Jharkhand University of Technology, Ranchi
NEP-2020 based Syllabus w.e.f – 2025-26 batch
B.Tech in Mechanical Engineering

Semester- VIth

S.No.	Course Code	Course Title	L	T	P	J	Cr	FM	Overall Pass Marks	Internal	External	Categorization
			Contact Hours per week									
		PROGRAMME CORE COURSES (PCC)										
01	MECC601	PCC-I (Machine Design)	3	1	0		4	100	35	30	70	
02	MECC602	PCC-II (Refrigeration and Air-Conditioning)	3	1	0		4	100	35	30	70	
		PROGRAMME ELECTIVES III & IV										
03	MECPEIII601, MECPEIII602, MECPEIII603, MECPEIII604, MECPEIII605, MECPEIII606, MECPEIII607, MECPEIII608, MECPEIII609, MECPEIII610	PE-III (Any one from the given basket of PE-III)	3	0	0		3	100	35	30	70	
04	MECPEIV601, MECPEIV602, MECPEIV603, MECPEIV604, MECPEIV605, MECPEIV606, MECPEIV607, MECPEIV608, MECPEIV609, MECPEIV610	PE-IV (Any one from the given basket of PE-IV)	3	0	0		3	100	35	30	70	
		OPEN ELECTIVE-I										
05	MECOEI601, MECOEI602, MECOEI603, MECOEI604, MECOEI605, MECOEI606, MECOEI607, MECOEI608, MECOEI609, MECOEI610, MECOEI611,	OE-I (Any one from the given basket of OE-I)	3	0	0	6	3	100	35	30	70	

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	MECOEI612, MECOEI613, MECOEI614, MECOEI615, MECOEI616, MECOEI617											
Total			**15**	**2**	**0**		**17**	**500**	--	--	--	
Practical			**L**	**T**	**P**		**Cr**	**FM**	**Overall Pass Marks**	**Internal**	**External**	**Categorization**
06	MECP601	**Lab-I** (Refrigeration and Air-Conditioning Laboratory)	0	0	3		1	50	25	30	20	
07	MECP602	**Lab-II** (Computational Laboratory)	0	0	3		1	50	25	30	20	
08	MECP603	**Lab-III** (Automobile Laboratory)	0	0	3		1	50	25	30	20	
Total			**0**	**0**	**9**		**3**	**150**	--	--	--	
Audit Course			**L**	**T**	**P**		**Cr**	**FM**	**Overall Pass Marks**	**Internal**	**External**	**Categorization**
09	AUC601, AUC602, AUC603, AUC604, AUC605, AUC606, AUC607	**FOREIGN LANGUAGE (ANY ONE THROUGH NPTEL / SWAYAM)** 1. GERMAN 2. JAPANESE 3. CHINESE 4. KOREAN 5. SPAINISH 6. RUSSIAN 7. FRENCH					-	100	35	30	70	
							Student will complete this Audit Paper of 12 weeks duration from NPTEL/SWAYAM. It is mandatory to pass this paper in order to pass this semester. Students may register on NPTEL/SWAYAM at any time from 1st to 6th semester also but the passing marks and credits will be reflected only in the 6th semester. The passing marks and certificate shall be forwarded by the institute to Controller of Examination (CoE), JUT, Ranchi timely.				
10	AUC608	Sports/NCC/NSS/YOGA/Painting/Music/ Classical Dance					--	50	25	30	20	
							Students shall participate actively in one of the activities and for Passing of the semester "Participation Certificate" in activity will be mandatory student participation shall be monitored and participation record shall be maintained at institute level. The marks obtained shall be forwarded to controller of Examination (CoE), JUT, Ranchi timely.					
Internship			**L**	**T**	**P**		**Cr**	**FM**	**Overall Pass Marks**	**Internal**	**External**	**Categorization**
11	INT601	Industrial Internship	08 weeks				**2**	**50**	**25**	**30**	**20**	
Minor Project (For Exit Option)			12 weeks				**4**	**100**	**50**	**60**	**40**	

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Total	**--**	**--**	**--**		**2**	**200**	**--**	**--**	**--**	
Grand Total	**15**	**2**	**9**		**22**	**850**	**--**	**--**	**--**	

Professional Elective- III

S. No.	Course Code	Subject
01	MECPEIII601	**Advanced IC Engines**
02	MECPEIII602	**Product Design and Development**
03	MECPEIII603	**Industrial Tribology**
04	MECPEIII604	**Advanced Casting Technology**
05	MECPEIII605	**Solar and Wind Power Technologies**
06	MECPEIII606	**Aerospace Engineering**
07	MECPEIII607	**Nano Technology and Surface Engineering**
08	MECPEIII608	**Finite Element Method**
09	MECPEIII609	**Fracture Mechanics**
10	MECPEIII610	**Automobile Engineering**

Professional Elective- IV

S. No.	Course Code	Subject
01	MECPEIV601	**Computer Aided Design and Manufacturing**
02	MECPEIV602	**Compressible Flow and Jet Propulsion**
03	MECPEIV603	**Advanced Welding Technology**
04	MECPEIV604	**Gas Dynamics & Jet Propulsion**
05	MECPEIV605	**Fundamentals of HVAC Systems**
06	MECPEIV606	**Fundamentals of Biomechanics**
07	MECPEIV607	**Advanced Forming Technology**
08	MECPEIV608	**Industrial Safety Engineering**
09	MECPEIV609	**Micro and Nano Manufacturing**
10	MECPEIV610	**Geometric Modelling for CAD**

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Open Elective I

S. No.	Course Code	Subject	S. No.	Course Code	Subject
01	MECOEI601	**Pollution and Control**	**10**	MECOEI610	**Welding Technology**
02	MECOEI602	**Design of Thermal systems**	**11**	MECOEI611	**Elementary Continuum Mechanics**
03	MECOEI603	**Smart Materials and Structure**	**12**	MECOEI612	**Modern Automotive Technology**
04	MECOEI604	**Optimization in Engineering Design**	**13**	MECOEI613	**Hydrogen – Production Handling and Storage**
05	MECOEI605	**Energy Conservation andManagement**	**14**	MECOEI614	**Alternative Sources of Energy**
06	MECOEI606	**Energy Storage Technology**	**15**	MECOEI615	**3D Printing**
07	MECOEI607	**Waste to Energy Conversion Techniques**	**16**	MECOEI616	**Industrial Management**

08	MECOEI608	**Low Temperature Technology**	**17**	MECOEI617	**Project management**
09	MECOEI609	**Non-Destructive Testing**	**18**		

Abbreviations: - AU-Audit Course; L: Lecture, T: Tutorial, P: Practice.
J-Self learning hours shall not be reflected in the Time table. Self-learning includes micro projects/assignments/other activities as mentioned in earlier semesters.
***Passing in the Audit Course shall be mandatory.**
Note:- Students may choose their two Professional Electives (PE-II1 & PE-IV) & Open Elective-I from NPTEL/SWAYAM also on the approval of departmental academic council if that subject is not mentioned in the above basket.
Students will complete the Elective Papers (Professional or Open) of 12 weeks duration from NPTEL/SWAYAM. Student may register on NPTEL/SWAYAM at any time between 1st to 6th semester but the passing marks and credits will be reflected only in the 6th semester.
The secured percentage of marks and passing certificate of the subject shall be forwarded by the institute to Controller of Examination (CoE), JUT, Ranchi timely.
The institute will inform University Examination Session about selection of PE and OE subjects by the students also before 1" mid-semester examination of that semester.

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SEMESTER-VII

Operations Research

Course Code: MECC701 **L:3 T:1 P:0**

Rationale:

- Discuss the necessity, scope, applications of operations research in industries
- Outline various resource management techniques and their applications in industries
- Construct real life problems into modeling and solving for decision making
- Apply cost effective techniques for cost and time reduction of the projects with reduced resources
- Recommend suitable decisions under competitive and uncertain environments

Course Outcomes:

CO1	Create the linear programming model and apply various techniques to optimize the objective function within the given constraints
CO2	Solve transportation and assignment models for cost effective solutions
CO3	Identify suitable job sequencing for reducing idle time of resources, and to identify ideal time of replacement of individual, group items for saving investment
CO4	Evaluate decision variables of queuing and inventory models for ensuring prompt service with limited resources
CO5	Construct the project network for cost and time effective project completion with limited resources, and to apply various techniques to determine best strategies under competitive and uncertain environments

Course Contents:

Unit-1 - Linear Programming Model 9 Hour

Necessity of OR in industry – Concept and formulation of LP models for the real life and industrial problems – Graphical method – Simplex method – Big M method. Solving tutorial problems using software.

Unit-2 - Transportation and Assignment Models 9 Hour

Transportation model – basic feasible solution using Least Cost, VAM – Optimality test using U-V method-Assignment model – Minimization and Maximization problems Solving tutorial problems using software.

Unit-3 - Sequencing and Replacement Models 9 Hour

Sequencing model – Processing of 'n' jobs on 2 & 3 machines. Replacement models – items that deteriorate with time – items that fail completely – individual and group replacement policy. Solving tutorial problems
using software.

Unit-4 - Queuing and Inventory Models 9 Hour

Queuing theory - Poisson arrival and exponential service times – single server with limited, unlimited number of arrivals allowed. Inventory models – Purchase and Manufacturing deterministic models without
shortages allowed Solving tutorial problems using software.

Unit-5 - Project Network Model and Game Theory 9 Hour

PERT & CPM techniques – Project completion time – CPM cost model. Game theory- 2 persons zero sum games. Pure and mixed strategies. Method of dominance – Matrix oddment method for n x n matrix -
Solving tutorial problems using software.

