Jabalpur Engineering College, Jabalpur

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

(AICTE Model Curriculum Based Scheme)

Bachelor of Technology (B.Tech.) VIII 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			L	T	P	
				End. Sem.	Mid Sem. Exam.	Quiz/ Assignment	End Sem.	Lab Work					
1	MT81	PEC/DLC	Professional Elective Course-IV	70	20	10	-	-	100	3	1	-	4
2	MT82	OEC/DLC	Open Elective Course-III	70	20	10	-	-	100	3	1	-	4
3	MT83	PI	Major Project / Internship	-	-	-	150	100	250	-	-	16	8
			Total	140	40	20	150	100	450	**6**	**2**	**16**	**16**

Note: 1. Departmental BOS will decide list of three/four optional subjects those are available in MOOC/NPTEL, PEC as well for OEC.

Professional Elective Course-IV		
S.No.	**Subject Code**	**Subject Name**
1	MT81A	Total Quality Management
2	MT81B	Renewable Energy Technology
3	MT81C	Refrigeration and Air Conditioning

Open Elective Course-III		
S.No.	**Subject Code**	**Subject Name**
1	MT82A	Image Processing & Machine Vision
2	MT82B	MEMS and NEMS Technology
3	MT82C	Operation Research and Supply Chain

Note: 2. Students going for internship would have to opt MOOC/NPTEL subjects decided / listed by the HOD / Coordinator.

Professional Elective Course-IV		
S.No.	**Subject Code**	**Subject Name**
1	MT81D	NPTEL-1
2	MT81E	NPTEL-2
3	MT81F	NPTEL-3

Open Elective Course-III		
S.No.	**Subject Code**	**Subject Name**
1	MT82D	NPTEL-4
2	MT82E	NPTEL-5
3	MT82F	NPTEL-6

Note: 3. For Major Project/ Internship, evaluation is based on work done, quality of report, presentation and performance in viva-voce through department project supervisor / Industry Project Coordinator.

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, PI: Project and Internship, DLC: Distance Learning Course

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		Theory			Practical			L	T	P	
		End. Sem	Mid Sem. Exam	Quiz/ Assign	End Sem	Lab Work					
MT 81A	Total Quality Management	70	20	10	-	-	100	3	1	-	4

MODULE I Evolution of total quality management, historical perspective, teamwork, TQM and IS09000; information technology and Business Process Re-engineering (BPR); TPM and quality awards; aids and barriers to quality management, creating vision and initiating transformation, establishing programs for education and self-coordination, policy setting and review, flowchart of policy management and relation with daily mgt. improvements, measurement of key indicators; quality management leader; cross functional teams and coordination, policy setting and review, flowchart of policy management and relation with daily mgt.

MODULE II Process- definition, variation and feedback, funnel-marble experiment- rules of adjustment and its effects, quality- definition, goalpost and kaizen view, quality of design, conformance and performance; Taguchi loss function, cost of quality, chain action of improving quality to productivity to motivation and low cost; Deming's theory of management, fourteen points and variance reduction; attributes enumerative and variables analytic studies.

MODULE III SQC-Control charts: basic discrete and continuous distributions, measures of central tendency, variability and shapes, sampling, size and central value theorem, control chart structure, process plotting and stability, study of out-of-control evidences, defect detection and prevention, use of control charts in evaluating past, present and future trends; attribute control charts, count and classification charts, construction and interpretation of p , np , c and u charts, PDSA cycle(plan, do, study, act), and R charts, and s charts, individual and moving range chart, trial control limits and out of control points.

MODULE IV Process diagnostics: Between and Within Group variations, periodic and persistent disturbances, control chart patterns-natural, level-shift, cycle, wild, multi-universe, relationship and other out of control patterns; diagnosing a process, brainstorming; cause-effect, Ishikava, interrelationship, systematic and matrix diagrams; change concepts and waste elimination

MODULE V Process improvement: Performance and technical specifications, attribute-process and variable-process capability studies; unstable and stable process capability studies and examples; attribute and variable improvement studies; Inspection: acceptance sampling(AS)- lot formation, single, double and multiple/sequential sampling plans, operating characteristic (OC) curve, producer and consumer risk, theoretical invalidation of AS, kp rule for stable and chaotic processes.

