Jabalpur Engineering College, Jabalpur

(Declared Autonomous by MP Govt., Affiliated to RGPV, Bhopal)
(AICTE Model Curriculum Based Scheme)
Bachelor of Technology (B.Tech.) VI 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	MT61	PEC	Professional Elective Course-II	70	20	10	-	-	100	3	1	-	4
2	MT62	OEC	Open Elective Course-I	70	20	10	-	-	100	3	1	-	4
3	MT63	PCC	Industry 4.0	70	20	10	30	20	150	3	-	2	4
4	MT64	PCC	Data Communication & Computer Networks	70	20	10	30	20	150	3	-	2	4
5	MT65	PCC	Robotics and Automation	70	20	10	30	20	150	3	-	2	4
6	MT66	PI	Minor Project	-	-	-	60	40	100	-	-	4	2
7		MC	Industrial Training	Minimum Four weeks Duration. Evaluation will be done in 7th semester.									
			Total	**350**	**100**	**50**	**150**	**100**	**750**	**15**	2	**10**	**22**
8	MT67	DLC	Self-Learning Presentation (SWAYAM/NPTEL/MOOC)	-	-	-	-	-	-	-	-		8
9	MT68	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 MT67 for the award of Honours (Minor Specialization).									

Note: 01. Departmental BOS will decide list of three/four optional subjects those are available in MOOC,OEC as well for PEC.
02. MOOC/NPTEL subjects shall be taken with permission of HOD/Coordinator.
03. Industrial training should be apart from laboratory work unertaken in the college rather it should have industrial orientation and practical aspects/field work. Report to be sbmitted at the beginning of 7th semester and students have to give a presentation in the Department. Evaluation will be done in 7th semester.

Professional Elective Course-II		
S.No.	**Subject Code**	**Subject Name**
1	MT61A	Automobile Engineering
2	MT61B	Dynamics of Machines
3	MT61C	Heat and Mass Transfer

Open Elective Course-I		
S.No.	**Subject Code**	**Subject Name**
1	MT62A	Data Analytics
2	MT62B	Industrial Management
3	MT62C	Industrial Electronics

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, PI: Project and Internship, 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-61 A	AUTOMOBILE ENGINEERING	70	20	10	-	-	100	3	1	-	4

Module I.: Chassis & Body Engineering: Types, Technical details of commercial vehicles, types of chassis, layout, types of frames, testing of frames for bending & torsion on unutilized body frame, vehicle body and their construction, driver's visibility and methods for improvement, safety aspects of vehicles, vehicle aerodynamics, optimization of body shape, driver's cab design, body materials, location of engine, front wheel and rear wheel drive, four wheel drive.

Module II. : Steering System: front axle beam, stub axle, front wheel assembly, Wheel Alignment, principles of types of wheel alignment, front wheel geometry viz. camber, kingpin inclination, castor, toe-in and toe-out, condition for true rolling motion, centre point steering, directional stability of vehicles, steering gear, power steering, sip angle, cornering power, over steer & under steer, gyroscopic effect on steering gears

Module III. : Transmission System: Function and types of clutches, single plate, multi-plate clutch, roller & spring clutch, clutch lining and bonding, double declutching types of gear boxes, synchronizer, gear materials, determination of gear ratio for vehicles, gearbox performances at different vehicle speed, automatic transmission, torque converters, fluid coupling, principle of hydrostatic drive, propeller shaft, constant velocity universal joints, differential gear box, rear axle construction, Introduction to Electric and Hybrid powertrain.

Module IV. : Suspension system : Basic suspension movements, Dependent and Independent Suspension, Independent front & rear suspension, shock absorber, type of springs: leaf spring, coil spring, air spring, torsion bar, location of shackles, power calculations, resistance to vehicle motion during acceleration and breaking, power & torque curve, torque & mechanical efficiency at different vehicle speeds, weight transfer, braking systems, disc theory, mechanical, hydraulic & pneumatic power brake systems, performance, self-energization, air-bleeding of hydraulic brakes, types of wheels and tyres, tyre specifications, construction and material properties of tyres & tubes.

