII 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	MT71	PEC	Professional Elective Course-III	70	20	10	-	-	100	3	1	-	4
2	MT72	OEC	Open Elective Course-II	70	20	10	-	-	100	3	1	-	4
3	MT73	PCC	Mechatronics System Design	70	20	10	30	20	150	3	-	2	4
4	MT74	PCC	EV and HV Technology	70	20	10	30	20	150	3	-	2	4
5	MT75	PCC	AI & ML	70	20	10	30	20	150	3	-	2	4
6	MT76	MC	Industrial Training Evaluation	-	-	-	60	40	100	-	-	4	2
			Total	**350**	**100**	**50**	**150**	**100**	**750**	**15**	**2**	**10**	**22**
7	MT77	DLC	Self-Learning Presentation (SWAYAM/NPTEL/MOOC)	-	-	-	-	-	-	-	-	-	8
8	MT78	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 MT77 for the award of Honours (Minor Specialization).									

Note: 01. Departmental BOS will decide list of three/four elective subjects for each PEC and OEC.
02. MOOC/NPTEL subjects shall be taken with permission of HOD/Coordinator
03. Industrial training presentation & viva shall take place in VII Sem. which students have already done in VI Sem.

Professional Elective Course-III

S.No.	Subject Code	Subject Name
1	MT71A	CAD/CAM
2	MT71B	Mechanical Vibration & Noise
3	MT71C	Power Plant Engineering

Open Elective Course-II

S.No.	Subject Code	Subject Name
1	MT72A	Wireless Sensor Networks
2	MT72B	Aerial Robotics
3	MT72C	Simulation & Modelling

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

PEC: Professional Elective Course, OEC: Open Elective Course, PCC: Professional Core Course, DLC: Distance Learning Course, MC: Mandatory Course

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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 71 A	CAD / CAM	70	20	10	-	-	100	3	1	-	4

Module I. Introduction: Information requirements of mfg. organizations; business forecasting and aggregate production plan; MPS, MRP and shop floor/ Production Activity Control (PAC); Mfg. as a system, productivity and wealth creation; production processes on volume-variety axes; importance of batch and job shop production; CIM definition and CIM wheel, evolution and benefits; CIM as a subset of Product Life Cycle (PLC) mgt; design for mfg. (DFM) and concurrent engg; product design in conventional and CIM environment; terms like CAD, CAE, CAM, CAP, CAPP, CATD and CAQ.

Module II. Graphics and standards: Raster scan, coordinate systems for model (lW WCS) user and display; database for graphic modelling; PDM, PIM, EDM; define EDM, features of EDM; basic transformations of geometry- translation, scaling, rotation and mirror; introduction to modelling software; need for CAD data standardization; developments in drawing data exchange formats; GKS, PHIGS, CORE, IGES, DXF, STEP, DMIS AND VDI; ISO standard for exchange of Product Model dataSTEP and major area application protocols.

Module III. Geometric Modelling: Its use in analysis and mfg.; 2D and 3D line, surface and volume models; linear extrusion and rotational sweep; Constructive Solid Geometry (CSG); basics of boundary presentation- spline, Bezier, b-spline, and NURBS; sculpture surfaces, classification, basics of coons, Bezier, b-spline and ruled surfaces; tweaking, constraint based parametric modelling; wire-frame Modelling, definition of point, line and circle; polynomial curve fitting; introduction to rapid prototyping.

Module IV. Numeric control and part programming: Principles of NC machines, CNC, DNC; NC modes of point to point, Jine and 2D, 3D contouring; NC part programming; ISO standard for coding, preparatory functions(G)- motion, dwell, unit, pre-set, cutter compensation, coordinate and plane selection groups; miscellaneous (M) codes; CLDATA and tool path simulation; ISO codes for turning tools and holders; ATC, modular work holding and pallets; time and power estimation in milling, drilling and turning; adaptive control, sequence control and PLC; simple part programming examples.