Reference

1. Hamdy A Taha, Operations Research : An Introduction, 10th edition, Prentice Hall of India, New Delhi, 2017
2. Gupta, P.K. and Hira, D.S, Operations Research, 3rd Edition, S.Chand and Company Ltd., New Delhi, 2015
3. Panneerselvam R, Operations Research, Prentice Hall of India, 2nd edition, New Delhi, 2016
4. Duraivelu K and Balasubramanian M, Operations Research, 2nd Edition, DeaR Publications, 2022
5. Sundaresan V, Ganapathy Subramanian and Ganesan K, Operations Research, 4th Edition, A.R.Publicattions, 2006.
6. Software for solving tutorial problems : TORA
Software:www.mediafire.com/file/t48w3vjo6os9pxp/ToraSystem7th.zip/file

Mechanical Vibration Laboratory

Course Code: MECP701 **L:0 T:0 P:3**

List of Experiments

1. Study of vibration measuring instruments
2. Study of undamped and damped free vibration of single degree of freedom system
3. To determine the natural frequency of a spring mass system
4. To determine the first two natural frequencies of a cantilever beam by resonance method
5. To perform the static balancing of a rotating disc by three point mass balancing method
6. Study of dynamic vibration absorber
7. To analyze vibration signals of a misaligned shaft and compare it with the vibration signals of an aligned shaft.
8. To analyze vibration signals of a shaft with damaged bearing and compare it with the vibration signals of normal bearing.

Fluid Machines Laboratory

Course Code: MECP702 **L:0 T:0 P:3**

1. **Impact Of Jet Of Water On Vane**
   - Aim: To find the coefficient of impact of jet on flat circular and hemispherical vanes.

2. **Pelton Wheel Turbine Test Rig**
   - Aim: To conduct performance test on the given Pelton wheel turbine

3. **Kaplan Turbine Test Rig**
   - Aim: The experiment is conducted to obtain Constant Head and Speed characteristics

4. **Performance Test On Centrifugal Pump**
   - To conduct a test at various heads of given centrifugal pump find its efficiency.

5. **Pelton Wheel Turbine Test Rig**
   - To conduct performance test on the given Pelton wheel turbine

6. **Francis Turbine Test Rig**
   - The experiment is conducted to obtain Constant Head and Speed characteristics.

7. **Reciprocating Pump Test Rig**
   - To conduct a test at various heads of given reciprocating pump finds its efficiency.

8. **Performance characteristics of Hydraulic Ram**
   - To conduct the performance test on hydraulic ram and to plot the operating characteristics.

9. **Performance characteristics of Centrifugal Pump**
   - To conduct the performance test on centrifugal pump and to plot the operating characteristics.

10. **Double acting Reciprocating Pump**
    - To conduct a performance test on double acting reciprocating pump and to plot the operating characteristics.

Program Elective-V

Condition Monitoring

Course Code: MECPEV701 **L:3 T:0 P:0**

Rationale:

Course Outcomes:

CO1	Understand effective maintenance schemes in industries.
CO2	Diagnose the mechanical systems by applying vibration monitoring techniques.
CO3	Apply oil analysis technique to diagnose the wear debris.
CO4	Identify nonconventional methods for machine diagnoses.
CO5	Develop technologies for effective plant maintenance.

Course Contents:

Introduction: Failures - System, component and services failures - classification and its causes, Maintenance Schemes - objectives - types and economic benefits, break down, preventive and predictive monitoring.

Vibration Monitoring - causes and effects of vibration, review of mechanical vibration concepts - free and forced vibrations, vibration signature of active systems - measurement of amplitude, frequency and phase.

Vibration monitoring equipment- vibration sensors (contact and non-contact type) -factors affecting the choice of sensors, signal conditioners, recording and display elements, vibration meter and analyzers, measurement of overall vibration levels.

Contaminant analysis: Contaminants in used lubricating oils - monitoring techniques (wear debris) - SOAP technique, Ferrography, X-ray spectrometry, Particle classification.

Temperature Monitoring - Various techniques - thermograph, pyrometers, indicating paint and NDT methods.

Special Techniques: Ultrasonic measurement method, shock pulse measurement, Kurtosis, Acoustic Emission mentoring, critical speed analysis, shaft orbit analysis, Cepstrum analysis. Non-destructive techniques, Structural health monitoring weldments for surface and subsurface cracks

Text Books:

1. Rao J. S., Vibration Condition Monitoring, Narosa Publishing House, 2/e 2000.
2. Isermann R., Fault Diagnosis Application, Springer-Verlag Berlin, 2011.
3. Collacott, R. A., Mechanical Faults Diagnosis, Chapman and Hall, London, 1990

Reference Books:

1. Choudary K K., Instrumentation, Measurement and Analysis, Tata McGraw Hill, 2012
2. Allan Davis, Handbook of Condition Monitoring, Chapman and Hall, 2000

Material Characterization

Course Code: MECPEV702 **L:3 T:0 P:0**

Rationale:

Course Outcomes:

CO-1	Identify advanced techniques available for characterization of materials
CO-2	Select constituent materials for producing a given composite
CO-3	Analyze defects and failure surfaces of materials
CO-4	Select a characterization technique for evaluating the behavior of materials

Course Contents:

UNIT I

Introduction: Overview of the course, material classification- metals and alloys, ceramics, polymers and composites, Importance of materials selection, property classification, Criteria for selection of materials, Ashby charts for materials selection

UNIT II

Introduction to Materials Characterization Techniques: Different techniques and their purposes; Introduction, Principle, construction and operation. Sample preparation for all the characterization.

UNIT III

Physical characterization of materials: Optical Microscopy, SEM,TEM, Density, Void content in materials,Electron Probe Micro Analyzer (EPMA), Atomic Force Microscopy (AFM), Thermogravimetric analysis (TGA), nano indentation, NMR spectroscopy, EDAX, FTIR, XRD

UNIT IV

Mechanical characterization: Tensile test, flexural test, compression test, ILSS, creep, fatigue, Hardness, Impact test, Fracture toughness test, Principle, construction and operation working parameters, equipment operation.

UNIT V

Tribological characterization: Abrasive wear, Pin-on Disc, Erosion test, Corrosion test, sand abrasion, slurry erosion, scratch test, nano indent scratch test.

Text Books:

1. M.F. Ashby, Materials Selection in Mechanical Design, Butterworth Heinemann, 2005
2. Yang Leng, Materials Characterization-Introduction to Microscopic and Spectroscopic Methods, John Wiley & Sons (Asia) Pte Ltd, 2008.
3. ASM Handbook: Materials Characterization, ASM International, 2008

Reference Books:

1. V. T. Cherapin and A. K. Mallik: Experimental Techniques in Physical Metallurgy, Asia Publishing House, 1967.
2. George E. Dieter, Mechanical Metallurgy, McGraw Hill, 2nd Edition, 2005

Engineering Acoustics

Course Code: MECPEV703 **L:3 T:0 P:0**

Rationale:

Course Outcomes:

CO-1	Understand wave propagation, absorption, transmission, reflection and radiation.
CO-2	Formulate acoustic problems for reduction of sound levels.
CO-3	Design resonant systems including pipes, mufflers, Helmholtz resonators.
CO-4	Evaluate architectural acoustics reverberation time, direct echoes and acoustical amplification.
CO-5	Analyse the acoustic levels and analytical predictions.

Course Contents:

UNIT I:

Introduction: Review of vibrations, resonance and frequency, Sound pressure, power and intensity and its measurement, Concept of Monopoles, Dipoles and Quadrupoles, Sound Power measurement, Transmission loss, Longitudinal and Transverse wave equations, Spherical and cylindrical wave equation, Acoustic intensity, decibel scales, Sound wave generators.

UNIT II:

Acoustic wave propagation: Transmission/reflection of waves in different media, radiation and reception of acoustic waves, absorption and attenuation of sound, Cavities and waveguides. Wave types in fluids and solids. Modes of vibrations in solids.

UNIT III:

Pipes, Resonators, and Filters: Resonance in pipes, standing waves, Absorption of sound, Helmholtz resonator, acoustic impedance, acoustic filters.

Damping Attenuation and Absorption: Viscous attenuation of sound, absorption by atmosphere, attenuation in water, absorption in fluid filled pipes, damping in solids.

UNIT IV:

Architectural Acoustics: Sound in enclosures, direct and reverberant sounds, sound absorption materials, acoustic factors in architectural design, standing waves and normal modes in enclosures.

UNIT V:

Noise Control: The auditory system, Effects of noise on humans, noise measurement and criterion, treatment at source and treatment of transmission path, Analysis and design of mufflers for automotive applications, Noise measurement and instrumentation standards. Noise Control approaches.

Text Books:

1. Robert D Finch., Introduction to acoustics, PHI, 2008
2. Michael Moser, Michael Maser, S. Zimmermann Engineering Acoustics: An introduction to Noise Control, Springer, Springer, 2009, 2nd edition.

Reference Books:

1. Frank J Fahy, Foundations of Engineering Acoustics, Academic Press, 2000.
2. L. E. Kinsler, A R. Frey, A B. Coppens and J V. Sanders, Fundamentals of Acoustics, Wiley Publishers, 2005

Other Suggested Readings:

1. https://nptel.ac.in/courses/112/104/112104212/

TURBO MACHINERY

Course Code: MECPEV704 **L:3 T:0 P:0**

Rationale:

- To classify the turbo-machines based on energy interactions
- To study the performance characteristics of turbo-machines under different operating conditions
- To gain knowledge in the design parameters of turbo-machines

Course Outcomes:

CO1	Compare the features and working of various turbo machines
CO2	Apply the concepts of energy transformation in turbo machines
CO3	Analyse the performance of Hydraulic pumps and turbines
CO4	Thermal design and evaluation of critical parameters of Steam turbines
CO5	Evaluate the performance of axial and centrifugal compressors

Course Contents:

Unit 1

Definition and Classification of turbo machines, Specific Work, T-S and h-s Diagram, Incompressible and compressible flow, Losses, Total-to-Total efficiency, Total-to-Static efficiency, Effect of reheat and preheat factor, Degree of reaction, Energy transfer - Euler's equation, velocity triangles. Dimensional analysis, Dimensionless parameters and their physical significance, specific speed.

Unit 2

Elementary cascade theory, cascade nomenclature, compressor cascade, turbine cascade, cascade efficiency. Dimensional analysis of compressible flow machines, stalling and surging.

Unit 3

Hydraulic Pumps: Centrifugal Pumps – Some definitions, pump output and efficiencies, effect of vane angle, Cavitation, pump characteristics, multistage pumps.

Hydraulic Turbines: Classification of hydraulic turbines - Velocity triangle, Efficiencies of draft tubes, Hydraulic turbine characteristics, Francis and Kaplan turbines: Velocity triangle, Efficiencies of Draft tubes, Turbine characteristics.