Module V. : Electrical and Control Systems: Storage battery, construction and operation of lead acid battery, testing of battery, principle of operation of starting mechanism, different drive systems, starter relay switch, regulator electric fuel gauge, fuel pump, horn, wiper, lighting system, head light dazzling, signaling devices, battery operated vehicles, choppers, importance of maintenance, scheduled and unscheduled maintenance, wheel alignment, trouble Shooting probable causes & remedies of various systems, microprocessor based control system for automobile, intelligent automobile control systems. Emission standards and pollution control: Indian standards for automotive vehicles-Bharat I, II, III, IV, Euro I to Euro VI norms, fuel quality standards, environmental management systems for automotive vehicles, catalytic converters, fuel additives, and modern trends in automotive engine efficiency and emission control.

Text & Reference Books:

1. Crouse, Automotive Mechanics TMH.
2. Srinivasan S; Automotive engines; TMH
3. Gupta HN; Internal Combustion Engines; PHI;
4. Joseph Heitner, Automotive Mechanics, Principles and practices, CBS pub.
5. Kripal Singh, Automotive Engineering Khanna Pub.
6. Newton Steeds, Automotive Engineering
7. Emission standards from BIS and Euro -I to Euro-VI.

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

CO1	Enlist the major parts of an automobile
CO2	Analyze The Steering, transmission, suspension, electrical and control systems of an automobile.
CO3	Explain the environmental implications of automobile emissions.
CO4	Knowledge of suspension system.
CO5	Analyze about the electrical and Control Systems.

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		Theory			Practical			L	T	P	
		End. Sem	Mid Sem. Exam	Quiz/ Assignment	End Sem.	Lab Work					
MT-61 B	Dynamics of Machine	70	20	10	-	-	100	3	1	-	4

Module-I Dynamics of Engine Mechanism: Displacement, velocity and acceleration of piston; turning moment on crankshaft, turning moment diagram, fluctuation of crankshaft speed, analysis of flywheel.

Module-II. Governor Mechanisms: Governor Mechanisms: Types of governors, characteristics of centrifugal governors, gravity and spring controlled centrifugal governors, hunting of centrifugal governors, effort and power of governor.

Module-III Balancing of Inertia Forces and Moments in Machines: Balancing of rotating masses, two plane determination of balancing masses (graphical and analytical methods), balancing of rotor:

Module-IV. Friction: Frictional torque in pivots and collars by uniform pressure and uniform wear rate criteria, Clutches: Single plate and multi plate clutches, Cone clutches.

Module-V. Brakes: Band brake, block brakes, Internal expanding shoe brakes, Dynamometer, Different types and their applications.

Text & Reference Books:

1. Ambekar, AG: Mechanism and Machine Theory; PHI
2. Rattan SS; Theory of machines; TMH
3. Sharma and Purohit: Design: of Machine elements; PHI
4. Bevan; Theory of Machine
5. Ghosh and Malik; Theory of Mechanisms and Machines; Affiliated Fast-Wes. Press, Delhi
6. Norton RL; kinematics and dynamics of machinery; TMH
7. Grover; Mechanical Vibrations
8. Balaney; Theory of Machines
9. Theory of Vibrations by Thomson
10. Theory of machines through solved problems by J.S.RAO.

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

CO1	Illustrate the working of flywheel, governor, clutch, brake and dynamometer.
CO2	Examine the turning moment diagrams, characteristic curve of governors, unbalanced forces and couple, failure of clutches and brakes.
CO3	Assess the motion of piston, hunting effort and power of governor.
CO4	Understand balancing masses characteristics.
CO5	Assess the frictional torque.

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		End. Sem.	Mid Sem. Exam.	Quiz/ Assign	End Sem.	Lab Work					
MT-61 C	Heat and Mass Transfer	70	20	10	-	-	100	3	1	-	4

Module I. Basic Concepts: Modes of heat transfer, Fourier's law, Newton's law, Stefan Boltzman law; thermal resistance and conductance, analogy between flow of heat and electricity, combined heat transfer process; Conduction: Fourier heat conduction equation, its form in rectangular, cylindrical and spherical coordinates, thermal diffusivity, linear one dimensional steady state conduction through a slab, tubes, spherical shells and composite structures, electrical analogies, critical insulation-thickness for pipes, effect of variable thermal conductivity.

