Jabalpur Engineering College, Jabalpur

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

(AICTE Model Curriculum Based Scheme)

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

w.e.f. Juy 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	MT51	PEC	Professional Elective Course-I	70	20	10	-	-	100	3	1	-	4
2	MT52	PCC	Thermodynamics & Applications	70	20	10	30	20	150	3	-	2	4
3	MT53	PCC	Internet of Things	70	20	10	30	20	150	3	-	2	4
4	MT54	PCC	Analog & Digital Communication	70	20	10	30	20	150	3	-	2	4
5	BT51	HSMC	Professional Ethics	70	20	10	-	-	100	3	1	-	4
			Total	**350**	**100**	**50**	**90**	**60**	**650**	**15**	2	**6**	**20**
6	MT56	DLC	Self-Learning Presentation (SWAYAM/NPTEL/MOOC)	-	-	-	-	-	-	-	-	-	8
7	MT57	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 MT56 for the award of Honours (Minor Specialization).									

Note: 01. Departmental BOS will decide list of three/four optional subjects those are available in MOOC as well for PEC.

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

Professional Elective Course-I		
S.No.	**Subject Code**	**Subject Name**
1	MT51A	Finite Element Methods
2	MT51B	Fluid Mechanics
3	MT51C	Machine Design

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

PEC: Professional Elective Course, PCC: Professional Core Course, HSMC: Humanities and Social Sciences including Management 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/ Assign.	End Sem	Lab Work					
MT-51 A	Finite Element Methods	70	20	10	-	-	100	3	1	-	4

Module-I. Introduction: Structural analysis, objectives, static, Dynamic and kinematics analyses, Skeletal and continuum Structures, Modeling of infinite Degree of freedom(D.O.F) system into finite D.O.F. system, Basic steps in finite element problem formulation, General applicability of the method.

Module-II. Element Types and Characteristics: Discretization of the domain, Basic element shapes, Aspect ratio, Shape functions, generalized co-ordinates and nodal shape functions. 1D bar and beam elements, 2D rectangular and triangular elements, Axisymmetire elements.

Module-III. Assembly of Elements and Matrices : Concept of element assembly, Global and local Co-ordinate systems, Band width and its effects, Banded and skyline assembly, Boundary conditions, Solution of simultaneous equations, Gaussian elimination and Choleksy decomposition methods, Numerical integration, ID and 2D applications.

Module-IV. Higher Order and Iso-parametric Elements: One dimensional quadratic and cubic elements, Use of natural Co-ordinate system, Area Co-ordinate system continuity and convergence requirements, 2D rectangular and triangular requirement.

Module-V. Static & Dynamic Analysis: Analysis of trusses and frames, Analysis of machine subassemblies, Use commercial software packages, Advantages and limitations Hamilton's principle, Derivation of equilibrium, Consistent and lumped mass matrices, Derivation of mass matrices for ID elements, Determination of natural frequencies and :node shapes, Use of commercial software packages.

Text & Reference Books:

1. Rao, S.S., The Finite Element Method in Engineering, 2nd ed., Peragarnon Press, Oxford.
2. Robert, D. Cook. David, S. Malkins, and Michael E. Plesha, Concepts andApplication of Finite Element Analysis 3 rd ed., John Wiley
3. Chandrupatla, T.R. anBelegundu, A.D., Introduction to Finite Elements inEngincering, Prentice Hall of India Pvt. Ltd.
4. Zienkiewicz OC, The Finite Element Method, 3rd ed, Tata Mc Graw Hill.

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

CO1	Make use of finite element method to solve simple problems from Structural & Dynamic domain.
CO2	Develop the concept of various elements and their characteristics.
CO3	Create element and global stiffness, displacement and force matrices for ID and 2D FEA Problems.
CO4	Apply the finite Element analysis using available commercial FEA tools.
CO5	Perform Static & Dynamic Analysis.

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		Theory			Practical			L	T	P	
		End. Sem.	Mid Sem. Exam.	Quiz/ Assignment	End Sem.	Lab Work					
MT-51 B	Fluid Mechanics	70	20	10	-	-	100	3	1	-	4

Module I. Fluid Statics: Basic concepts & properties of the fluid. Newton's law of viscosity, types of fluids. Pressure measurement by manometers and gauges. Pressure variation in static fluid, Absolute and gauge pressure, total force and centre of pressure, hydraulic forces on submerged surfaces - plan, inclined and curved surfaces; buoyancy, meta-center , Stability of floating and submerged bodies, Relative equilibrium.