Text & Reference Books:

1. Gitlow HS, Oppenheim et al; Quality Management;TMH'
2. Gryna FM; Juran's Quality Planning and Analysis; TMH'
3. Crosby Phil ps; Quality is still free; New Amer Library'
4. Kulkami VA and Bewoor AK;Quality Control;Wiley'
5. Jankiraman B and Gopal RK; Total Quality Management- Text and Cases; PHI Learning.
6. SugandhiLandSamualA;TotalQualityManagement;PHILearning'
7. Subburaj R; Total Quality Management; TMH'
8. Naidu Babu and Rajendran; TQM; New age International pub'
9. Chase Richard B et al; Operations management; SIE-TMH'
10. Chary SN; Production and Operations Management; TMH'

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

CO1	Understand the concept of quality, its measurement, and improvements techniques.
CO2	Knowledge of quality of design, conformance and performance, motivation attributes.
CO3	Selection and application of sampling techniques and use of control charts.
CO4	Able to diagnose a process and prepare systematic and matrix diagrams.
CO5	Ability of inspection, process improvement and capability studies.

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		End. Sem.	Mid Sem. Exam.	Quiz/ Assign	End Sem.	Lab Work					
MT 81 B	Renewable energy Technology	70	20	10	-	-	100	3	1	-	4

MODULE-I Solar Radiation: Extra-terrestrial and terrestrial, radiation measuring instrument, radiation measurement and predictions. Solar thermal conversion: Basics, Flat plate collectors-liquid, and air type. Theory of flat plate collectors, selective coating, advanced collectors, Concentrators: optical design of concentrators, solar water heater, solar dryers, solar stills, solar cooling, and refrigeration. Solar photovoltaic: Principle of photovoltaic conversion of solar energy; Technology for fabrication of photovoltaic devices; Applications of solar cells in PV generation systems; Organic PV cells.

MODULE-II Wind Energy: Characteristics and measurement: Metrology of wind speed distribution, wind speed statistics, Weibull, Rayleigh, and Normal distribution, Measurement of wind data, Energy estimation of wind regimes; Wind Energy Conversion: Wind energy conversion principles; General introduction; Types and classification of WECS; Power, torque and speed characteristics; power curve of wind turbine, capacity factor, matching wind turbine with wind regimes; Application of wind energy.

MODULE-III Production of biomass: Photosynthesis-C3 & C4 plants on biomass production; Biomass resources assessment; Co2 fixation potential of biomass; Classification of biomass; Physicochemical characteristics of biomass as fuel Biomass conversion routes: biochemical, chemical and thermochemical Biochemical conversion of biomass to energy: anaerobic digestion, biogas production mechanism, technology, types of digesters, design of biogas plants, installation, operation and maintenance of biogas plants, biogas plant manure-utilization and manure values. Biomass Gasification: Different types of power generation from gasification, cost-benefit analysis of power generation by gasification.

MODULE-IV Small Hydropower Systems: Overview of micro, mini, and small hydro system; hydrology; Elements of the turbine; Assessment of hydropower; selection and design criteria of turbines; site selection and civil works; speed and voltage regulation; Investment issue load management and tariff collection; Distribution and marketing issues. Ocean Energy: Ocean energy resources, ocean energy routes; ocean thermal energy conversion system principle, ocean thermal power plants. Principles of ocean wave energy and Tidal energy conversion.

MODULE-V Geothermal Energy: Origin of geothermal resources, type of geothermal energy deposits, site selection geothermal power plants; Hydrogen Energy: Hydrogen as a source of energy, Hydrogen production and storage. Fuel Cells: Types of the fuel cell, fuel cell system and subsystem, Principle of working basic thermodynamics

References:

1. Kothari, Singal & Rajan; Renewable Energy Sources and Emerging Technologies, PHILearn
2. Khan, B H, Non-Conventional Energy, TMH.
3. Sukhatme and Nayak, Solar Energy, Principles of Thermal Collection and Storage, TMH.
4. Tiwari and Ghosal, Renewable Energy Resources: basic principle & application, NarosaPubl
5. Koteswara Rao, Energy Resources, Conventional & Non-Conventional, BSP Publication.
6. Chetan Singh Solanki, Solar Photovoltaics: Fundamental, technologies and Application,PHI L 7. Abbasi Tanseem and Abbasi SA; Renewable Energy Sources; PHI Learning
8. Ravindranath NH and Hall DO, Biomass, Energy and Environment, Oxford University Press. 9. Duffie and Beckman, Solar Engineering of Thermal Processes, Wiley
10. Nikolai, Khartchenko; Green Power; Tech Book International
11. Tester, Sustainable Energy-Choosing Among Options, PHI Learning.
12. Godfrey Boyle, Renewable Energy: Power for a sustainable future, Oxford OUP.