Module II. Extended Surfaces (fins): Heat transfer from a straight and annular fin (plate) for a uniform cross section; error in measurement of temperature in a thermometer well, fin efficiency, fin effectiveness, applications; Unsteady heat conduction: Transient and periodic conduction, heating and cooling of bodies with known temperatures distribution, systems with infinite thermal conductivity, response of thermocouples.

Module III. Convection: Introduction, free and forced convection; principle of dimensional analysis, Buckingham 'pie' theorem, application of dimensional analysis of free and forced convection, empirical correlations for laminar and turbulent flow over flat plate and tubular geometry; calculation of convective heat transfer coefficient using data book.

Module IV. Heat Exchangers: Types- parallel flow, counter flow; evaporator and condensers, overall heat transfers coefficient, fouling factors, log-mean temperature difference (LMTD), method of heat exchanger analysis, effectiveness of heat exchanger, NTU method; Mass transfer: Fick's law, equi-molar diffusion, diffusion coefficient, analogy with heat transfer, diffusion of vapour in a stationary medium.

Module V. Thermal Radiation : Nature of radiation, emissive power, absorption, transmission, reflection and emission of radiation, Planck's distribution law, radiation from real surfaces; radiation heat exchange between black and gray surfaces, shape factor, analogical electrical network, radiation shields. Boiling and condensation: Film wise and drop wise condensation; Nusselt theory for film wise condensation on a vertical plate and its modification for horizontal tubes; boiling heat transfer phenomenon, regimes of boiling, boiling correlations.

Text & Reference Books:

1. Sukhatme SP; Heat and mass transfer; University Press Hyderabad
2. Holman JP; Heat transfer; TMH
3. Nag PK; heat and Mass Transfer; TMH
4. Domkundwar,Heat and Mass Transfer, Dhanpat Rai & Co.
5. Sachdeva R.C., Fundamentals of Engineering Heat and Mass Transfer, New Age Science
6. Dutta BK; Heat Transfer Principles And App; PHI Learning
7. Mills AF and Ganesan V; Heat transfer; Pearson
8. Cengel Yunus A; Heat and Mass transfer;TMH
9. Yadav R; Heat and Mass Transfer; Central India pub-Allahabad
10. Incropera FP and Dewitt DP; Heat and Mass transfer; Wiley

Course Outcomes:

After completing the course, students will be able to:

CO1	Know about the basic concept of heat transfer and its modes.
CO2	Solve problems based on conduction, convection, and radiation.
CO3	Differentiate the modes of heat transfer i.e. conduction, convection, and radiation
CO4	Understand the working principle and types of heat exchangers.
CO5	Understand the concept of boiling and condensation, mass transfer.

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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-62 A	Data Analytics	70	20	10	-	-	100	3	1	-	4

Module - I INTRODUCTION Data Analytics - Types – Phases - Quality and Quantity of data Measurement - Exploratory data analysis - Business Intelligence, Data Serialization - Data Extraction - Stacking Data - Dealing with data, Introduction to data visualization.

Module – II ANALYTICS AND MACHINE LEARNING Machine learning – Modelling Process – Training model – Validating model – Predicting new observations –Supervised learning algorithms – Unsupervised learning algorithms

Module – III R AND R STUDIO Getting started with R - installing R and R studio - getting help - installing and loading packages - simple arithmetic calculations - data structure – expressions - conditional statements – functions – loops - R–markdown - introduction to Statistics - probability and data with R.

Module – IV EXPLORATORY DATA ANALYSIS Visualizing numerical data - graphing systems available in R - descriptive Statistics - measures of central tendency and dispersion – correlation - transforming data - exploring categorical variables.

Module – V PROBABILITY AND PROBABILITY DISTRIBUTIONS Introduction - disjoint events - general addition rule – independence - probability examples - disjoint vs. Independent - conditional probability - probability trees - normal distribution, binomial distribution, ESTIMATION Introduction to Inference - sampling from population - maximum likelihood estimator - least square estimator - confidence interval (CI) (for a mean) - accuracy vs. Precision - required sample size for mean, CI (for the mean) examples.

Text & Reference Books:

1. Davy Cielen, Arno D. B. Meysman, Mohamed Ali, Introducing Data Science, Manning Publications Co., 1st edition, 2016.
2. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, An Introduction to Statistical Learning: with Applications in R, Springer, 1st edition, 2013.