Module II. Kinematics of Flow : Types of flow-ideal & real , Lagrange and Eulerian methods of study of fluid, . steady & unsteady, uniform & non-uniform, one, two and three dimensional flow, path lines, streak-lines, streamlines and streamtubes; continuity equation for one and three dimensional flow, rotational & ir-rotational flow, circulation, stagnation point, separation of flow, source, sink and combination of source-sink flow, velocity potential; stream function, flow net & its applications.

Module III. Dynamics of Flow: Euler's equation of motion along a streamline and derivation of Bernoulli's equation, application of Bernoulli's equation, energy correction factor, linear momentum equation for steady flow; momentum correction factor. Fluid Measurements: Velocity measurement Pitot tube, current meters etc.); flow measurement (orifices, nozzles, mouthpieces, orifice meter, nozzle meter, venturi-meter, weirs and notches).

Module IV. Dimensional Analysis: Dimensional analysis, dimensional homogeneity, use of Buckingham-pi theorem, calculation of dimensionless numbers, similarity laws and model investigations. **Introduction to boundary layer**, Boundary layer development on a flat plate and its characteristics - Boundary layer thickness, displacement thickness, momentum thickness, energy thickness. Momentum equation for boundary layer by Von karman, drag on flat plate, boundary layer separation and its control. Aero-foil theory lift and drag coefficients, streamlined and bluff bodies.

Module V. Flow through Pipes: Reynolds experiment & Reynolds number, laminar & turbulent flow, Introduction to Navier Stokes Equation, relation between shear & pressure gradient, laminar flow through circular pipes, friction factor, laminar flow between parallel plates, flow through pipes in series and parallel, different types of head losses, friction factor and pressure drop.

Text & Reference Books:

1. Streeter VL, Wylie EB, Bedford KW; Fluid Mechanics; Mc Graw Hills.
2. FOX, McDonald Pritchard, Fluid Mechanics Wiley students edition
3. White; Fluic Mechanics; McGraw Hill's
4. Cengal; Fluid Mechanics; Mc Graw Hills
5. RMohant Y: Fluid Mechanics; PHI
6. K L Kumar Fluid Mechanics
7. Fluid Mechanics & hydraulic Machines, Modi & Seth
8. CS Jog, fluid Mechanics Volume II CAMBRIDGE IISc Series, Third Edition.

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

CO1	Define fluid and its Properties.
CO2	Explain the characteristics of fluid in static and dynamic conditions.
CO3	Apply the equations derived for static and dynamic conclusions for flow measurement
CO4	Demonstrate dimensional homogeneity and similarity between model and Prototype
CO5	Analyse the flows mechanism.

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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-51 C	Machine Design	70	20	10	-	-	100	3	1	-	4

Module l. Stress concentration and fatigue: Causes of stress concentration, stress concentration in tension, bending and torsion, reduction of stress concentration, theoretical stress concentration factor, notch sensitivity, fatigue stress concentration factor, cyclic loading, endurance limit, S-N Curve, loading factor, size factor, surface factor. Design consideration for fatigue, Goodman and modified Goodman's diagram, Soderberg equation, Gerber parabola, design for finite life, cumulative fatigue damage factor.

Module ll: Shafts: Design of shaft under combined bending, twisting and axial loading, shock and fatigue factors, design for rigidity, design of shaft subjected to dynamic load, design of keys and shaft couplings.

Module III : Design of Bearings: Sliding Bearing, hydrodynamics lubrication, mechanical aspects of bearing design, lubricants, journal bearing design, rolling element bearings.

Module IV: Brakes & Clutches: Materials for friction surface, uniform pressure and uniform wear theories, Design of friction clutches: Disk, plate clutches, cone & centrifugal clutches, Design of brakes: Rope, band & block brake, Internal expending brakes, Disk brakes.

Module V : Design of Power screws types, screw drives, threaded joints efficiency, stresses in power screws, design procedure and calculation.

Text & Reference Books:

1. Shigley J.E; Machine Design; TMH
2. Sharma and Purohit; Design of Machine elments; PHI
3. Wentzell Timothy H; Machine Design; Cengage learning
4. Mubeen; Machine Design; Khanna Publisher
5. Ganesh Babu K and Srithar k; Design of Machine Elements; TMH
6. Sharma & Agrawal; Machine Design; Kataria & sons
7. Maleev; Machine Design

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

CO1	Understand modes of failure, fatigue and different factors used in design.
CO2	Design cotter joints, knuckle joints and welded joints used in different machines.
CO3	Design shafts under combined bending, twisting and axial loading.
CO4	Select bearing for given conditions using design procedure.
CO5	Design different types of Power screws.