Unit 4

Steam and Gas Turbines: Axial turbine stages, stage velocity triangles, work, single stage impulse turbine, speed ratio, maximum utilization factor , compounding of turbines and its types, degree of reaction - reaction Stages. Inward Flow Radial turbine stages (IFR) - Working principle and performance characteristics.

Unit 5

Centrifugal Compressors: Constructional details, stage pressure rise, stage pressure coefficient, stage efficiency, degree of reaction, various slip factors, Introduction to Fans and Blowers, working principle, fan laws, performance characteristics.

Axial flow Compressors: general expression for degree of reaction; velocity triangles for different values of degree of reaction, blade loading and flow coefficient, static pressure rise, work done factor.

Textbooks:

1. Yahya S. M. - 'Turbines, Fans and Compressors' - Tata McGraw Hill Publishing Company Limited – 2002

Reference Books:

1. Cengel Y. A. &Cimbala J., "Fluid Mechanics -Fundamentals and Applications", 3/e, McGraw Hill Edition, 2013.
2. Dixon S. L. - 'Fluid Mechanics & Thermodynamics of Turbo machinery' - Elsevier - 2012 - 6th Edition
3. Kadambi V. and Manohar Prasad - 'Energy Conversion - Vol.III: Turbo Machinery' - New Age International Publishers – 1999

Total Quality Management

Course Code: MECPEV705 **L:3 T:0 P:0**

Rationale:

Course Outcomes:

CO-1	Understand quality management philosophies, techniques, and frameworks
CO-2	Adopt TQM methodologies for continuous quality improvement
CO-3	Identify the areas of improvement through measurement of cost of poor quality, effectiveness and efficiency of processes
CO-4	Apply TQM process and concepts to enhance the performance of systems
CO-5	Understand the implications of quality management standards and systems

Course Contents:

UNIT I:

Introduction: Dimensions of Quality, Quality Planning, Quality Costs and Analysis, Axioms of TQM.

UNIT II:

Contribution of Quality Gurus: Shewhart SPC**,** Deming Philosophy, Juran Trilogy, Crosby zero Defect Philosophy, Barriers to TQM Implementation, Benefits of TQM, Characteristics of successful quality leader, Contributions of Gurus of TQM, Case studies.

UNIT III:

TQM Principles: Customer satisfaction - Customer Perception of Quality, Customer Complaints, Service Quality. Customer Retention, Employee Involvement - Motivation, Empowerment teams, Continuous Process Improvement - Juran Trilogy, PDSA Cycle, Kaizen, Supplier Partnership, Performance Measures, Case studies.

UNIT IV:

TQM Tools: Benchmarking, Quality Function Deployment (QFD) - House of Quality, Taguchi Robust Design Concept, Total Productive Maintenance (TPM), FMEA, The seven tools of quality, Process capability, Concept of six sigma, New seven management tools, Case studies.

UNIT V:

Quality Systems: Need for ISO 9000 and Other Quality Systems, ISO 9000:2000 Quality System -

Elements, Implementation of Quality System, Documentation, Quality Auditing, QS 9000, ISO 14000 - Concept, Requirements and Benefits, Case Studies **Learning Resources:**

Text Books:

1. Total Quality Management, Dale H.Besterfiled, Pearson Education, Delhi, 2015, 4th Edition .
2. Total Quality Management, SubburajRamasamy, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2005.
3. Quality Management - Concepts and Tasks, Narayana V and Sreenivasan N.S., New Age International, Delhi, 1996.

Reference Books:

1. Out of the Crisis, Edward Deming, MIT Press, July, 2000
2. ISO 9000: Concepts, Methods and Implementation, Tapan P Bagchi, A.H.Wheeler, 1999

Online Resources:

1. https://deming.org/explore/seven-deadly-diseases/ - Video by Edward Deming
2. https://www.iso.org/standard/45481.html - For ISO 9000 standards

MICRO MACHINING

Course Code: MECPEV706 L:3 T:0 P:0

Rationale:

Course Outcomes:

Course Contents:

UNIT I: (07 hours)

Introduction to Micro-manufacturing and Scaling Laws – Types of Scaling laws - Scaling in Geometry,Scaling in Mechanics, Scaling in Adhesive Forces, Scaling in Electrostatic Forces, Scaling inElectromagnetic Forces, Scaling in Fluid Mechanics, Scaling in Heat Transfer; Salient Features ofMicro-Machining - Workpiece microstructure effect, Tool design effect - Crystallographic OrientationEffect, Edge Radius Effect Minimum Chip thickness.

UNIT II: (08 hours)

Overview about micro fabrication methods -

Chemical vapor deposition (CVD) - basic principles of CVD LPCVD, PECVD; Physical vapordeposition (PVD) methods – thermal evaporation and sputtering; Lithography - optical and electronbeam lithography; Dry and wet etching

UNIT III: (08 hours)

Conventional micromachining processes - micro turning, micro drilling, micro milling, micro grinding – Cutting force, Surface roughness, Chip formation, burr formation, diamond turned machining;Advanced micromachining processes - micro Electro-discharge machining – Principle, systemdevelopment, heat affected zone, applications;

UNIT IV: (08 hours)

Electro-chemical micromachining – Principle, types,applications; Laser machining processes – Types of LASER for micromachining, LASER micromachining system; Ultrasonic micro machining; abrasive water jet micromachining - Nano finishing –magneto-rheological and allied finishing processes – Micro-machine Tool systems.

UNIT V:(10 hours)

Inspection and metrology; Various inspection and metrology based on optical, mechanical, chargedbeam and electrical; 3D Optical profilometer – white light interferometry, focus variation methods,Nano intender, SEM, TEM, AFM; Force, vibration and acoustic emission measurements.

References:

1. J. A. McGeough, Micromachining of Engineering Materials, 1st ed., CRC Press, 2001.

2. Marc J. Madou, Fundamentals of Microfabrication, 2nd ed., CRC Press, Taylor and Francis Group, 2002.

3. Stephen A. Cambell, The Science and Engineering of Microelectronic Fabrication, 2nd ed., Oxford University Press, 2001.

4. V. K. Jain, Micromanufacturing, 1st ed., CRC press, 2012.

5. N. P. Mahalik, Micromanufacturing & Nanotechnology, Springer, 2010.

6. Mark J. Jackson, Microfacbrication&Nanomanufacturing, 1st ed., CRC Press, 2005.

7. Manas Das, V. K. Jain and P. S. Ghoshdastidar, Nanofinishing Process using Magnetorheological Polishing Medium, Lambert Academic Publishing, 2012.

8.Richard Leach, Characterisation of Areal Surface Texture, 1st ed., Springer-Verlag Berlin Heidelberg, 2013.

9.Richard Leach, Optical Measurement of Surface Topography, 1st ed., Springer-Verlag Berlin

Advanced Turbo machinery

Course Code: MECPEV707 **L:3 T:0 P:0**

Rationale:

Course Outcomes:

Flexible Manufacturing System

Course Code: MECPEV708 **L:3 T:0 P:0**

Rationale:

Course Outcomes:

CO-1	Classify and distinguish FMS and other manufacturing systems including job-shop and mass production systems.
CO-2	Explain processing stations and material handling systems used in FMS environments.
CO-3	Design and analyze FMS using simulation and analytical techniques.
CO-4	Describe tool management in FMS.
CO-5	Analyze the production management problems in planning, loading, scheduling, routing and breakdown in a typical FMS.

Course Contents:

UNIT I:

Understanding of FMS: Evolution of Manufacturing Systems, FMS: Definition, objective and Need, FMS: components, Merits, Demerits and Applications, Flexibility in Pull and Push type.

UNIT II:

Classification of FMS Layout: FMS: Layouts and their Salient features, Single line, dual line, loop, ladder, robot centre type etc.

UNIT III:

Salient features of processing stations: Processing stations- Machining Centers, Turning centre, Coordinate measuring machine (CMM), Washing/ Deburring station.

MHS; An introduction: Material Handling System Conveyor, Robots, Automated Guided Vehicle (AGV), Automated Storage Retrieval System (ASRS).

UNIT IV:

Management Technology: Tool Management, tool magazine, Tool preset, identification, Tool monitoring and fault detection, FMS: Configuration planning and routing, FMS: Production Planning and Control, FMS: Scheduling and loading.

UNIT V:

Design of FMS: FMS: Performance Evaluation introduction, Analytical model of FMS, Simulation model of FMS.

Case studies: Typical examples /case studies of FMS.

Text Books:

1. William W Luggen, "Flexible Manufacturing Cells and System" Prentice Hall of Inc New Jersey, 1991
2. Reza A Maleki "Flexible Manufacturing system" Prentice Hall of Inc New Jersey, 1991
3. John E Lenz "Flexible Manufacturing" marcel Dekker Inc New York, 1989.
4. Groover,M.P "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India Pvt.Ltd. New Delhi 2009

Alternative Refrigerants

Course Code: MECPEV709 **L:3 T:0 P:0**

Course Code:

Rationale:

- understand the importance of refrigerant and its properties
- To understand the impact of refrigerants on the environment.
- To understand the safety measures applicable for refrigerants.
- To provide design procedures with alternative refrigerants.
- To identify the changes in retrofitting the systems with alternative refrigerants.

Course Outcomes

CO1	To comprehend the significance of refrigerants and their characteristics.
CO2	To recognize the environmental impact of refrigerants.
CO3	To understand the safety protocols associated with refrigerants.
CO4	To offer design guidelines for using alternative refrigerants.
CO5	To identify the modifications required when retrofitting systems with alternative refrigerants.

Course Content

UNIT I

Refrigerants and its classification – Need of alternate refrigerants, Desirable properties-thermodynamic-chemical and transport properties - designation of refrigerants - inorganic, halo carbon refrigerants - secondary refrigerants - Properties of mixtures of refrigerants, Ozone depletion potential and global warming potential.

UNIT II

Flammability of the alternate refrigerants, methods for identifying the safe zone of operation,

UNIT III

Measuring the financial and environmental impact of leakage of refrigerants on the environment, Refrigerant Hazards.

UNIT IV

Safety and risk assessment of alternative refrigerants, System design using alternative refrigerants, Leak detection of alternative refrigerants,

UNIT V

Maintenance and repair of alternative refrigerant systems, Retrofitting existing systems.