3. Bart Baesens, Analytics in a Big Data World: The Essential Guide to Data Science and its Applications, Wiley.
4. D J Patil, Hilary Mason, Mike Loukides, Ethics and Data Science, O' Reilly, 1st edition, 2018.
5. Grolemund G., Hands-on programming with R: write your own functions and simulations, O' Reilly Media Inc., 2014.
6. James G., Witten D., Hastie T., & Tibshirani R, An introduction to statistical learning: with Applications in R, Springer, 2013.

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

CO1: Explore the fundamental concepts of data analytics techniques
CO2: Visualize and present the inference using various tools
CO3: Learn to think through the ethics surrounding privacy, data sharing and algorithmic decision-making.
CO4: Understand R and R studio, create reports using R markdown
CO5: Apply probability and statistics in real life problems, scientific inference from data.

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		End. Sem.	Mid Sem. Exam.	Quiz/ Assignment	End Sem.	Lab Work					
MT-62 B	Industrial Management	70	20	10	-	-	100	3	1	-	4

Module 1: Reliability Engineering: Introduction and objectives of Reliability Engineering, System Reliability, Achieving Reliability, Failure Rate, Hazard Rate, Failure Modes and the 'Bath tub'curve, Series Structure, Parallel Structure, Combination Structure, Design , Important Aspect of Reliability, Maintainability, Availability, Improving Reliability.

Module 2: Capacity Planning: Measurement of Capacity, Estimating Future capacity, Factors influencing effective capacity, Factors Favouring over capacity and under capacity, Business Process Reengineering, Definition, Characteristics of BPR, Need for Re-engineering, Steps in Reengineering, Process of Re-engineering, Industrial Engineering and Re-engineering, Success factors in reengineering, Advantages of Re-engineering.

Module 3: Sequencing Models: Introduction, Assumptions, Gantt chart for Solving Sequencing Problems, Processing n jobs through 2 machines, Johnsons Algorithm, Loading, Sequencing and Scheduling, Visual load Profile, Priority Sequencing, Assignment Problems, Principles of scheduling, Inputs to scheduling, Scheduling strategies, Forward scheduling and backward scheduling, Finite Loading, Critical ratio loading, Index method.

Module 4: Marketing Management: Marketing Function, Marketing Management Process and Marketing Planning, Market Research, Consumer Behaviour, Product Life Cycle, Product, Product Lines and Brands, Physical Distribution Channels, Sales Promotion & advertising programs.

Module 5: Human Resource Management: Definition, Objective of Human Resource Management, Characteristics, Functions/Scope, Principles of Human Resource Management, and Manpower Planning -factors Affecting Manpower Planning, Steps in Manpower Planning, recruitment and Selection procedure of Manpower. Training and Development of Manpower: Need of Training, Benefits of Training, Method of Training Workers, Foreman or Supervisory Training, Executive/IV1anagers Training and Development, learning curves and classifications.

Text & References:

1. Khanna O. P., "Industrial Engineering and Management", Dhanpat Rai and sons, 2007.

2. BangaT. R. and Sharma S. C., "Industrial Organization & Engineering economics",23ed., Khanna Publishers, 2001.

3. Mahajan M., "Industrial Engineering and Production Management" Dhanpat rai and Sons Publishers, 2005.

4. Industrial Engineering & Operations Management, SK Sharma.

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

CO1	Understand about the Reliability concept and how to allocate Reliability to each component.
CO2	Apply core concepts of Capacity Planning
CO3	Solve sequencing problem
CO4	Understand Marketing Function, market dynamics, demands, and environment. Marketing Management Process
CO5	Understand Principles of Human Resource Management

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		End. Sem.	Mid Sem. Exam.	Quiz/ Assignment	End Sem.	Lab Work					
MT-62 C	Industrial Electronics	70	20	10	-	-	100	3	1	-	4

Module 1: POWER SEMICONDUCTOR DEVICES:
Power Diodes, transistors, power MOSFET, IGBT. thyristors. characteristics, two- transistor equivalent model, turn on & off, techniques thyristor performance parameters, protection circuits & thermal design of thyristors, commutation techniques-forced and natural.