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		Theory			Practical			L	T	P	
		End. Sem.	Mid Sem. Exam.	Quiz/ Assignment	End Sem.	Lab Work					
MT-52	Thermodynamics & Applications	70	20	10	30	20	150	3	-	2	4

Module I. Introduction of Thermodynamics: Fundamentals - System and Control volume, Property, State & Process, Cycle, Temperature, Types of equilibrium, Zeroth law of thermodynamics, Temperature scales, Various thermometers, Heat & Work transfer.

Module II. The First Law of Thermodynamics: Heat/work interaction in systems, First Law for Cyclic & Non-cyclic processes, Total energy, Various modes of energy, Internal energy and Enthalpy, First Law for Flow Processes, Steady state flow processes, Unsteady processes, Limitations of first law of thermodynamics.

Module III. The Second Law of Thermodynamics: Second law-Kelvin-Planck and Clausius statements, Heat engine, Heat reservoir, Refrigerator, Heat pump, Thermal efficiency and COP, Reversible and irreversible processes, Carnot cycle, Internal and external irreversibility, Absolute temperature scale. Clausius inequality, Entropy, Entropy for solids, liquids, ideal gases undergoing various processes, Principle of increase of entropy, T-S diagrams, Irreversibility and Availability, Energy.

Module IV. Properties of Pure Substance: Pure Substance, Phase, Phase-transformations, Formation of steam, Properties of steam, PVT surface, HS, TS, PV, PH, TV diagram, Processes of vapor, Measurement of dryness fraction, Use of Steam tables and Mollier chart.

Module V. Air Standard Cycles and Non-reactive Gas Mixture: Carnot, Otto, Diesel, Dual cycles and their comparison, Brayton Cycle, PVT relationship, Mixture of ideal gases, Properties of mixture of ideal gases-Internal energy, Enthalpy and Specific heat of gas mixtures.

Text & Reference Books:

1. P.K.Nag: Engineering Thermodynamics; TMH
2. VanGJ; Thermodynamics;John Wylen
3. CengelY: Thermodynamics; TMH
4. AroraCP, Thermodynamics TMH

5. Omkar Singh Engineering Thermodynamics, New Age International.
6. Radha Krishanan Engineering Thermodynamics PHI India Pvt. Ltd.
7. M.Achuthan Engineering Thermodynamics, PHIIndia.

List of Experiments:

1. To find mechanical equivalent of heat using Joule's apparatus.
2. To study working of impulse and reaction steam turbine by models.
3. To study working of Gas turbines by models and to identify various processes of Brayton Cycle.
4. To calculate COP of vapor compression refrigeration system and to plot on T-s, p-H diagrams.
5. To plot specific fuel consumption versus rpm diagrams for diesel and petrol engines.
6. Verification of First law of thermodynamics.
7. Study of low-pressure boilers and Mountings and Accessories.
8. Measurement of dryness fraction by Separating and Throttling Calorimeter.
9. Study of 2 stroke and 4 stroke petrol engines.
10. Study of 2 stroke and 4 stroke diesel engines.

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

CO1	Analyze the laws of thermodynamics, and their applications
CO2	Explain working of heat engine, heat reservoir entropy, entropy change.
CO3	Explain Real gas, it's deviation with ideal gas Maxwell relations and their applications.
CO4	Analyze Pure Substance, phase, phase-transformations use of steam table and Mollier chart
CO5	Understand working of Air Standard cycles, Carnot, Otto, Diesel, Dual cycles

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		Theory			Practical			L	T	P	
		End Sem	Mid Sem. Exam	Quiz/ Assign.	End Sem	Lab Work					
MT-53	Internet Of Things	70	20	10	30	20	150	3	-	2	4

MODULE-I: IoT Introduction and Fundamentals: Deciphering the term IOT. Applications where IOT can be deployed, Benefits/challenges of deploying an IoT, IoT components: Sensors, front-end electronics (amplifiers, filtering, digitization), digital signal processing, data transmission, choice of channel (wired/wireless), back-end data analysis. Understanding packaging and power constraints for IOT implementation

MODULE-II: Signals, Sensors, Actuators, Interfaces: Sensors: types, signal types, shape and strength, Sensor non-idealities: Sensitivity and offset drift, noise, minimum detectable signal. nonlinearity, Read-out circuits: Instrumentation-amplifier, SNR definition, noise-bandwidth- power trade off, Circuit component mismatch and mitigation techniques (calibration, chopping. auto zeroing etc.), Power/energy considerations, Basic signal processing (filtering, quantization, computation, storage),