References

1. 1.Arora, R.C., Refrigeration and Air Conditioning, PHI Pvt Ltd, 2010
2. 2 Arora, C.P., Refrigeration and Air Conditioning, 2nd ed., Tata McGraw-Hill, 2000
3. Randall F. Barron, Cryogenic Systems, McGraw-Hill, 1985.
4. 3 Klaus D. Timmerhaus and Thomas M. Flynn, Cryogenic Process Engineering, Plenum Press New York, 1989.
5. 4 Randall F. Barron, Cryogenic heat transfer, CRC Press,1999.
6. 5 Stoecker N.F and Jones, Refrigeration and Air Conditioning, TMH NewDelhi,2nd edition 1982.

Design of Transmission System

Course Code: MECPEV710 L:3 T:0 P:0

Rationale:

Course Outcomes:

Prerequisites:

CO1	Design the flexible drives like belt, chain and rope drives used in industrial mechanical transmission systems.
CO2	Design the spur and helical gear used in mechanical transmission systems.
CO3	Design the straight bevel and worm gear used in industrial machinery.
CO4	Design the multi speed gear box used in mechanical transmission systems.

Course Content

UNIT I

Introduction:

Flexible Transmission Elements: Design of flat belts & pulleys, Design of V-belts and pulleys, Selection of hoisting wire ropes and pulleys, Design of chains and sprockets.

UNIT II

Gear Transmission: Spur gear, speed ratios and number of teeth, force analysis, tooth stresses, dynamic effects, fatigue strength, factor of safety, gear materials; Design of straight tooth spur gear and parallel axis helical gears based on strength and wear considerations, pressure angle in the normal and transverse plane; equivalent number of teeth and forces for helical gears.

UNIT III

Straight Bevel Gear: Straight bevel gear, tooth terminology, tooth forces and stresses, equivalent number of teeth. estimating the dimensions of a pair of straight bevel gears.

UNIT IV

Worm gear: Worm gear,merits & demerits, terminology, thermal capacity, materials, forces and stresses, efficiency, estimating the size of worm gear pair.

UNIT V

Gear Box: Gear box, geometric progression, standard step ratio, ray diagram, kinematics layout; Design of sliding mesh gear box, Design of multi-speed gear box; constant mesh gear box, speed reducer unit, variable speed gear box.

UNIT VI

Fluid Coupling and Torque Convertor: Fluid couplings and Torque converters for automotive applications.

Text Books:

1. Shigley, Mechanical Engineering Design, McGraw-Hill Science Engineering
2. V.B. Bhandari, Design of Machine Elements, Tata McGraw Hill Education Private Limited, 2020, Fifth edition.
3. P.C. Sharma, D.K. Aggarwal, A Textbook of Machine Design, S.K. Kataria & Sons
4. R.K. Jain, Machine Design, Khanna Publishers

Reference Books:

1. Robert L Norton, Machine design an integrated approach, Pearson Education, 2018, Fifth edition.
2. Richard G. Budynas, J Keith Nisbett, Mechanical Engineering Design, Shigley's. McGraw Hill, 2011, Ninth edition.
3. Black and Adams, Machine Design, McGraw Hill and Co, New Delhi, 2002.

Program Elective-VI

AERODYNAMICS OF ELECTRIC AND SPORTS VEHICLES

Course Code: MECPEVI701 **L:3 T:0 P:0**

Rationale:

- Acquire knowledge of the basics of aerodynamics
- Identify the suitable optimization for the cars
- Explain the various dynamics and controls
- Acquire knowledge of the electric vehicle aerodynamics
- Acquire knowledge of the electric sports aerodynamics

Course Outcomes:

CO1	extrapolate the knowledge of basic aerodynamics
CO2	apply the optimization parameters of the vehicles
CO3	apply the various dynamics and control to the vehicles
CO4	analyze the aerodynamics of the electric vehicles
CO5	analyze the aerodynamics of the sports vehicles

Course Contents:

Unit-1 - History and Aerodynamic Forces 9 Hour

Historic development of vehicle aerodynamics, Boundary layer and flow separation, Bernoulli's equation, Flow over bodies and pressure coefficient, Flow phenomenon related to vehicles – External & Internal flow,

Aerodynamics of cars, Resistance to vehicle motion – Types of drags, Fuel consumption and performance.

Unit-2 - Airfoils and Shape Optimization 9 Hour

Airfoils and types, Finite wing, Front and rear modification, wind shield angle, Boat tailing, Hatch back, Fast back, Square back, Effect of gap and fasteners configuration, wind tunnel measurement techniques, road

testing methods

Unit-3 - Vehicle Dynamics and Control 9 Hour

Lateral and longitudinal dynamics, Steering control for automated lane keeping, Differential braking systems, Steer by wire systems, Torque distribution – left and right wheels, Active control of torque transfer

Unit-4 - Electric Vehicle Aerodynamics 9 Hour

Electric vehicle and types, Components of Electric Vehicle, EV aerodynamic parts – front end – upper body – rear end – under body – wheels, Air curtain, Wheelhouse ventilation, Front spoiler/Splitter package,

Underbody vanes, Diffuser extension, Roof and trunk spoiler extension, Consideration of Vehicle Speed and mass, Power requirement to overcome aerodynamic drag.

Unit-5 - Sports Vehicles Aerodynamics 9 Hour

Various components – Splitter – Hood vents – NACA ducts – Diffuser – Spoiler, Vehicle dynamics, Role of inverted airfoil shape, Various aerodynamic forces, Pressure distribution, Role of Speed and Mass, Stall,Flow over wheels, Tyer performance, Effect of aerodynamics performance on speed.

References:

1. Hucho,W.H. 1987 “Aerodynamics of Road vehicles”, Butterworths Co. Ltd.,
2. Yi Zhang and Chris Mi, 2018, “Automotive Power Transmission Systems”, Wiley.
3. Rajesh Rajamani, 2003, “Vehicle Dynamics and Control”, Springer.
4. Larminie, J. and Lowry, J. 2012, “Electric Vehicle Technology Explained”, Second Edition. John Wiley & Sons, Chichester.
5. Joseph Katz (2003), “Race Car Aerodynamics: Designing for Speed”, Bentley Publishers.

Quality Control and Reliability Engineering

Course Code: MECPEVI702 **L:3 T:0 P:0**

Rationale:

- To introduce the principles and techniques of statistical quality control and their applications
- To familiarize with basic concepts and techniques of reliability engineering

Course Outcomes:

CO1	Apply the knowledge of statistics and probability to attain the quality improvement in industries
CO2	Analyze the product quality using statistical tools
CO3	Determine the reliability and maintainability of systems

Course content

UNIT I

Basic concepts in Quality Engineering and Management: definitions, approaches and relevance to organizational excellence. Product quality control: Acceptance sampling methods- single, multiple and sequential sampling plans; Recent developments in inspection methods.

UNIT II

Statistical Process Control: Process evaluation and control by control charts: Various control charts including CUSUM charts and multivariate charts. Process capability studies: Various indices and approaches; use of Nomographs; Discussions on capabilities of Process, Machine and Gauge; Unit yields and rolled throughput yield.

UNIT III

Total Quality Management perspective, methodologies and procedures; Roadmap to TQM, ISO 9000, KAIZEN, Quality Circles, Models for organizational excellence.

UNIT IV

Quality Function Deployment, Quality cost systems and Quality Policy Deployment Process evaluation and control by designs of experiment: Various basic designs; Special methods such as EVOP and ROBUST design (Taguchi Methods).

UNIT V

Six Sigma Management: Concepts, Steps and Tools ; Benchmarking and Balanced Score Cards Reliability engineering; statistical analysis of life time data and determination of reliability,

availability and maintainability; TPM; FMECA, Fault Tree Analysis Quality and reliability perspectives of JIT. Application of Software tools and Case Studies.

References

1. A.J.Duncan, Quality Control and Industrial Statistics, Richard Darwin Inc., USA.1965
2. A.V.Feigenbaum, Total Quality Control, McGraw Hill International Editions, USA.1987
3. D.C.Montgomery, Design and Analysis of Experiments, John Wiley and Sons, USA.1984
4. J.M.Juran, Juran on Quality Control by Design, The Free Press.1992.
5. W.E.Deming, Out of Crisis: Quality, Productivity and Competitive Position, Productivity and Quality Publishing Private Limited, Madras.1992
6. A.Mitra, Fundamentals of Quality Control and Improvement, Pearson Education, 2nd ed. 2005.
7. J.R.Evans and W.M.Lindsay, The Management and Control of Quality, Thomson.2005.
8. H.M.Wadsworth, K.S.Stephens and A.B.Godfrey, Modern Methods for Quality Control and Improvement, John Wiley & Sons.2004.

SIX SIGMA

Course Code: MECPEVI703 L:3 T:0 P:0

Rationale:

Course Outcomes:

Course Contents:

UNIT I: (6 hours)

Six Sigma Basics: Overview & Implementation, the DMAIC process.Simple graphical tools: 7 QC Tools, Box Plot, Dot Plot, Stem & Leaf Plot.Basic Statistics: Histograms to Distributions, Normal Distribution, Central Limit Theorem, Law of largenumbers, t, chi-squared and F distributions.

UNIT II:(6 hours)

Normal Probability Plotting on ordinary graph paper, InterpretationTesting a new process for improvement - Variability known from past, Variability estimated from the experimentComparing two processes - Randomised samples, Paired samples, Comparing more than twomethods simultaneously-ANOVASix Sigma Analyse: Experimental strategies - Deficiencies of one factor at a time experiments,Problems in analysis of past data, Necessity for randomization

UNIT III: (08 hours)

Basics of Experimental Design - Terminology, Two level factorials, Estimation of effects and interactions, Yates algorithm, Unreplicated experiments - judging significance, Testing forsignificancein replicated experimentsDeveloping mathematical model equations, calculating residuals, checking whether experiment hasbeen conducted satisfactorilyHandling non-normal response - Transformations.