Module 2: CONTROLLED RECTIFIERS:
Principle of phase controlled converter operation, single-phase half wave, Full wave and semi converters. Three phase half wave, Full wave and semi converters Dual converters, power factor improvement, Symmetrical angle control, pulse width modulation control, effects of load and source inductance, Design of converter circuits, regulated DC power supplies.

Module 3: AC VOLATGE CONTROLLERS:
Principle of phase control, single phase AC Voltage controllers with resistive and inductive loads. Three phase AC voltage controllers with resistive & inductive loads, Industrial applications of AC controllers. Unity power factor controller, design of AC controller.
Cyclo converter: Principles of operation of single and three phase cyclo converters.

Module 4: DC CHOPPER:
Principles of step down & step up choppers, operation with R-L load, four quadrants choppers, thyristor chopper circuit, impulse commutation, effects of source inductance, chopper circuit design, switched mode power suppliers. and regulators.

Module 5: INVERTER CIRCUITS:
Principle of operation of inverter, single phase & three phase voltage source, inverter magnitude of voltage & harmonics control. forced commutation techniques, current source inverters, inverter circuit design.

Text & Reference Books:

1. M.H.Rashid," Power Electronics Circuit, Devices & Applications", Person publication, 1 993.
2. M.Ramsmoorthy, "An Introduction to transistor their Applications", affiliated East-West Press.
3. P.C.Sen "Power Electronics", TMH publication.
4, MD.Singh, K.B.Khanchandani," Power Electronics", TMH, Delhi 2001
5. Chakravarti A.," Fundamental of Power Electronics and Drives", Dhanpat Rai & Co
6. Dr P.S. Bhimra," Power Electronics", Khanna Publication
7. Vedam Subramanyam," Power Electronics" New Age International Revised II 2006.
8. Randal Shaffer, "Fundamental of Power Electronics with MATLAB learning" 2008.

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

CO1	Ability to illustrate the performance and characteristics of various power semiconductor devices.
CO2	Analysis of various power electronic circuits for single phase and three phase power supply.
CO3	Design and operation of power electronic circuits for various loads and supply.
CO4	Knowledge of DC chopper circuits.
CO5	Understand the principle of operation of inverter.

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		End Sem	Mid Sem. Exam	Quiz/ Assign.	End Sem.	Lab Work					
MT-63	Industry 4.0	70	20	10	30	20	150	3	-	2	4

Module 1: Introduction to Industrial IoT (IIOT) Systems:

The Various Industrial Revolutions, Role of Internet of Things (IoT) & Industrial Internet of Things (IIoT) in Industry, Industry 4.0 revolutions, Support System for Industry 4.0, Smart Factories.

Module 2: Implementation systems for IIOT:

Sensors and Actuators for Industrial Processes, Sensor networks, Process automation and Data Acquisitions on IoT Platform, Microcontrollers and Embedded PC roles in IIOT, Wireless Sensor nodes with Bluetooth, WiFi, and LoRa Protocols and IoT Hub systems.

Module 3: IIOT Data Monitoring & Control:

IoT Gate way, IoT Edge Systems and It's Programming, Cloud computing, Real Time Dashboard for Data Monitoring, Data Analytics and Predictive Maintenance with IIOT technology.

Module 4: Cyber Physical Systems:

Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Introduction to Artificial Intelligence, Big Data and Advanced Analysis

Module 5: Industrial IoT- Applications:

Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security (Including AR and VR safety applications), Facility Management, Smart Factory.

Text & Reference Books:

1. Industry 4.0 The Industrial Internet of Things Alasdair Gilchrist Publications: Apress.

2. The Concept Industry 4.0 An Empirical Analysis of Technologies and Applications in Production Logistics Authors: Bartodziej, Christoph Jan Springer: Publication in the field of economic science.

3. Embedded System: Architecture, Programming and Design by Rajkamal, TMH3.

4. Dr. OvidiuVermesan, Dr. Peter Friess, "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems", River Publishers.

List of Experiments:

1. Demonstration of a wireless router works with neat architectural sketch.
2. Design a Virtual Machine to manage the control room of COVID DISASTER MANAGEMENT with your own specifications
3. Case study of any 3 Applications of AI in INDUSTRY 4.0 with its advantages and disadvantages.
4. Design an IOT system to save energy and visualize data using a machine and implement algorithms to tackle problems in the industry.
5. Demonstrate and explain how Jabalpur can be converted into a smart city with the applications of IOT in smart cities.
6. Demonstration of the working of Mobile IP.