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

CO1	Classify Solar energy conversion systems and applications.
CO2	Selection and estimation of the Wind energy potential of site and turbines.
CO3	Understand the production and advantages of Biomass.
CO4	Explain assessment of hydro power and Tidal energy conversion.
CO5	Analyze Geothermal energy, Hydrogen Production and storage and Fuel cell.

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		Theory			Practical			L	T	P	
		End. Sem.	Mid Sem. Exam.	Quiz/ Assign	End Sem.	Lab Work					
MT 81 C	Refrigeration and Air Conditioning	70	20	10	-	-	100	3	1	-	4

MODULE-I Introduction: Principles and methods of refrigeration, freezing; mixture cooling by gas reversible expansion, throttling, evaporation, Joule Thomson effect and reverse Carnot cycle; unit of refrigeration, coefficient of performance, vortex tube & thermoelectric refrigeration, adiabatic demagnetization; air refrigeration cycles- Joule's cycle Boot-strap cycle, reduced ambient cycle and regenerative cooling cycles.

MODULE-II Vapour compression system: Vapor compression cycle, p-h and t-s diagrams, deviations from theoretical cycle, subcooling and superheating, effects of condenser and evaporator pressure on cop; multi-pressure system: removal of flash gas, multiple expansion & compression with flash inter cooling; low temperature refrigeration: production of low temperatures, cascade system, dry ice, production of dry ice, air liquefaction system,.

MODULE-III (a) Vapour absorption system: Theoretical and practical systems such as aqua-ammonia, Electrolux & other systems;
(b) Steam jet refrigeration: Principles and working, simple cycle of operation, description and working of simple system,
(c)Refrigerants: nomenclature & classification, desirable properties, common refrigeration, comparative study, leak detection methods, environment friendly refrigerants and refrigerant mixtures, brine and its properties

MODULE-IV Psychometric: Calculation of psychrometric properties of air by table and charts; psychrometric processes: sensible heating and cooling, evaporative cooling, cooling and dehumidification, heating and humidification, mixing of air stream, sensible heat factor; principle of air conditioning, requirements of comfort air conditioning, ventilation standards, infiltrated air load, fresh air load human comfort, effective temperature & chart, heat production & regulation of human body,

MODULE-V Air conditioning: Calculation of summer & winter air conditioning load, bypass factor of coil, calculation of supply air rate & its condition, room sensible heat factor, grand sensible heat factor, effective sensible heat factor, dehumidified air quantity. Problems on cooling load calculation. Air distribution and ventilation systems

Text & Reference Books:

1. Arora CP; Refrigeration and Air Conditioning; TMH
2. Sapali SN; Refrigeration and Air Conditioning; PHI
3. Ananthanarayan; Basic Refrigeration and Air conditioning; TMH
4. Manohar Prasad; Refrigeration and Air Conditioning; New Age Pub
5. Ameen; Refrigeration and Air Conditioning; PHI
6. Pita; Air conditioning Principles and systems: an energy approach; PHI
7. Stoecker W F, Jones J; Refrigeration and Air conditioning; McGH, Singapore
8. Jordan RC and Priester GB Refrigeration and Air Conditioning, PHI USA

Course Outcomes: Upon successful completion of course students will demonstrate the ability to:

CO1	Explain the principles and methods of refrigeration.
CO2	Explain the working of Vapour compression systems and applications.
CO3	Evaluation of Vapor absorption systems and applications
CO4	Analyze psychrometric properties and processes.
CO5	Elaborate the heating and cooling load for a given AC system.

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		End. Sem.	Mid Sem. Exam.	Quiz/ Assignment	End Sem.	Lab Work					
MT 82 A	Image Processing & Machine Vision	70	20	10	-	-	100	3	1	-	4

MODULE-I IMAGE PROCESSING: Elements of image processing system, Image acquisition using sensors, Image formation and contrast sensitivity, Sampling and quantization, Neighbors of a pixel, Distance measures, Pixel connectivity, Image geometry.