MODULE-III: Networking in IoT: Review of Communication Networks, Challenges in Networking of IOT Nodes, range, bandwidth, Machine-to-Machine (M2M) and IOT Technology Fundamentals, Medium Access Control(MAC) Protocols for M2M Communications, Standards for the IoT, Basics of 5G Cellular Networks and 5G IOT Communications, Low-Power Wide Area Networks (LPWAN), Wireless communication for IOT: channel models, power budgets, data rates, IOT Security and Privacy, MQTT Protocol, Publisher and Subscriber Model

MODULE-IV: Cloud Computing in IoT: Cloud computing platform (open source) and local setup of such environment, embedded software relevant to microcontroller and IOT platforms (enterprise or consumer), user interfaces

MODULE-V: Data Analysis for IoT applications: Statistics relevant to large data, linear regression, Basics of clustering, classification.

Text & Reference Books:

1. S. Vitturi, C. Zunino and T. Sauter, "Industrial Communication Systems and Their Future Challenges: Next-Generation Ethernet, IOT, and 5G," in Proceedings of the IEEE, vol. 107, no. 6, pp. 944-961, June 2019, doi: 10.1109/JPROC.2019.2913443.

2. F. John Dian, R. Vahidnia and A. Rahmati, "Wearables and the Internet of Things (IoT), Applications, Opportunities, and Challenges: A Survey," in IEEE Access, vol. 8, pp. 69200-69211, 2020, doi: 10.1109/ACCESS.2020.2986329.

3. O. Liberg, M Sundberg, E. Wang, J. Bergman, J.Sachs, "Cellular Internet of Things: Technologies, Standards, and Performance", Academic Press, ISBN: 978-0-12-812458-1, Oct. 2017.

4. S. Vitturi, C. Zunino and T. Sauter, "Industrial Communication Systems and Their Future Challenges: Next-Generation Ethernet, IOT, and 5G," in Proceedings of the IEEE, vol. 107, no. 6, pp. 944-961, June 2019, doi: 10.1109/JPROC.2019.2913443.

List of Experiments:

1. Select any one development board (Eg., Arduino or Raspberry Pi) and control LED using the board. 2. Using the same board as in (1), read data from a sensor. Experiment with both analog and digital sensors.

3. Control any two actuators connected to the development board using Bluetooth.

4. Read data from sensor and send it to a requesting client. (using socket communication)

Note: The client and server should be connected to same local area network.

5. Create any cloud platform account, explore IoT services and register a thing on the platform.

6. Push sensor data to cloud.

7. Control an actuator through cloud.

8. Access the data pushed from sensor to cloud and apply any data analytics or visualization services. 9. Create a mobile app to control an actuator.

10. Design an IoT based air pollution control system which monitors the air pollution by measuring carbon monoxide, ammonia, etc and gives alarm or sends message when the pollution level is more than permitted range.

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

CO1	Understand the fundamentals of Internet of things
CO2	Knowledge of interfacing of signal, sensors and actuators in Internet of Things
CO3	Interpret networking in Internet of things
CO4	Implement on Cloud computing in Internet of things
CO5	Analyze the data for various Internet of things applications

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MT-54	Analog & Digital Communication	70	20	10	30	20	150	3	-	2	4

Module-1 Introduction to signals, cosine, sine, step, ramp, signum, gate pulse, constant, properties of impulse function. Convolution theorem (time & frequency), correlation (auto & cross), energy & power spectral density.

Module-2 Introduction to frequency domain analysis of signals and systems. FT, DFT, DCT and their properties.

Module-3 Overview of Communication system, Communication channels Need for modulation, Baseband and Pass band signals, Amplitude Modulation: Double side band with Carrier (DSB-C), Double side band without Carrier, Single Side Band Modulation, DSB-SC, DSB-C, SSB-SC, Angle modulation, narrowband FM, wideband FM, Pre-emphasis and De-emphasis, FM transmission & reception, AGC, AVC, AFC, Phase modulation.

Module-4 Sampling theorem for low pass and band pass signals time division multiplexing, Pulse code modulation, Quantization, quantization noise, companding, Inter symbol interference, Eye pattern, Delta and adaptive modulation.