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

CO1	Knowledge of theory and practice related to Industrial IoT Systems.
CO2	Ability to identify, formulate and solve engineering problems by using Industrial IoT.
CO3	Demonstrate the cyber physical systems.
CO4	Ability to implement real field problem by gained knowledge of Industrial applications.
CO5	Ability to implement real field problem by gained knowledge of Industrial applications with IoT capability

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		End. Sem.	Mid Sem. Exam.	Quiz/ Assignment	End Sem.	Lab Work					
MT-64	Data Communication & Computer Networks	70	20	10	30	20	150	3	-	2	4

Module-I Data Communication: Introduction, Components, Data representation, Serial & Parallel transmission, Modes of data transmission, Networks-Protocols and standards, Standards organizations, Line configurations, Different Topologies, Transmission mode, Categories of networks- LAN,MAN,WAN, Network edge, End systems, clients, servers, connectionless and connection oriented services, Connecting devices. The OSI model, different layers in OSI model, TCP/IP protocol suite.

Module-II Physical layer: Transmission media: Guided media, Unguided media, Transmission impairment, Performance. Line Coding: Line Coding Schemes, Unipolar, Polar, Bipolar, Block Coding, Scrambling. **Switching**: Circuit switched Networks, Datagram Networks, Virtual Circuit Networks, Structure of a Switch. **Multiplexing**: Frequency Division, Wavelength Division, Synchronous Time Division, Statistical Time Division Multiplexing. Dial-up Modems, Digital Subscriber Line.

Module-III Data Link Layer: Data link control; Framing, flow and error control, ARQ protocols and reliable data transfer service, stop-and wait, Go-Back-N, selective repeat ARQ, HDLC, Point-to-Point Protocol. **Multiple Access**: Random access, ALOHA, Slotted ALOHA, CSMA, CSMA/CD, Reservation systems, polling, token-passing, comparisons, Channelization, Delay performance of MAC. **Local area networks**: LAN protocols, Ethernet, token ring, wireless LAN and IEEE 802.11 standard, Bluetooth, ATM networks and x.25, Wi-Fi Standard.

Module-IV Network Layer: Logical Addressing, Internetworking, IPv4, IPv6, fragmentation and reassembly, address resolution, reverse address resolution, CIDR, NAT, Address Mapping, ICMP, IGMP, DHCP, **Routing**: Unicast routing protocols, Multicast routing protocols. **TCP/IP**: Architecture and protocol, IP packet, addressing, subnet, IP routing, UDP, SCTP.

Module-V Application Layer and Security: Domain name system, domain name space, DNS in the Internet, SMTP and FTP, WWW and HTTP, Network Management; SNMP, Multimedia, general application layer services. **Security**: Cryptography, Symmetric key cryptography; ciphers, Asymmetric key cryptography, Network security.

Text & Reference Books:

1. Communication Networks, 2 ed., A Leon-Garcia, I Widjaja, McGraw Hill Education India.

2. Computer Networking: A top down approach, 5 ed., J F Kurose, K W Ross, Pearson Education.

3. Behrouz A. Forouzan, "Data communication and Networking", Tata McGraw-Hill, 2004.

4. Data Networks, 2 ed, DP Bertsekas, R G Gallagar, Prentice Hall.

5. Analysis of Computer and Communication Networks, F Gebali, Springer 2008.

List of Experiments:

1. To analyze the performance of various configurations and protocols in LAN
2. To construct a Wireless LAN and make the PC's communicate wirelessly
3. To construct simple LAN and understand the concept and operation of Address Resolution Protocol (ARP)
4. To understand the concept and operation of Routing Information Protocol (RIP)
5. To construct multiple router networks and understand the operation of OSPF Protocol
6. To construct multiple router networks and understand the operation of EIGRP Protocol
7. To understand the operation of AODV Routing using MATLAB Software
8. To understand the operation of Distance Vector Routing using MATLAB Software
9. To understand the operation of Pure Aloha protocol using MATLAB Software
10. To understand the operation of Slotted Aloha protocol using MATLAB Software

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

CO1	Classify various type of data communication network.
CO2	Analyze design constraints of physical layer.
CO3	Study various data link layer protocols and multiple access techniques.
CO4	Design various addressing mechanism.
CO5	Analyze the concept of application layer and various network security mechanism.