MODULE-II IMAGE ENHANCEMENT: Definition, Spatial domain methods, Contrast stretching, Slicing, Averaging, Frequency domain methods Histogram modify techniques, Neighborhood averaging, Segmentation techniques, Media and filtering, Edge detection, Image sharpening by differentiation, Low and high pass filtering.

MODULE-III IMAGE TRANSFORMS: Introduction to Fourier transform-DFT, Properties of two dimensional DFT, Average value, FFT algorithm, Walsh transforms, Hadamard transform, Haar transform, K-L transform, Discrete cosine transform, Wavelet transform and comparison of all transforms.

MODULE-IV APPLICATIONS: Transforming sensor reading, Mapping Sonar Data, Aligning laser scan measurements - Vision and Tracking: Following the road, Iconic image processing, Multiscale image processing, Video Tracking - Learning landmarks: Landmark spatiograms, K-means Clustering, EM Clustering.

MODULE-V ROBOT VISION: Basic introduction to Robotic operating System (ROS) - Real and Simulated Robots - Introduction to OpenCV, Open NI and PCL, installing and testing ROS camera Drivers, ROS to OpenCV - The cv_bridge Package.

REFERENCE BOOKS:

1. "Digital Image Processing" by Rafael, C. Gonzlez and Paul, Wintz, Addision-Wesley Publishing Company.

2. "Fundamentals of Digital Image Processing" by Anil K. Jain Prentice Hall.

3. "Digital Image Processing" by Sosenfeld, and Kak. A.C., Academic Press.

4. The Image Processing Handbook,(5/e), CRC, 2006 by J.C. Russ.

5. Digital Image Processing with MATLAB by R.C. Gonzalez & R.E. Woods, Prentice Hall 2003.

6. Carsten Steger, Markus Ulrich, Christian Wiedemann, "Machine Vision Algorithms and Applications", WILEY-VCH, Weinheim,2008.

7. Damian m Lyons," Cluster Computing for Robotics and Computer Vision", World Scientific, Singapore, 2011.

Course Outcomes: Upon successful completion of course students will demonstrate the ability to:

CO1	Knowledge of elements of digital image processing system.
CO2	Understand image enhancement techniques.
CO3	Apply different transforms over images.
CO4	Implement restoration techniques in Digital Images.
CO5	Develop various image compression techniques.

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		End. Sem.	Mid Sem. Exam.	Quiz/ Assign	End Sem.	Lab Work					
MT 82 B	MEMS and NEMS Technology	70	20	10	-	-	100	3	1	-	4

Module 1: INTRODUCTION TO MEMS and NEMS - Overview of Micro electro mechanical systems and Nano Electro mechanical systems, devices and technologies, Laws of scaling- Survey of materials- Smart Sensors-Applications of MEMS and NEMS.

Module 2: MICRO-MACHINING AND MICROFABRICATION TECHNIQUES - Photolithography- Film deposition, Etching Processes- wafer bonding- Bulk micro machining, silicon surface micro machining- LIGA process.

Module 3: MICRO SENSORS AND MICRO ACTUATORS - Transduction mechanisms in different energy domain- Micro-machined capacitive, piezoelectric, piezoresistive and Electromechanical and thermal sensors/actuators and applications

Module 4: NEMS TECHNOLOGY - Atomic scale precision engineering- Nano Fabrication techniques - NEMS in measurement, sensing, actuation and systems design.

Module 5: MEMS and NEMS APPLICATION - Introduction to Micro/Nano Fluids and applications- Bio MEMS- Optical NEMS- Micro and Nano motors- Recent trends in MEMS and NEMS.

Text & Reference Books:

1. Chang Liu, "Foundations of MEMS", Pearson International Edition, 2006.

2. Marc F madou" Fundamentals of micro fabrication" CRC Press 2002 2nd Edition Marc Madou.

3. M.H.Bao "Micromechanical transducers :Pressure sensors, accelerometers and gyroscopes", Elsevier, Newyork, 2000.

4. Maluf, Nadim "An introduction to Micro Electro-mechanical Systems Engineering "AR Tech house, Boston 2000.

5. Mohamed Gad – el – Hak "MEMS Handbook" Edited CRC Press 2002 2. Sabriesolomon "Sensors Handbook", Mc Graw Hill 1998.

6. Tai-.Ran Hsu, "MEMS and Microsystems: design , manufacture, and Nanoscale"- 2nd Edition, John Wiley & Sons, Inc., Hoboken, New Jersey, 2008

7. Lyshevski, S.E. " Nano- and Micro-Electromechanical Systems: Fundamentals of Nano-and Microengineering " (2nd ed.). CRC Press,2005.