Module V: Group Technology: Importance of batch and job shop production; merits of converting zigzag process layout flow to smooth flow in cellular layout, Production Flow Analysis (PFA) and clustering methods; concept of part families and coding; hierarchical, attribute and hybrid coding; OPITZ, MICLASS and DCLASS coding; FMS; material handling; robots, AGV and their programming; agile mfg; Computer Aided Process Planning (CAPP), variant/ retrieval and generative approach.

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

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	Knowledge of geometric modelling.
CO4	Analyze Numerical control and part programming.
CO5	Illustrate the elements of group technology in an automated manufacturing environment.

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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 71 B	Mechanical Vibration & Noise	70	20	10	-	-	100	3	1	-	4

Module I. Fundamental Aspects of Vibrations: Vibration, main causes, advantages and disadvantages; engineering applications of vibration and noise; vector method of representing harmonic motion; characteristics of vibration, harmonic analysis and beats phenomenon, work done by harmonic forces on harmonic motion; periodic, non-harmonic functions- Fourier series analysis; evaluation of coefficients of Fourier series; elements of vibratory system; lumped and distributed parameter systems. Undamped Free Vibrations: Derivation of differential equation of motion: the energy method, the method based on Newton's second law of motion, and Rayleigh's method. Solution of differential equation of motion: Natural frequency of vibration. Systems involving angular oscillations: the compound pendulum.

Module II. Damped Free Vibrations: Viscous damping: coefficient of damping; damping ratio; underdamped, over damped and critically damped systems; logarithmic decrement; frequency of damped free vibration; Coulomb or dry friction damping; frequency, decay rate and comparison of visCous and coulomb damping; solid and structural damping; slip or interfacial damping.

Module III. Harmonically excited Vibration: One degree of freedom- forced harmonic vibration; vector representation of forces; excitation due to rotating and reciprocating unbalance; vibration Isolation, force and motion transmissibility; absolute and relative motion of mass (Seismic Instruments).

Whirling Motion and Critical Speed: Whirling motion and Critical speed: Definitions and significance. Critical -speed of a vertical, light -flexible shaft with single rotor: with and without damping. Critical speed of a shaft carrying multiple discs (without damping), Secondary critical speed.

Module IV. Systems with Two Degrees of Freedom: Un-damped free vibration of 2 d.o.f and Principal modes of vibration; torsion vibrations; Forced, Un-damped vibrations with harmonic excitation Coordinate coupling; Dynamic vibration absorber; torsion Vibration Absorber; Pendulum type of dynamic vibration.

Module V. : Noise Engineering -Subjective response of sound: Frequency and sound dependent human response; the decibel scale; relationship between, sound pressure level (SPL), sound power level and-sound intensity scale; relationship between addition, subtraction and averaging, sound spectra and Octave band analysis; loudness; weighting networks; equivalent sound level, auditory effects of noise; hazardous noise, exposure due to machines and equipment; hearing conservation and damage risk criteria, daily noise doze.

Reference Books:

1. Ambekar A.G., 'Mechanical Vibrations and Noise Engineering', PHI.
2. Meirovitch Leonard,'Element of Vibration Analysis', TMH.
3. Dukkipati RV, Srinivas J,'Text book of Mechanical Vibrations', PHI.
4. Kelly SG and kudari SK,'Mechanical Vibrations',Schaum Series, TMH.
5. Thomson, W.T., 'Theory of Vibration with Applications', C.B.S Pub & distributors .
6. Singiresu Rao, 'Mechanical Vibrations', Pearson Education.
7. G.K. Grover, 'Mechanical Vibration', Nem Chand and Bross, Roorkee.

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

CO1	Analyse Un-damped and Damped free vibration systems.
CO2	Evaluate the two Degrees of Freedom.
CO3	Explain whirling motion and critical speed in Harmonically excited Vibration.
CO4	Evaluate sound pressure level (SPL), sound power level and sound intensity.
CO5	Analyse sources, isolation and control mechanism.