UNIT IV: (8 hours)

Choosing the number of experiments, Testing whether linear model is satisfactory - Curvature,Handling uncontrollable factors – Blocking, Dealing with difficult to randomise factors – split plotexperimentsDealing with large number of factors, Fractional Factorial experiments,Design Resolution.Use of DoE software

UNIT V: (12 hours)

Six Sigma Metrics: DPU, DPO, DPMO, Sigma levels, Yield, First Time Yield, Overall Yield,Throughput Yield, Rolled Throughput Yield, Normalized YieldProcess Capability Indices: Cp, Cpk, Cpm, Cpkm. Dealing with non-normality throughtransformations, Importance of stability for capability, Effect of sample size - Confidence IntervalsMeasurement System Analysis: Repeatability and ReproducibilityEvery student should carry out an individual project and present the results.

References:

1. F. Breyfogle, Implementing Six Sigma: Smarter Solutions Using Statistical Methods, 2nd ed., John Wiley & Sons, New York, 2003.

2. M. Harry and R. Schroeder, Six Sigma: The Breakthrough Management Strategy Revolutionizing the World's Top Corporations, Doubleday, New York, 2000.

3. J. Lawson, and J. Erjavec, Modern Statistics for Engineering and Quality Improvement, Thomson Duxbury, 2000.

4. D. C. Montgomery, Introduction to Statistical Quality Control, 6th ed., John Wiley & Sons, Inc., New York, 2009.

Biofluids and Bio-heat transfer

Course Code: MECPEVI704 **L:3 T:0 P:0**

Rationale:

Course Outcomes:

CO-1	Understand fluid mechanics of biological fluids inside the human body.
CO-2	Demonstrate of cardiovascular systems and significant fluid flow problems in large arteries
CO-3	Apply the knowledge of fluid mechanics to analyze the flow behavior in biological systems
CO-4	Apply bio-heat transfer models to analyze human body thermoregulation

Course Contents:

UNIT I

Introduction: Basic topics on human physiology and anatomy, Review of fluid mechanics concepts in the context of bio fluids, Shear stress in Aorta, viscosity of blood, dimensionless numbers, Blood – a multiphase fluid, Flow in Arteries – FSI problem, Heat transfer between blood and tissue

UNITR II

Cardiovascular System: Anatomy and physiology, blood flow through the heart, pressure-volume relationship in a Cardiac cycle, pulsatility index, heart valves

UNIT III

Blood Flow: Physiology of arterial and venous systems, blood rheology, wave propagation, Tube law, bifurcations, tapered and curved channels, pulsatile flow in arteries, oscillatory shear index, aneurysm

UNIT IV

Respiratory System: Physiology, volumes, ventilation and perfusion, breathing mechanics, oxygen and carbon-di-oxide transport within the blood and the role of hemoglobin

UNIT V

Bio-heat transfer: The bioheat equation and other models, Human body thermoregulation - modeling and simulation of the human thermoregulatory system and its applications, Heat Transfer models of single organs, Heat and mass transfer in the respiratory system, Hypothermia and hyperthermia - techniques and applications, Analysis of thermal processes for treating tumors: cryosurgery and localized hyperthermia, Analysis of Skin Burns, Modeling and simulation of the human respiratory system – applications.

Text Books:

1. Rubenstein, David, Wei Yin, and Mary D. Frame. Biofluid mechanics: an introduction to fluid mechanics, macrocirculation, and microcirculation. Academic Press, 2015.
2. Lee Waite, Ph, and Jerry Fine. Applied biofluid mechanics. The McGraw-Hill Medical Companies, Inc., 2007.
3. Ostadfar, Ali. Biofluid mechanics: Principles and applications. Academic Press, 2016.
4. Ghassemi, Majid, and Azadeh Shahidian. Nano and bio heat transfer and fluid flow. Academic Press,2017.

Advanced IC Engines

Course Code: MECPEVI705 **L:3 T:0 P:0**

Rationale:

Course Outcomes:

AI In Manufacturing

Course Code: MECPEVI706 **L:3 T:0 P:0**

Rationale:

Course Outcomes:

Reliability Engineering

Course Code: MECPEVI707 **L:3 T:0 P:0**

Rationale:

Course Outcomes:

CO-1	Understand the concepts of Reliability, Availability and Maintainability
CO-2	Develop hazard-rate models to know the behavior of components.
CO-3	Build system reliability models for different configurations.
CO-4	Assess reliability of components & systems using field & test data.
CO-5	Implement strategies for improving reliability of repairable and non-repairable systems.

Course Contents:

UNIT I:

Introduction: Probabilistic reliability, failures and failure modes, repairable and non-repairable items, pattern of failures with time, reliability economics.

Component Reliability Models: Basics of probability and statistics, hazard rate and failure rate, constant hazard rate model, increasing hazard rate models, decreasing hazard rate model, time-dependent and stress-dependent hazard models, bath-tub curve.

UNIT II:

System Reliability Models: Systems with components in series, systems with parallel components, combined series-parallel systems, k-out-of-m systems, standby models, load sharing models, stress-strength models, reliability block diagram.

UNIT III:

Life Testing and Reliability Assessment: Censored and uncensored field data, burn-in testing, acceptance testing, accelerated testing, identifying failure distributions and estimation of parameters, reliability assessment of components and systems.

UNIT IV:Reliability Analysis and Allocation: Reliability specification and allocation, failure modes and effects and criticality analysis (FMECA), fault tree analysis, cut sets and tie sets approaches

UNIT V:

Maintainability Analysis: Repair time distribution, MTBF, MTTR, availability, maintainability, preventive maintenance, introduction to reliability software

Text Books:

1. Charles E. Ebeling (2019) “An Introduction to Reliability and Maintainability Engineering”, 3rd edition, Publisher: McGraw Hill Education.
2. Patrick D. T. O’Connor, Andre Kleyner (2012) “Practical Reliability Engineering”, 5th edition, Publisher: Wiley.
3. Roy Billinton, Ronald N. Allan (1992) “Reliability Evaluation of Engineering Systems: Concepts and Techniques”, 2nd edition, Publisher: Springer.
4. Mohammad Modarres, Mark P. Kaminskiy, VasiliyKrivtsov (2016) “Reliability Engineering and Risk Analysis: A practical guide”, 3rd edition, Publisher: CRC Press.
5. Krishan B. Misra, “reliability analysis and prediction: a methodology oriented treatment”, Publisher: Elsevier.

Advanced Material Processing

Course Code: MECPEVI708 **L:3 T:0 P:0**

Rationale:

Course Outcomes:

CO-1	Select appropriate advanced manufacturing Processes materials and Surface finish.
CO-2	Select suitable welding processes for joining different materials
CO-3	Analyze metal removal mechanism in subtractive processes
CO-4	Identify appropriate advanced material processing techniques for different requirements and applications.
CO-5	Compare different advance material processing techniques for industry applications.

Course Contents:

UNIT I

Overview and Prospective Challenges: Introduction to Advanced Materials Processing and Manufacturing.

UNIT II

Laser Lubrication Techniques: Laser Processing Techniques. Ingot Metallurgy Routes: Conventional and Non-Conventional Casting Routes. Powder-Based Manufacturing Techniques: Powder Metallurgy Routes. Advanced machining processes - introduction of USM, AJM, ECM,EDM, LBM, and EBM;

UNIT III

Advanced forming processes - electro-magnetic forming, explosive forming, electro-hydraulic forming, stretch forming, contour roll forming; Advanced welding processes - EBW, LBW, USW; Advanced foundry processes - metal mould, continuous, squeeze, vacuum mould, evaporative pattern, and ceramic shell casting. Characterization Techniques: Material Testing and Characterization.

UNIT IV

Hybrid Processes: Process variables and applications and advantages Hybrid welding processes, hybrid welding process (TIG and Plasma welding, etc.).

Surface Coating: Coating Materials, Coating on different materials, Coating methods and its applications, Limitations.

UNIT V

Composite Materials Introduction, Classification of composites, Manufacturing methods: Spray Lay-Up, Wet/Hand Lay-up, Vacuum Bagging, Filament Winding, Pultrusion, Resin Transfer Moulding (RTM), Resin Film Infusion (RFI), Mechanical Properties -Stiffness and Strength

Text Books:

1. Bolokang, A. S., &Mathabathe, M. N. (2023). Advanced Materials Processing and Manufacturing: Research, Technology, and Applications. CRC Press.

2. Jaluria, Y. (2018). Advanced materials processing and manufacturing. Cham, Switzerland: Springer.

3. P. C. Pandey, H. S. Shan, Modern Machining Processes, Tata McGraw-Hill

4. Nadkarni S.V., Modern Arc Welding Technology, Oxford IBH Publishers, 1996.

5. Surender Kumar, Technology of Metal Forming Processes, Prentice- Hall, Inc., 2008.

Reference Books:

1. El-Hofy, H.. Advanced machining processes: nontraditional and hybrid machining processes, McGraw-Hill Professional, 2005.

2. Groover, M. P. Fundamentals of modern manufacturing: materials, processes, and systems. John Wiley & Sons, 2010.

3. Mamalis, A. G. Advanced manufacturing engineering. Journal of Materials Processing Technology, 161(1-2), 1-9, 2005.

Online Resources:

1. https://archive.nptel.ac.in/courses/113/105/113105081/

2. https://www.coursera.org/learn/material-science-engineering

3. https://handbook.monash.edu/2022/units/MTE4102

Jet Propulsion and Rocketry

Course Code: MECPEVI709 **L:3 T:0 P:0**

Rationale:

Course Outcomes:

CO-1	Understand the principles of Rocket propulsion
CO-2	Analyze the performance of Rocket components
CO-3	Select suitable solid, liquid and hybrid propellants for specific application
CO-4	Evaluate the performance of Rocket engines

Course Contents:

UNIT I:Jet Propulsion Cycles and their Analysis & Fundamentals of Rotating Machines

Criteria of Performance, Simple Turbojet Engine, Simple Turbofan Engine, Simple Turboprop Engine, Turbo-shaft Engine, Thrust Augmentation Techniques.General Fluid Dynamic Analysis, Euler's Energy Equation, Components of Energy Transfer, Impulse and Reaction Machines.