Module-5 Encoding techniques, On-Off signalling, Polar signalling, RZ signalling, Bipolar signalling, AMI, Manchester code, Differential encoding their advantage and disadvantages. Band pass data transmission: ASK, Binary phase shift keying (BPSK), QPSK, DPSK, coherent and non-coherent BFSK, minimum shift keying, QAM, Concept of M-ary PSK and M-ary FSK.

Text/Reference Books:

1. Simon Haykins, Communication System, John Willy
2. Singh & Sapre, Communication System, TMH
3. B.P. Lathi, Modern Digital and analog communication system; TMH
4. Singhal, analog and Digital communication, TMH
5. Rao, Analog communication, TMH
6. P K Ghose, principal of communication of analog and digital, universities press.
7. Taub& shilling, Communication System, TMH
8. Hsu; Analog and digital communication(Schaum); TMH
9. Proakis fundamental of communication system. (Pearson edition).

List of Experiments

1. To generate and analyse various signals.
2. To analyse characteristics of AM and FM modulators & Demodulators.
3. To analyse characteristics of super heterodyne receivers.
4. To analyse characteristics of FM receivers.
5. To construct and verify pre-emphasis and de-emphasis and plot the wave forms.
6. To analyse characteristics of Automatic volume control and Automatic frequency control.
7. To construct frequency multiplier circuit and to observe the waveform.
8. To design and analyse characteristics of FM modulator and AM Demodulator using PLL.
9. To design a system using Delta and adaptive modulation.
10. To compare various digital modulation techniques such as ASK, PSK, BPSK, QPSK and QAM.

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

CO1: Understand various types of signals and their properties.

CO2: Knowledge of communication system and Analog modulation.

CO3: Analyse FM and PM modulation techniques.

CO4: Understand the concept of digital modulation.

CO5: Analyse various digital modulation techniques.

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BT- 51	Professional Ethics	70	20	10	-	-	100	3	1	-	4

Module l. HUMAN VALUES:

Morals, values and Ethics-Integrity-Work Ethics-Service Learning-Civics virtue-respect for others- Living peacefully - Caring – Sharing - Honestly – Courage - Valuing time- Cooperation - Commitment- Empathy - Self Confidence – Character – Spirituality - Introduction to Yoga and meditation for professional excellence and stress management.

Module ll: ENGINEERING ETHICS:

Sensors of Engineering Ethics- Variety of moral Issues- Types of Inquiry – Moral dilemmas- Moral autonomy- Kohiberg's theory – Gilligan's theory – Consensus and Controversy – Models of Professional roles – Theories about right action – self interest – Customs and Religion- Uses of Ethical Theories.

Module III : ENGINEERING AND SOCIAL EXPERIMENTATION:

Engineering as Experimentation – Engineering as responsible Experimenters – Codes of Ethics – A balanced Outlook on Law.

Module IV: SAFETY, RESPONSIBILITIES AND RIGHT:

Safety and Risk – Assessment of Safety and Risk – Risk Benefit analysis and Reducing Risk – Respect for Authority – Collective Bargaining – Confidentially – Conflict of interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.

Module V : GLOBAL ISSUES:

Multinational Corporations – Environment Ethics – Computer Ethics – Weapons Development – Engineering as Managers – Consulting Engineers – Engineering as Expert Witnesses and Advisors – Moral Leadership – Code of Conduct – Corporate social Responsibility.

Text & Reference Books:

1. Mike W.Martin and Roland Schinzinger, "Ethics in Engineering" Tata Mc-Graw Hill New Delhi,2003.
2. Govindaranjan M, Natarajan S, Senthil Kumar V.S, "Engineering Ethics", Prentice Hall of India, New Delhi,2004.
3. Charies B. Feddermann, "Engineering Ethics" Pearson Prentics Hall, New Jersey 2004
4. Charies E. Herris Michael S. Pritchard and Michael J. Rabins "Engineering Ethics Concepts and cases" Learning, 2009.
5. John R Boatright, "Ethics and the conduct of Business" , Pearson Education New Delhi 2003.
6. Edumund G Seebauer and Robert L Barry, "Fundamental of Ethics for Scientists and Engineers", Oxford University Press, Oxford 2001.
7. Laura P. Hartman and joe Desjardins, "Buisness Ethics: Decision Making for Personal Intigrity and Social Responsibility" Mc Graw Hill Education India Pvt Ltd, New Delhi 2013.
8. World Community Service Centre, "Value Education",Vethathiri publication, Erode 2011.

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

CO1	Understand Human Values
CO2	Apply Engineering Ethics.
CO3	Apply Engineering as Social expectation.
CO4	Assess Safety and Risks.
CO5	Deep Perception of Global Issues.

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