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Subject Code	Subject Name	Maximum Marks Allotted						Contact Hours Per Week			Total Credits
		Theory			Practical		Total Marks				
		End. Sem.	Mid Sem. Exam.	Quiz/ Assignment	End Sem.	Lab Work		L	T	P	
MT 71 C	Power Plant Engineering	70	20	10	-	-	100	3	1	-	4

Module 1: Renewable Energy Power Plants: Introduction to methods of converting various energy sources of electric power, direct conversion methods renewable energy sources, solar, wind, tidal, geothermal, bio-thermal, biogas and hybrid energy systems, fuel cells, thermoelectric modules, MHD-Converter.

Module 2: Fossil Fuel Steam Stations: Fossil Fuel Steam Stations: Basic principles of station design, recent trends in turbine and boiler sizes and steam conditions, plant design and layout, outdoor and indoor plant, system components, fuel handling, burning systems, feed water treatment plant, condensing plant and circulating water systems, cooling towers, turbine room and auxiliary plant equipment., instrumentation, testing and plant heat balance. Combined cycle power generation, heat recovery steam generator, co-generation plant.

Module 3: Nuclear Power Station: Nuclear Power Station: Importance of nuclear power development in the world and Indian context, Review of atomic structure and radio activity, binding energy concept, fission and fusion reaction, fissionable and fertile materials, thermal neutron fission, important nuclear fuels. moderators and coolants. Types of reactors, pressurized water reactor, boiling water reactor., breader reactor , CANDU reactor, gascooled reactor,

Module 4: Hydro-Power Station: Classification on of hydroelectric power plant, introduction to hydrology, Plant layout, hydro plant auxiliaries, cost of plant, life of plant, hydro power control, electrical and mechanical components, comparison of hydro power station with thermal power station, automatic and remote control of power plant, safety measures and preventive maintenance of hydro power plant, calculation of available hydro power.

Module 5: Power Station Economics: Estimation and prediction of load. Maximum demand, load factor, diversity factor, plant factor and their influence on plant design, operation and economics; comparison of hydro and nuclear power plants typical cost structures, simple problems on cost analysis, economic performance and tariffs, interconnected system and their advantages, elements of load dispatch in interconnected systems.

Text & Reference Books:

1. Nag PK; Power plant Engg; TMH
2. AI-Wakil MM; Power plant Technology; TMH
3. Sharma C: Power plant Engg: Kataria and sons, Delhi
4. Domkundwar: Power Plant Engg, Dhanpatraic sons.
5. Rajput RK, A text book ot Power plant Engg.,Laxmı Publications.
6. Yadav R, Steam and gas turbine and power plant engg.

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

CO1	Define the procedure of site selection for power plant and able to know the procedure to convert renewable, fossil fuel energy, nuclear energy & fluid energy in to electric power.
CO2	Explain function of different mechanism of power plant like fuel handling, its combustion, Utilization of potential of energy to convert in power by using mechanical and electrical equipments.
CO3	To draw the layout of power plant like renewable energy based, fossil fuel based, hydro and nuclear based power plants.
CO4	Estimate the power plant load, maximum demand, load factors, diversity factor.
CO5	Assess, plant factor and their influence on plant design, operation and economics.

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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 72 A	Wireless Sensor Networks	70	20	10	-	-	100	3	1	-	4

Module-1 OVERVIEW OF WIRELESS SENSOR NETWORKS: Single Node Architecture Hardware Components Network Characteristics unique constraints and challenges, Enabling Technologies for Wireless Sensor Networks, Types of wireless sensor networks.

Module-2 ARCHITECTURES: Network Architecture Sensor Networks, Scenarios Design Principle, Physical Layer and Transceiver Design Considerations, Optimization Goals and Figures of Merit, Gateway Concepts WSN Communication standards.

Module-3 NETWORKING SENSORS: MAC Protocols for Wireless Sensor Networks, Low Duty Cycle Protocols And Wakeup Concepts – SMAC, BMAC Protocol, IEEE 802.15.4 standard and ZigBee, the Mediation Device Protocol, Wakeup Radio Concepts, Address and Name Management, Assignment of MAC Addresses, Routing Protocols, Classifications, Energy Efficient Routing, Geographic Routing.