UNIT II: MOTION IN SPACE

REQUIREMENT FOR ORBIT: Motion of Bodies in space, Parameters describing motion of bodies, Newton's Laws of motion, Universal law of gravitational force, Gravitational field, Requirements of motion in space, Geosynchronous and geostationary orbits, Eccentricity and inclination of orbits, Energy and velocity requirements to reach a particular orbit, Escape velocity, Freely falling bodies, Means of providing the required velocities

UNIT III: THEORY OF ROCKET PROPULSION

Illustration by example of motion of sled initially at rest, Motion of giant squid in deep seas, Rocket principle and rocket equation, Mass ratio of rocket, Desirable parameters of rocket, Rocket having small propellant mass fraction, Propulsive efficiency of rocket, Performance parameters of rocket, Staging and clustering of rockets, Classification of rockets.

UNIT IV: ROCKET NOZZLE AND PERFORMANCE

Expansion of gas from a high pressure chamber, Shape of the nozzle, Nozzle area ratio, Performance loss in conical nozzle, Flow separation in nozzles, Contour or bell nozzles, Unconventional nozzles, Mass flow rates and characteristics velocity, Thrust developed by a rocket; Thrust coefficient, Efficiencies, Specific impulse and correlation with C* and CF, General Trends.

UNIT V: SOLID PROPELLANTS, LIQUID PROPELLANTS, AND HYBRID ROCKETS
Working principle, Choice of fuels and oxidizer, Mechanism of burning and burn rate

Text Books:

1. Barrere, M., Rocket Propulsion, Elsevier Pub. Co., 1990.
2. Sutton, G. P., Rocket Propulsion Elements, John Wiley, New York, 1993.
3. Ramamurthi K., Rocket Propulsion, Macmillan Publishers India Ltd., 2010
4. Feedesiev, V. I. and Siniarev, G. B., Introduction to Rocket Technology, Academic Press, New York, 2000.
5. Saravanamuttoo, H.I.H., Rogers, G. F. C. and Cohen, H., Gas Turbine Theory, Pearson PrenticeHall, 6th Edition, 2008.

Program Elective-VII

Supply Chain Management

Course Code: MECPEVII701 **L:3 T:0 P:0**

Rationale:

- Understand the complexity and key issues in supply chain management.
- Describe logistics networks, distribution planning, routing design and scheduling models.
- Familiarize dynamics of supply chain and the role of information in supply chain.
- Understand the issues related to strategic alliances, global supply chain management, and procurement and outsourcing strategies.

Course Outcomes:

CO1	Analyze the complexity and key issues in supply chain management
CO2	Evaluate single and multiple facility location problems, logistics network configuration, vehicle routing and scheduling models
CO3	Analyze inventory management models and dynamics of the supply chain
CO4	Develop the appropriate supply chain through distribution requirement planning and strategic alliances
CO5	Identify the issues in global supply chain management, procurement and outsourcing strategies

Course Contents:

Unit 1

Introduction: Introduction to SCM-the complexity and key issues in SCM – Location strategy – facility location decisions – single facility and multiple location models.

Logistics: Logistics Network Configuration – data collection-model and data validation- solution techniques-network configuration DSS – Transport strategy – Service choices: single service and inter modal services – vehicle routing and scheduling models – traveling salesman problems – exact and heuristic methods.

Unit 2

Inventory: Inventory Management and risk pooling-managing inventory in the SC. Value of Information-bullwhip effect-lead time reduction.

Unit 3

Supply Chain Integration: Supply chain integration-distributed strategies-push versus pull systems. Distribution Requirements Planning – DRP and demand forecasting, DRP and master production scheduling.

Unit 4

DRP techniques – time-phased order point – managing variations in DRP – safety stock determination-Strategic alliances-third party logistics-distribution integration.

Unit 5

Issues in SCM: Procurement and outsourcing strategies – framework of e-procurement. International issues in SCM-regional differences in logistics. Coordinated product and supply chain design-customer value and SCM.

Textbooks:

1. Simchi-Levi, D., Kaminsky, P., Simchi-Levi, E., Shankar, R., 'Designing and Managing the Supply Chain: Concepts, Strategies, and Cases', Tata McGraw Hill, 2008.

Reference Books:

1. Christopher, M., 'Logistics and Supply Chain Management: Strtegies for reducing Cost and Improving Service', PH, 19199.
2. Ballou, M., 'Business logistics / Supply chain management', Pearson Education, 2003.
3. Vollmann, T.E., 'Manufacturing Planning and Control for Supply Chain Management', 5e, McGraw Hill, 2005.

Hybrid Electric Vehicles

Course Code: MECPEVII702 **L:3 T:0 P:0**

Rationale:

Course Outcomes:

CO-1	Understand the need for hybrid electric vehicles and classify based on configuration
CO-2	Identify power sources for hybrid electric vehicles
CO-3	Analyse plug-in hybrid systems with different energy storage devices
CO-4	Evaluate the HEV configurations with battery, hybrid and fuel cell electric vehicles

Course Contents:

UNIT I:

Introduction: Sustainable Transportation - Population, Energy, and Transportation - Environment - Economic Growth – Emissions regulations and norms- impact of modern drivetrains on energy supplies-New Fuel Economy Requirement Emergence of Electric Vehicles- Basics of the EV - Constituents of an EV -Vehicle and Propulsion Loads.

UNIT II:

HEV Fundamentals: Classification- Hybridization of the Automobile-Mild Hybrids, Full Hybrids, Plug-In Hybrids and Electric Vehicles with Range Extender Hybrids- Architectures of HEVs - Series HEVs Parallel HEVs - Series–Parallel HEVs - Complex HEVs - Diesel and other Hybrids - Other Approaches to Vehicle Hybridization Basics of the HEV-Importance of HEV-Constituents of an HEV –Vehicle Model - Vehicle Performance - HEV Powertrain Component Sizing - Series Hybrid Vehicle - Parallel Hybrid Vehicle - Electrically Peaking Hybrid Concept - Gradeability Requirement -Selection of Gear Ratio from ICE to Wheel - Wheel Slip Dynamics.

UNIT III:

Plug-In Hybrid Electric Vehicles: Basics of Plug-In Hybrid Electric Vehicle (PHEV) - Constituents of a PHEV - Comparison of HEV and PHEV - Basics of Fuel Cell Vehicles (FCVs) - Constituents of a FCV-Some Issues Related to Fuel Cells-Introduction to PHEVs - PHEVs and EREVs - Blended PHEVs - Electricity for PHEV Use -PHEV Architectures - Equivalent Electric Range of Blended PHEVs - Fuel Economy of PHEVs -

Well-to-Wheel Efficiency - PHEV Fuel Economy - Utility Factor - Power Management of PHEVs - Vehicle-to-Grid Technology(V2G) - PHEV Battery Charging - Impact of G2V - The Concept of V2G- Advantages of V2G - Case Studies of V2G.

UNIT IV:

Electric Machines and Drives in HEVs: Introduction - Induction Motor Drives – Principle of Induction Motors - Equivalent Circuit of Induction Motor - Speed Control of Induction Machine - Variable Frequency, Variable Voltage Control of Induction Motors – Efficiency and Losses of Induction Machine - Permanent Magnet Motor Drives - Basic Configuration of PM Motors - Basic Principle and Operation of PM Motors - Unsaturated Motor -Saturated Motor.

Electric Energy Sources and Storage Devices: Introduction – Characterization of Batteries - Battery

Capacity - Energy Stored in a Battery - State of Charge in Battery (SOC) and Measurement of SOC - SOC Determination - Direct Measurement - Amp-hr Based Measurement - Some Better Methods - Initialization Process - Depth of Discharge (DOD) of a Battery - Specific Power and Energy Density - Ampere-Hour (Charge and Discharge) Efficiency - Number of Deep Cycles and Battery Life - Some Practical Issues About Batteries and Battery Life- Battery Management Implementation - Comparison of Energy Storage Technologies.

UNIT V:

Fundamentals of Regenerative Braking: Braking Energy Consumed in Urban Driving - Braking Energy versus Vehicle Speed - Braking Energy versus Braking Power Braking Power versus Vehicle Speed - Braking Energy versus Vehicle Deceleration Rate - Braking Energy on Front and Rear Axles - Brake System of EV, HEV, and FCV.

Special Hybrid Vehicles: Brief Introduction of Hydraulic Hybrid Vehicles – Regenerative Braking in HHVs-Off-Road HEVs - Hybrid Excavators - Hybrid Excavator Design Considerations - Diesel HEVs Electric or Hybrid Ships- Locomotives.

Text Books:

1. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, Mehrdad Ehsani, Yimin Gao, Stefano Longo and Kambiz Ebrahimi, CRC Press, 2018, II Edition.
2. Hybrid Electric Vehicles Principles and Applications with Practical Perspectives, Chris Mi, M. Abul Masrur John Wiley & Sons, Inc.,2018, II Edition.

Reference Books:

1. Electric vehicle technology explained, John Lowry and James Larmine, John Wiley and Sons, 2012.
2. Electric and Hybrid Vehicles: Design Fundamentals, Iqbal Hussein, CRC Press, 2003.

Other Suggested Readings:

1. Introduction to Hybrid and Electric vehicles by Dr. Praveen Kumar and Prof. S. Majhi (IIT Guwahati), NPTEL Course (Link: https://nptel.ac.in/courses/108/103/108103009/)

Analysis of Mechanisms

Course Code: MECPEVII703 **L:3 T:0 P:0**

Rationale:

Course Outcomes:

CO-1	Analyze coupler curves and design both exact and approximate straight-line mechanisms.
CO-2	Perform position, velocity, and acceleration analysis using loop closure equations
CO-3	Explore the concepts of dimensional synthesis, focusing on two/ three-position synthesis for rocker output and precision points.
CO-4	Synthesize double dwell cams based on critical extreme position motion constraints

Course Contents:

UNIT I: Position analysis

Introduction and overview of the kinematics of machinery, position and systems, coordinate transformation, rotation, translation and combined motion, algebraic position analysis

UNIT II: Loop closure equation

Position of any point on a linkage, transmission angles and toggle positions, position-based synthesis of planar mechanisms.

UNITS III: Kinematic analysis

Plane motion of a rigid body, graphical velocity and acceleration analysis, instantaneous centers of velocity, centrodes, the velocity of rub, analytical solutions for velocity analysis – velocity of any point on a linkage, acceleration of any point on a linkage, coriolis acceleration, analytical solutions for velocity and acceleration analysis, case studies – four-bar pin joined linkage, four-link slider-crank.