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

CO1: Explain the material properties and the significance of MEMS and NEMS for industrial automation.
CO2: Demonstrate knowledge delivery on micromachining and micro fabrication.
CO3: Apply the fabrication mechanism for MEMS sensor and actuators.
CO4: Apply the concepts of MEMS and NEMS to models, simulate and process the sensors and actuators.
CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on MEMS and NEMS technology.

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		End Sem	Mid Sem. Exam.	Quiz/ Assign	End Sem.	Lab Work					
MT 82 C	Operation Research and Supply Chain	70	20	10	-	-	100	3	1	-	4

MODULE I Linear system and distribution models: Mathematical formulation of linear systems by LP, Graphical solution of LP for two variables, Simplex method, special cases of LP-transportation and assignment models and their solution, Vogel's Approximation Method (VAM) or penalty method, cell evaluation degeneracy, basics of SW Lindo, Tora, Excell..

MODULE II Supply chain (SCM): Definition, importance, expenditure and opportunities in SCM; integration of inbound, outbound logistics and manufacturing to SCM, flow of material money and information, difficulties in SCM due to local v/s system wide (global) optimization and uncertainties in demand and transportation; Bull-whip effect; customer value; IT, info-sharing and strategic partnerships; plant and warehouse-network configuration; supply contracts and revenue sharing; outsourcing; transportation, cross docking and distribution, forecasting models in SCM; coordination and leadership issues; change of purchasing role and vendor rating, variability from multiple suppliers.

MODULE III Inventory models: Necessity of inventory in process and safety stock, problem of excess inventory and cycle time, JIT/ Lean Mfg; basics of inventory models with deterministic demand, Classical EOQ Model, ABC, VED and other analysis based on shelf life, movement,, size, MRP technique and calculations, lot sizing in MRP, linking MRP with JIT; evolution of MRP to ERP to SCM and e-business.

MODULE IV (a) Waiting Line Models: Introduction, Input process, service mechanism, Queue discipline, single server (M/M/1), average length and average time calculations, optimum service rate; basic multiple server models (M/M/s)

(b) Competitive strategy: concept and terminology, assumptions, pure and mixed strategies, two-person zero sum games, saddle point, dominance, graphical, algebraic and LP methods for solving game theory problems.

MODULE V: (a) Network Analysis: Project Planning, Scheduling and Controlling; Project management; Network Techniques and its role in project management, Network logics, Fulkerson's Law, Merits and Demerits of AON Diagrams; Programme Evaluation and Review Technique (PERT), Critical Path Method (CPM), Determination of critical path, Float/Slack.

(b) Meta-heuristics: Definition of heuristic and meta-heuristic algorithms; introduction to Tabu search, Simulated Annealing and Genetic algorithms and solution of traveling salesman, nonlinear optimization problems.

References:

1. Hillier FS and Liberman GJ; Introduction to Operations Research concept and cases; TMH
2. Simchi-Levi, Keminsky; Designing and managing the supply chain; TMH.
3. Srinivasan G; Quantitative Models In Operations and SCM; PHI Learning 4. Mohanty RP and Deshmukh SG; Supply Chain Management; Wiley India
5. Taha H; Operations research; PHI
6. Sen RP; Operations Research-Algorithms and Applications; PHI Learning
7. Sharina JK; Operations Research; Macmillan
8. Ravindran, Phillips and Solberg; Operations research; Wiley India
9. Vollman, Berry et al; Manufacturing planning and control for SCM; TTMH.
10. Bowersox DJ, Closs DJ, Cooper MB; Supply Chain LogistiMgt; TMH
11. Burt DN, Dobler DW, StarlingSL; World Class SCM; TMH
12. Bronson R; Theory and problems of OR; Schaum Series; TMH
13. George Hadley; Linear programming; Addison Wesley

Course Outcomes: Upon successful completion of this course the student will be able to:

CO1	Formulate linear programming problems.
CO2	Elaborate optimum solution of transportation problems and forecasting in the supply chain.
CO3	Determine average queue length and waiting time of queuing models.
CO4	Estimate optimum inventory and cost in inventory models.
CO5	Design a model for project planning.

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