Module-4 INFRASTRUCTURE ESTABLISHMENT: Topology Control, Clustering, Time Synchronization, Localization and Positioning, Sensor Tasking and Control.

Module-5 SENSOR NETWORK PLATFORMS AND TOOLS: Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level software platforms, Node level Simulators, State-centric programming.

Text/Reference Books:

1. Holger Karl & Andreas Willig, "Protocols And Architectures for Wireless Sensor Networks", John Wiley, 2005.

2. Feng Zhao & Leonidas J.Guibas, "Wireless Sensor Networks An Information Processing Approach", Elsevier, 2007.

3. Waltenegus Dargie , Christian Poellabauer, "Fundamentals of Wireless Sensor Networks Theory and Practice", John Wiley & Sons Publications, 2011.

4. Kazem Sohraby, Daniel Minoli, & Taieb Znati, "Wireless Sensor NetworksTechnology, Protocols,
and Applications", John Wiley, 2007.
5. Anna Hac, "Wireless Sensor Network Designs", John Wiley, 2003.

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

CO1	Understand challenges and technologies for wireless networks
CO2	Understand architecture and sensors
CO3	Describe the communication, energy efficiency, computing, storage and transmission
CO4	Establishing infrastructure and simulations
CO5	Explain the concept of programming the in WSN environment

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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 72 B	Aerial Robotics	70	20	10	-	-	100	3	1	-	4

MODULE 1 - Fundamentals of Aerial robotics: Introduction to Aerial robotics, Types and classification of UAVs. Basic principles of Flight and Aerodynamics. Components of aerial robots UAV Design considerations.

MODULE 2 - Control systems and Dynamics: Introduction to control systems PID controllers for Aerial robotics, Modeling and dynamics of UAVs, Stability and control of aerial systems, Trajectory planning and control algorithms.

MODULE 3 - Computer vision and sensing for Aerial robots: Basics of computer vision, Image processing for UAVs, Sensors for aerial robotics- Cameras, lidar, IMU. Object detection and tracking, Visual SLAM for Autonomous navigation.

MODULE 4 - Autonomous navigation and Mission planning: Localization techniques for UAVs, Path planning and obstacle avoidance, GPS and inertial navigation, Waypoint navigation and mission planning. Autonomous decision-making Algorithms.

MODULE 5 - Applications for Industries: Industry- specific applications e.g. agriculture, surveillance, Search and Rescue. Payload integration and data collection. Legal & ethical considerations, Aerial robotics, Making program for an aerial robot for a specific application.

Text Books/References:

1. Nagrath IJ and Mittal RK; Robotics and Control; TMH

2. "Introduction to UAV Systems", Paul S. Brian and Samuel M. Nof Publication: Wiley, 2012

3. Spong Mark and Vidyasagar; Robot Modelling and control; Wiley India

4. Murphy; Introduction to Al Robotics; PHI Learning

5. "Computer Vision: Algorithms and Applications", Richard Szeliski Publication: Springer, 2010.

6. "Planning Algorithms", Steven M. LaValle, Cambridge University Press, 2006.

COURSE OUTCOMES: At the end of this course, the students will have the ability to;

CO1	Illustrate the concept of aerial robotics and UAV.
CO2	Understanding the control system and dynamics of UAV.
CO3	Explain the working of various types of sensors and their application.
CO4	Operation of different aerial robots.
CO5	Different application and programming of aerial robotics.

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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 72 C	Simulation and Modelling	70	20	10	-	-	100	3	1	-	4

Module-1 Introduction to modelling and simulation: Modelling and simulation methodology, system modelling , concept of simulation, continuous and discrete time simulation.

Module-2 Basic concept of probability and random variables continuous and discrete random variables, distribution of random variables: discrete and continuous, Compartmental models: linear, nonlinear and stochastic models.

Module-3 Introduction to Queuing Theory: Characteristics of queuing system, Poisson's formula, birth-death system, equilibrium of queuing system, analysis of M/M/1 queues. Application of queuing theory in computer system like operating systems, computer networks etc.

Module-4 System Dynamics modelling: Identification of problem situation, preparation of causal loop diagrams and flow diagrams, equation writing, level and rate relationship. Simulation of system dynamics models.