UNIT V: Synthesis

Types of kinematic synthesis – motion and path generation, number synthesis, dimensional synthesis, two-position synthesis for rocker output, precision points, comparison of analytical and graphical two-position synthesis, three-position synthesis

UNIT V: Cams

Terminology, types of followers, follower motions, cams, svaj diagrams, law of cam design, single and double dwell cam design using SHM, cycloidal displacement, combined functions, critical path motion, practical design considerations.

Text Books:

1. Robert L Norton, Design of Machinery, an Introduction to the Synthesis and Analysis of Mechanisms and Machines, 2nd Edition, McGraw Hill reprint 2011.

Reference Books:

1. J. J. Uicker Jr., G. R. Pennock, J. E. Shigley, Theory of Machines and Mechanisms, 4th Edition, Oxford University Press, 2011
2. David H. Myszka, Machines and Mechanisms: Applied Kinematic Analysis, 4th Edition, Pearson, 2011

Industry 4.0 and IoT

Course Code: MECPEVII704 **L:3 T:0 P:0**

Rationale:

Course Outcomes:

CO-1	Explore how Industry 4.0 will change the current manufacturing technologies and processes by digitizing the value chain
CO-2	Understand the drivers and enablers of Industry 4.0.
CO-3	Learn about various IIoT-related protocols
CO-4	Build simple IIoT Systems using Arduino, ESP32 and Raspberry Pi

Course Contents:

UNIT I

Introduction to Industry 4.0: Industry 4.0: Globalization and Emerging Issues, The Fourth Revolution, LEAN Production Systems,Smart and Connected Business Perspective, Smart Factories, Industry 4.0:

UNIT II

Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Artificial Intelligence, Big Data and Advanced Analysis

UNIT III

Introduction to IIoT: Architectural Overview, Design principles and needed capabilities, IoT Applications, Sensing, Actuation, Basics of Networking, M2M and IoT Technology Fundamentals- Devices and gateways, Data management, Business processes in IoT, Everything as a Service (XaaS), Role of Cloud in IoT, Security aspects in IoT.

UNIT IV

Elements of IIoT: Hardware Components- Computing (Arduino, Raspberry Pi), Communication, Sensing,
Actuation, I/O interfaces. Software Components- Programming API's (using Python/Node.js/Arduino) for Communication Protocols-MQTT, ZigBee, Bluetooth, CoAP, UDP, TCP.

UNIT V

IIoT Application Development: Solution framework for IoT applications- Implementation of Device integration, Data acquisition and integration, Device data storage- Unstructured data storage on cloud/local server, Authentication, authorization of devices. Case Studies: IoT case

studies and mini projects based on Industrial automation, Transportation, Agriculture, Healthcare, Home Automation

Text Books:

1. Vijay Madisetti, ArshdeepBahga, Ïnternet of Things, "A Hands on Approach", University Press.
2. Dr. SRN Reddy, RachitThukral and Manasi Mishra, "Introduction to Internet of Things: A practical Approach", ETI Labs
3. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press
4. Adrian McEwen, "Designing the Internet of Things", Wiley.
5. Raj Kamal, "Internet of Things: Architecture and Design", McGraw Hill.
6. CunoPfister, "Getting Started with the Internet of Things", O Reilly Media

Foundation skills in integrated product Development

Course Code: MECPEVII705 **L:3 T:0 P:0**

Rationale:

- Apply fundamentals of Product Development
- Incorporate the requirement Engineering and System Design of any product.
- Develop the Conceptual design
- Organize the documentation details of the product
- Implement the maintenance, PLM and IPR for the Business Dynamics

Course Outcomes:

CO1	Apply the concepts of product development
CO2	Incorporate the Requirement engineering, System Design with QFD
CO3	Implement the conceptual design to develop the prototype
CO4	Develop the Product verification process and its documentation
CO5	Implement the Business Dynamics

Course Contents:

Unit-1 - Fundamentals of Product Development 9 Hour

Types of various trends affecting product decision - Social Trends (Demographic, Behavioral, Psychographic), Technical Trends (Technology, Applications, Tools, Methods), Economical Trends (Market, Economy,

GDP, Income Levels, Spending Pattern, target cost, TCO), Environmental Trends (Environmental Regulations and Compliance), Political/Policy Trends (Regulations, Political Scenario, IP Trends and Company

Policies); PESTLE Analysis. Overview of Products and Services (Consumer product, Industrial product, Specialty products etc); Types of Product Development (NPD/ Re-Engineering (Enhancements, Cost

Improvements)/ Reverse Engineering/ Design Porting & Homologation); Overview of Product Development methodologies (Over the Wall/ Waterfall/ V-Model/ Stage-Gate Process/ Spiral/Systems Engineering/

Agile); Product Life Cycle (S- Curve, Reverse Bathtub Curve); Product Development Planning and Management (Budgeting, Risk, Resources and Design Collaboration, Scheduling, Change Management, Product

Cost Management

Unit-2 - Requirements and System Design 9 Hour

Types of Requirements (Functional, Performance, Physical, Regulatory, Economical, Behavioral, Technical, Stakeholder, Environmental, Industry specific, Internal-Company Specific); Requirement Engineering

(Gathering (VOC), Analysis (QFD), Design Specification); Traceability Matrix and Analysis; Requirement Management .System Design & Modeling: Introduction to System Modeling; System Optimization;

System Specification; Sub-System Design; Interface Design.

Unit-3 - Design and Testing 9 Hour

Industrial Design and User Interface Design; Introduction to Concept generation Techniques; Concept Screening & Evaluation - Concept Design, S/W Architecture, Hardware Schematics and simulation. Component

Design and Verification; High Level Design/Low Level Design of S/W Programs, S/W Testing; Hardware Schematic, Component design, Layout and Hardware Testing. Prototyping: Types of Prototypes (Mockups,

Engineering Assessment Prototype, Alpha, Beta, Gama); Introduction to Rapid Prototyping and Rapid Manufacturing

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Unit-4 - System Integration, Testing, Certification and Documentation 9 Hour

Manufacturing/Purchase and Assembly of Systems; Integration of Mechanical, Embedded and S/W systems; Introduction to Product verification processes and stages – Industry specific (DFMEA, FEA, CFD);

Introduction to Product validation processes and stages - Industry specific (Sub-system Testing/ Integration Testing/ Functional Testing/ Performance Testing / Compliance Testing); Product Testing standards and

Certification – Industry specific; Product Documentation (Compliance Documentation, Catalogue, Brochures, user manual, maintenance Manual, Spares Parts List, Warranty, Disposal Guide, IETMS, Web Tools).

Unit-5 - Sustenance Engineering, End-of-Life (EoL) Support and Business Dynamics 9 Hour

Maintenance and Repair; Enhancements. Product EoL: Obsolescence Management; Configuration Management; EoL Disposal Engineering Services Industry – overview; Product development in Industry versus

Academia. The IPD Essentials: Introduction to vertical specific product development processes; Product development Trade-offs; Intellectual Property Rights and Confidentiality; Security and configuration

Management.

References:

1. Foundation Skills in Integrated Product Development (FSIPD),Ist

Edition,2013, Published by NASSCOM.

2. Ulrich, Karl T. and Eppinger, Steven D (2004) Product Design and Development,

5th Edition, McGraw-Hill, 2012

3. Kevin N. Otto, “product design – techniques in reverse engineering and new product development”,

PEARSON, New Delhi, 2011.

MECHATRONICS SYSTEMS

Course Code: MECPEVII706 L:3 T:0 P:0

Rationale:

Course Outcomes:

Course Contents:

UNIT I: (6 hours)

Introduction to mechatronics: key elements in mechatronics, design process, types of design:traditional and mechatronics designs; advanced approaches in mechatronics;

UNIT II (6 hours)

real time interfacing;elements of data acquisition system; case studies of mechatronics systems, identification of key elements of various mechatronics systems, examples.

UNIT III: (12 hours)

Introduction to signals, system and controls; system representation, linearisation, time delays,measures of system performance; closed loop controller: PID controller, digital controllers, controllertuning, adaptive control; introduction to microprocessors, micro-controllers and programmable logiccontrollers components, PLC programming, examples.

UNIT IV: (8 hours)

Actuator and Sensors: fluid power and electrical actuators, piezoelectric actuator; sensors for position,motion, force and temperature, flow sensors-range sensors, ultrasonic sensors, fibre optic sensors,magnetostrictive transducer, selection of sensors; case studies on selection of actuators and sensorsfor mechatronics systems.

UNIT V: (8 hours)

Advanced applications in mechatronics: sensors for condition monitoring, mechatronics control inautomated manufacturing; artificial intelligence in mechatronics: fuzzy logic application inmechatronics, microsensors in mechatronics; case studies and design of mechatronics systems

References:

1. Devadas Shetty, Richard A Kolk, Mechatronics System Design, 6th ed., Thomson Learning,

2015

2. W. BOLTON, Mechatronics, 4th ed., Pearson education Asia 2004.

3. Dan Necsulescu, Mechatronics, Parson Education Asia 2002.

4. HMT Ltd, Mechatronics, 1st ed., Tata McGraw Hill, 2000

5. B.P. Singh, Microprocessors and Microcontrollers, 1st ed., Galgotia Pub, 1997

6. Frank D.Petruzella, Programmable Logic Controllers,4th ed., Tata McGraw Hill, 2010

7. Krishna Kant, Computer Based Industrial Control, 2nd ed., PHI, 1999

Heat Exchanger Design

Course Code: MECPEVII707 **L:3 T:0 P:0**

Rationale:

Course Outcomes:

CO-1	Understand the physics and the mathematical treatment of typical heat exchangers.
CO-2	Apply LMTD and Effectiveness - NTU methods in the design of heat exchangers
CO-3	Design the shell and tube heat exchanger.
CO-4	Apply the principles of boiling and condensation in the design of boilers and condensers

Course Contents:

UNIT I:

Introduction to Heat Exchangers: Definition, Applications, Various methods of classification of heat exchangers with examples.

Governing Equation for heat exchangers: Derivation from steady-state steady-flow considerations.

UNIT II;

Mathematical treatment of Heat Exchangers: Concept of Overall Heat Transfer Coefficient, Derivation of the concerned equations, Fouling, Fouling Factor, Factors contributing to fouling of a heat exchanger, Ill-Effects of fouling, Numerical Problems.