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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. VI 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			L	T	P	
		End. Sem.	Mid Sem. Exam.	Quiz/ Assignment	End Sem.	Lab Work					
MT-65	Robotics and Automation	70	20	10	30	20	150	3	-	2	4

Module I. Robot Kinematics, Dynamics: Review of Robot Kinematics: Joint/Task space, Forward Kinematics, Inverse Kinematics, Jacobians and Trajectory Generation, Robot Dynamics: Lagrange-Euler Dynamics, Force, Inertia, and Energy, Formulation of robot dynamics

Module II. Robot Control State-Variable Representations, Robot Control Problems: Regulator problem, tracking problem, controllers, Lyapunov Stability Theorem, Robust control and Feedback-Linearization Controllers, Variable-Structure Controllers and Saturation-Type Controllers.

Module III. Autonomous Mobile Robots and Motion Planning: Locomotion: Wheeled locomotion, Robot kinematics models & constraints, Configuration Space and Potential Functions, Path Planning Algorithms: Graph Search A*, Weighted A*, Anytime & Incremental Search D*, Cell Decomposition: Trapezoidal decomposition, Morse cell decomposition, Visibility-based decomposition, Sampling Based Algorithms: Rapidly Exploring Random Trees (RRT).

Module IV Motion Planning under kinematics and dynamic constraints, Trajectory planning, Non-holonomic constraints, Combined path planning and control. Introduction to Soft Robotics, Soft Actuators and Sensors, Materials for Soft Robots: Electroactive Polymer, Shape Memory Alloy, Artificial Muscles, 3D Printing of Soft Materials.

Module V. Robotics Applications: Case Studies on Wearable Robotics, Space Robotics, Deep-Sea Robotics, Healthcare Systems, Under-actuated Robots.

Text & Reference Books:

1.Adrian Rosebrock, Deep Learning for Computer vision with Python- Practitioner Bundle, Pyimagesearch, 2017.
2.Szeliski, Richard. Computer vision: algorithms and applications. Springer Science & Business Med a, 2010.
3.Mark W. Spong, Seth Hutchinson, M. Vidyasagar, Robot Modeling and Control, (2e), John Wiley and sons, 2009.
4.Mark W. Spong, Robot Dynamics and Control, (2e), John Wiley and sons, 2009.
5.Fahimi, Farbod, Autonomous robots: modeling, path planning, and control. Vol. 107. Springer Science & Business Media, 2008.
6.Alexander Verl, Alin Albu-Schaffer, Oliver Brock, Annika Raatz, Soft Robotics Transferring Theory to Application, Springer, 2015.

List of Experiments:

1. Image Filtering: Apply linear filters such as Gaussian and Sobel filters to enhance images and extract edges.
2. Feature Extraction: Implement corner detection algorithms like Harris corner detector and extract descriptors using SIFT or SURF.
3. CNN Training: Train a convolutional neural network (CNN) using a dataset like CIFAR-10 for image recognition.
4. Object Detection: Implement the Faster R-CNN algorithm to detect objects in images or video streams.
5. Image Segmentation: Use a fully convolutional network (FCN) to perform semantic segmentation on images.
6. Robot Kinematics: Calculate the forward kinematics of a robotic manipulator given joint angles and geometric parameters.
7. Robot Control: Design and implement a controller to make a robot arm track a desired trajectory using inverse kinematics and feedback control.
8. Soft Robotic Actuation: Build and control a soft robotic gripper using electroactive polymer actuators or shape memory alloys.

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

CO1	Understand image processing concepts and techniques for computer vision.
CO2	Design and train CNNs for image recognition, object detection, and segmentation.
CO3	Gain proficiency in robot kinematics, dynamics, and control system design
CO4	Apply stability analysis and control strategies for nonlinear systems.
CO5	Comprehend the principles and applications of soft robotics, including materials and 3D printing techniques.

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