Module-5 Verification and validation: Design of simulation experiments, validation of experimental models, testing and analysis. Simulation languages comparison and selection, study of Simulation softwares -SIMULA, DYNAMO, STELLA, POWERSIM.

Text and Reference Books :

1. Gorden G., System simulation, Printice Hall.

2. Payer T., Introduction to system simulation, McGraw Hill.

3. Seila, Applied Simulation Modeling, Cengage

4. Spriet, Computer Aided Modeling and Simulation, W.I.A.

5. Sushil, System Dynamics, Wiley Eastern Ltd. 23

6. Shannon R.E., System simulation, Prentice Hall

Course Outcomes: Upon successful completion of course students will be able to:

CO1	Learn the utility of simulation and modelling.
CO2	Describe concept of probability and random variables.
CO3	Illustrate reasoning using Queuing Theory.
CO4	Elaborate system dynamics modelling.
CO5	Analyse verification and validation in experiments.

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		End. Sem.	Mid Sem. Exam.	Quiz/ Assignment	End Sem.	Lab Work		L	T	P	
MT 73	Mechatronics System Design	70	20	10	30	20	150	3	-	2	4

Module 1: Introduction to Mechatronics System Design:
Introduction to Mechatronics system, Elements of Mechatronics system: Sensor, actuator, plant, and controller, Applications of Mechatronics system, Systems like CDROM and scanner: exploration of internal components and their functionality.

Module 2: Integrated Mechanical-Electronics Design and Microprocessor Fundamentals:
Integrated mechanical-electronics design philosophy, Examples of real-life Mechatronics systems, Smart sensor concept, Utility of compliant mechanisms in Mechatronics, Microprocessor building blocks, Combinational and sequential logic elements, Memory, timing, and instruction execution fundamentals, Example of a primitive microprocessor.

Module 3: Microcontrollers for Mechatronics and Mathematical Modeling:
Microcontrollers for Mechatronics, Philosophy of programming interfaces, Setting sampling time, Getting started with TIVA programming, Microcontroller programming philosophy with emphasis on TIVA, Programming different interfaces like PWM, QEI, etc., Mathematical modelling of Mechatronics systems, Modelling friction, DC motor, Lagrange formulation for system dynamics.

Module 4: Control Systems in Mechatronics:
Dynamics of a 2R manipulator, Simulation using MAT lab, Selection of sensors and actuators, Concept of feedback and closed-loop control, Mathematical representations of systems, Control design in the linear domain, Basics of Lyapunov theory for nonlinear control, Notions of stability, Lyapunov theorems and their application, Trajectory tracking control development based on Lyapunov theory.

Module 5: Signal Processing and Practical Implementations:
Basics of sampling a signal, Signal processing, Digital systems and filters for Mechatronics system implementation, Research examples/case studies of the development of novel Mechatronics systems:3D micro-printer, Hele Shaw system for micro fabrication

Text Reference Books:

1.Mechatronics Systems Design and Solid Materials by Satya Bir Singh (Editor); Prabhat Ranjan (Editor); Alexander V. Vakhrushev (Editor); A. K. Haghi (Editor).

2.The Design of High Performance Mechatronics - 3rd Revised Edition by R. Munnig Schmidt; G. Schitter; A. Rankers

3.Mechatronics System Design, Devdas Shetty, Richard A. Kolk, Cengage Learning, 2010.

List of Experiments:

1: The Principles of Switching.

2: Stepper Motor Control.

3: Dc Motor Speed- Control Using PWM.

4: Design of Temperature Control System.

5: Design of Simple Hydraulic Presser.

6. Datasheets Analysis of Industrial Sensors.

7: Analysis Of Mechatronics System: The ROBOTINO.

8: VFD & SPEED Time Profiling.

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

CO1	Understand mechatronics system elements and their interplay.
CO2	Apply integrated mechanical-electronics design to real-life systems.
CO3	Program microcontrollers (TIVA) for control and signal processing.
CO4	Master mathematical modeling for friction, DC motors, and system dynamics.
CO5	Gain expertise in control systems, feedback, linear control design, and Lyapunov theory.

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		Theory			Practical						
		End. Sem.	Mid Sem. Exam.	Quiz/ Assignment	End Sem.	Lab Work		L	T	P	
MT 74	EV and HV Technology	70	20	10	30	20	150	3	-	2	4

Module 1. Introduction to Electric Vehicle: History of Electric Vehicles, Development towards the 21st Century, Types of Electric Vehicles in use today – Battery Electric Vehicle, Hybrid (ICE & others), Fuel Cell EV, Solar Powered Vehicles. Motion and Dynamic Equations of the Electric Vehicles: various forces acting on the Vehicle in static and dynamic conditions.

Module 2. Induction to Hybrid Electric Vehicle: Social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid Drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

Module 3. Electric Drive Trains: Basic concept of electric traction, introduction to various electric drive train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

Module 4. Types of Storage Systems: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Calculation for the ratings.

Module 5. Battery Management Systems (BMS): Introduction to BMS, Objectives of the BMS: Discharging control, Charging control, State-of-Charge Determination, State-of-Health Determination. Cell Balancing; BMS topologies: Distributed Topology, Modular Topology and Centralized Topology, Firmware development, Certification, Aging. **Modelling of Hybrid Electric Vehicle Range:** Driving Cycles, Types of Driving Cycles, Range modelling for Battery Electric Vehicle, Hybrid (ICE & others), Fuel Cell EV, Solar Powered Vehicles. Case study of 2 wheeler, 3 wheeler and 4 wheeler vehicles

Text & Reference Books:

1. James Larminie, J. Lowry, "Electric Vehicle Technology Explained", John Wiley & Sons Ltd. 2003.

2. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.

3. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies",Springer, 2015.

4. Iqbal Hussein, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press, 2003.

5. Ali Emadi, "Advanced Electric Drive Vehicles", CRC Press, 2015.

6. Berker B., James W. J. & A. Emadi, "Switched Reluctance Motor Drives", CRC Press, 2019.

List of Experiments:

1. Vector control of PMSM and IM drives over complete drive cycle of EV.

Objective: - To familiarize with the basic vector control of PMSM and IM drive with speed/torque control operation. Two-level DC-AC voltage source converter, fed from a DC power source, would be used for operating the motor.

2. Characterization of power, torque and efficiency for EV over drive cycle.

Objective: - Chassis of 4-wheeller EV would be operated in all possible modes for this experiment. Power, torque and efficiency would be plotted against speed of EV over the complete range of operation.

3. Power flow in EV power train during charging, V2G feeding, motoring and braking.

Objective: - To understand the flow of energy in the power train of EV during various modes of operation i.e. charging, V2G feeding, motoring and braking. EV would be operated in the aforementioned modes and power would be measured at different sections of EV.

4. Forward & backward motoring and regenerative braking of EV consisting of multiple motor drives

Objective: - EV must be capable of operating in all four quadrants viz. forward motoring, forward braking, reverse motoring and reverse braking. This experiment would consider operation of EV in all four quadrants with necessary PWM and control techniques.

5. Synchronized PWM techniques for high-power and high-speed IM drives.

Objective: - Special PWM techniques would be implemented on IM drive in context with the high-power and/or high-speed applications. Field weakening would be demonstrated on the experimental setup.

Course Outcomes: After completing the course, students will be able to:

CO1 Select appropriate source of energy for the hybrid electric vehicle based on driving cycle.

CO2 Analyse the power and energy needs of the various hybrid electric vehicle.

CO3 Measure and Estimate the energy consumption of the Hybrid Vehicles.

CO4 Evaluate energy efficiency of the vehicle for its drive trains.

CO5 Analyse modelling of hybrid electric vehicle range.

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Academic
JEC, Jabalpur (M.P.)

JABALPUR ENGINEERING COLLEGE, JABALPUR (MP)
(Established in 1947 as Government Engineering College, Jabalpur Declared autonomous by Govt. of M.P in 1998)
Revised B. Tech. VII sem (AICTE) Mechatronics Engineering

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

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 75	AI & ML	70	20	10	30	20	150	3	-	2	4

Module - I: Introduction to Regression, Mathematics Foundations, Model Building using Least squares, Model Accuracy & Selection, Overfitting, Interpretability of regression models.

Module - II: Overview of the Classification Module, Nearest-neighbour Methods, Naïve Bayes Classifier, Logistic Regression, Decision Tree, Optimization Foundations for Support Vector Machines, Support Vector Machines, Support Vector Machines in overlapping class distributions & Kernels, Ensemble Methods.

Module - III: Introduction to Unsupervised Learning, Clustering, K-Means Algorithm, K-Means – Variations, Detecting Outliers, Math Fundamentals for EM Algorithm, EM Algorithm, Clustering for Customer Segmentation, Association Rule Mining, Apriori Algorithm, Time series Prediction and Markov Process, Hidden Markov Model.

Module - IV:. Feature extraction: Statistical features, Principal Component Analysis. Feature selection: Ranking, Decision tree - Entropy reduction and information gain, Exhaustive, best first, Greedy forward & backward, Applications of feature extraction and selection algorithms in Mechanical Engineering.

Module - V: Introduction to Deep Learning, Artificial Neural Network, Sequence Modeling in Neural Network, Deep Learning, Convolution Networks with Deep Learning, Auto-encoders with Deep Learning Generative deep learning models.

Text & Reference Books:

1. Rich E and Knight K, Artificial Intelligence, TMH New Delhi.
2. Nelsson N.J., Principles of Artificial Intelligence, Springer Verlag, Berlin.
3. Barr A, Fergenbaub E.A. and Cohen PR. Artificial Intelligence, Addison Wesley, Reading Waterman D.A., A guide to Expertsystem, Adision - Wesley, Reading.
4. Artificial Intelligence Hand book, Vol. 1-2, ISA, Research Triangle Park. Kos Ko B, Neural Networks and Fuzzy system –PHI.
5. Haykin S, Artificial Neural Networks-Comprehensive Foundation, Asea,Pearson.

List of Experiments:

1. Study of PROLOG Programming language and its Functions. Write simple facts for the statements using PROLOG.
2. Implementation of Depth First Search for Water Jug problem.
3. Implementation of Breadth First Search for Tic-Tac-Toe problem.
4. Solve 8-puzzle problem using Best First Search. Write a program to Implement A*.
5. Write a PROLOG program to solve N-Queens problem.
6. Implementation of Traveling Salesman Problem.
7. Implementation of Python Basic Libraries such as Statistics, Math, Numpy and Scipy

a) Usage of methods such as floor(), ceil(), sqrt(), isqrt(), gcd() etc.

b) Usage of attributes of array such as ndim, shape, size, methods such as sum(), mean(), sort(), sin() etc.

c) Usage of methods such as det(), eig() etc.

d) Consider a list datatype (1D) then reshape it into 2D, 3D matrix using numpy

e) Generate random matrices using numpy

f) Find the determinant of a matrix using scipy

g) Find eigenvalue and eigenvector of a matrix using scipy

8. Implementation of Python Libraries for ML application such as Pandas and Matplotlib.

a) Create a Series using pandas and display

b) Access the index and the values of our Series

c) Compare an array using Numpy with a series using pandas

d) Define Series objects with individual indices

e) Access single value of a series

f) Load datasets in a Dataframe variable using pandas

g) Usage of different methods in Matplotlib.

9. Creation and Loading different types of datasets in Python using the required libraries.

i. Creation using pandas

ii. Loading CSV dataset files using Pandas

iii. Loading datasets using sklearn

10. Write a python program to compute Mean, Median, Mode, Variance, Standard Deviation using Datasets.

Course Outcomes: Upon successful completion of course, students will be able to:

CO1	Characterize Artificial intelligence system
CO2	Describe knowledge representation in AI systems
CO3	Illustrate reasoning using fuzzy
CO4	Elaborate natural language processing
CO5	Knowledge of neural networks

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