UNIT III:

Concept of Logarithmic Mean Temperature Difference: Expression for single-pass parallel-flow and single-pass counter flow heat exchangers – Derivation from first principles, Special Cases, LMTD for a single-pass cross-flow heat exchanger – Nusselt's approach, Chart solutions of Bowman et al. pertaining to LMTD analysis for various kinds of heat exchangers, Numerical Problems, Arithmetic Mean Temperature Difference [AMTD], Relation between AMTD and LMTD, Logical Contrast between AMTD and LMTD, LMTD of a single-pass heat exchanger with linearly varying overall heat transfer coefficient [U] along the length of the heat exchanger.

Concept of Effectiveness: Effectiveness-Number of Transfer Units Approach, Effectiveness of single-pass parallel-flow and counter-flow heat exchangers, Physical significance of NTU, Heat capacity ratio, Different special cases of the above approach, Chart solutions of Kays and London pertaining to Effectiveness-NTU approach, Numerical Problems.

UNIT IV:

Hair-Pin Heat Exchangers: Introduction to Counter-flow Double-pipe or Hair-Pin heat exchangers,

Industrial versions of the same, Film coefficients in tubes and annuli, Pressure drop, Augmentation of performance of hair-pin heat exchangers, Series and Series-Parallel arrangements of hair-pin heat exchangers, Comprehensive Design Algorithm for hair-pin heat exchangers, Numerical Problems.

Shell and Tube Heat Exchangers: Single-Pass, One shell-Two tube [1S-2T] and other heat exchangers,

Industrial versions of the same, Classification and Nomenclature, Baffle arrangement, Types of Baffles, Tube arrangement, Types of tube pitch lay-outs, Shell and Tube side film coefficients, Pressure drop calculations, Numerical Problems.

UNIT V:

Principles of Boilers and Condensers: Boiling, Fundamentals and Types of boiling – Pool boiling curve, Various empirical relations pertaining to boiling, Numerical problems on the above, Condensation –

Classification and Contrast, Types of condensers, Nusselt's theory on laminar film-wise condensation, Empirical Refinements, Several empirical formulae, Numerical problems.

Cooling Towers: Cooling towers – basic principle of evaporative cooling, Psychrometry, fundamentals, Psychrometric chart, Psychrometric Processes, Classification of cooling towers, Numerical problems.

Text Books:

1. Compact Heat Exchangers, Kays, W. M. and London, A. L., McGraw – Hill, New York, 2nd Edition.
2. Process Heat Transfer, Donald Q. Kern, McGraw – Hill, New York.

Reference Books:

1. Fundamentals of Heat and Mass Transfer, Incropera, F. P. and Dewitt, D. P., 4th Edition, John Wiley and Sons, New York.
2. Fundamentals of Heat Exchanger Design, Shah, R. K. and Sekulic, D. P., John Wiley and Sons, New Jersey.

Thermal Energy Storage

Course Code: MECPEVII708 **L:3 T:0 P:0**

Rationale:

Course Outcomes:

CO-1	Understand the principles, concepts, and operation of thermal energy storage systems.
CO-2	Select the suitable energy storage materials.
CO-3	Design thermal energy storage systems.
CO-4	Evaluate the performance of thermal energy storage systems for different applications.

Course Contents:

UNIT I

Introduction: Classification of Energy Resources, Energy Scenario in the World and India, Need for Energy Efficiency, Energy Conservation and Management.

Introduction to Thermal Energy Storage Systems: Introduction, Thermodynamics of Energy Storage, System Types, Environmental Impact.

UNIT II

Sensible Heat Storage Systems: Introduction, Types, Principles of Sensible Heat Storage Systems, Limitations, Advantages and Future Trend.

Latent Heat Storage Systems (Phase Change Materials): Introduction, Types, Selection Criteria, Thermophysical Properties, Thermal Stability, Corrosion, Phase Segregation, Sub Cooling, Applications.

UNIT III

Microencapsulation and Nanoencapsulation of Phase Change Materials: Introduction, Microencapsulation and Nanoencapsulation of Phase Change Materials, Methods, Shape Stabilized Phase Change Materials, Applications.

Design of Latent Heat Storage System: Introduction, Requirements and Considerations for the Design, Design Methodologies, Applications of Latent Heat Storage Systems Incorporating Pcms, Future Trends.

UNIT IV

Modelling of Heat Transfer in Phase Change Materials (PCMS): Introduction, Inherent Physical Phenomena in Phase Change Materials, Modelling Methods and Approaches for the Simulation of Heat Transfer in Pcms for Thermal Energy Storage, Examples of Modelling Applications, Future Trends.

Phase Change Materials for Energy Conservation in Buildings: Introduction, Integration of Pcms into Building Envelop, PCM Containment, Measurement of Thermal Properties of PCM Integrated in Buildings, Experimental and Numerical Studies.

UNIT V

Thermochemical Heat Storage: Introduction, Phenomena and Principles, Thermochemical Energy Storage Systems, Applications, Remarks.

Thermal Energy Storage Systems Applications: Introduction, Solar Air Heating, Solar Water Heating, District Heating, Heat to Waste, Cogeneration and Trigeneration Systems, Concentrated Solar Power, Cooling.

Text Books:

1. Kalaiselvam, S., Parameshwaran, R., Thermal Energy Storage Technologies for Sustainability Systems Design, Assessment and Applications, Elsevier, 2014.
2. Luisa F. Cabeza .,Advances in Thermal Energy Storage Systems - Methods and Applications, , Elsevier, 2015.

Reference Books:

1. Ibrahim Dinçer., Thermal Energy Storage: Systems and Applications, Marc A. Rosen, John Wiley & Sons Ltd., 2010.

Power Plant Engineering

Course Code: MECPEII506 / MECPEVII709 **L:3 T:0 P:0**

Rationale:

Course Outcomes:

CO1	Understand functions of the components of power plant
CO2	Understand the working of nuclear, thermal and gas based power plants.
CO3	Evaluate the design layout and working of hydroelectric power plants
CO4	Evaluate economic and environmental implications on power plants.

Course Content

UNIT I

Introduction: Energy resources and their availability, types of power plants, review of basic thermodynamic cycles used in power plants.

Steam Power Plants: Flow sheet and working of modern-thermal power plants, site selection, plant efficiency.

Steam generators and their accessories: High pressure Boilers and its accessories, Draught system.

UNIT II

Fuel and combustion: coal storage, preparation, coal handling systems, mass and energy balance of steam generator, feeding and burning of pulverized fuel, Fluidized bed combustion system, ash handling systems, dust collection-mechanical dust collector and electrostatic precipitator.

Condensers: Direct Contact Condenser, Surface Condensers, Cooling towers and cooling ponds.

UNIT III

Combined Cycles: Gas turbine power plants, integrated gasification combined cycle, PFBC based combined cycle, re-powering of thermal power plant.

Nuclear Power Plants: Principles of nuclear energy, basic nuclear reactions, nuclear cross-section, and different components of nuclear power station, PWR, BWR, fast breeder, nuclear waste disposal.

UNIT IV

Non-conventional energy generation: Geothermal power plant, Tidal and wave power plant, solar power plant, wind power generation, direct to electricity method - Magneto-hydrodynamic (MHO) power generation.

UNIT V

Hydro Electric Power Plants: Rainfall and run-off measurements and plotting of various curves for estimating stream flow and size of reservoir, power plant design, comparison with other types of power plants.

Power Plant Economics: load curve, different terms and definitions, base load and peak load plants, energy storage, cost of electrical energy, tariffs methods of electrical energy performance & operating characteristics of power plants- incremental rate theory, input- output curves, efficiency, heat rate, economic load sharing, Problems.

Text Books:

1.Power Plant Engineering, P. K. Nag, McGraw Hill Education, 4th Edition, 2017

2.Power plant engineering, Arrora, Domkundwar, DhanpatRai& Sons, New Delhi, 2008

3.Power plant engineering, P. C. Sharma, S.K. Kataria & Sons, New Delhi, 2010

Reference Books:

1.Power plant Technology, M.M.Ei-Wakil, McGraw Hill Com., Other Suggested Readings:

2.https://www.alternative-energy-tutorials.com/

Open Elective-II

Introduction to Drones

Course Code: MECOEII701 **L:3 T:0 P:0**

Rationale:

Course Outcomes:

Course Contents:

UNIT I: Flight Dynamics of Aerial Vehicles

Definitions of Drone, UAV, RPA, Quad copters -Basic Components and Categories – Principlesof Flight - Flight Maneuvers – Airframes - Creating a Frame: Materials, Different Frame Shapes– Building Airframes - Flight dynamics - Applications - Future potential - Comparison withother aerial vehicles

UNIT II: Hardware Anatomy of Quadcopter

Power Train – Propellers, Motors- Total Lift - Electronic Speed Controllers – Flight Battery – Radio transmitter and receiver – Flight Controller – GPS, Compass, Camera Assembling forQuad copter – Connectors, Mounting of Propellers and Powering up.

UNIT III: Testing And Maintenance of Quadcopter

Key Flight Safety Rules - Preflight Checklist and Flight Log Information – Flight Instructions - Repair and Maintenance: Crash analysis, Common issues, Voltage testing.Test and troubleshoot Flight Controller Board (FCB), Electronic Speed Controller (ESC), and itsassociated peripherals.Perform programming and configure the flight control board (FCB). Identify, explore, and testthe interconnectivity of different peripherals with FCB. Establish connection of FCB with motor,GPS, ESC, and sensors. Configure, test, and record FCB with battery to monitor battery leveland perform return to home operation Perform and carry out drone leveling using IMU sensor.Perform calibration of the compass, Lidar, and gyro sensor.

UNIT IV: The test communication link

between FCB and RF transceiver. Write and upload computer code to FCB to test sensor results.Test and record data of motor connectivity with ESC. Perform motor rotation using FCB andESC. Test signal flow into the drone to test ESC parameters on FCB to check its operation. Writeand upload computer code to FCB to ESC working.

UNIT V: Real World Applications and Case Studies

Beneficial Drones, Aerial Photography, Mapping and Surveying, Precision Agriculture, Searchand Rescue, Infrastructure Inspection, and Conservation. Case Studies: Agriculture WeedClassification, Microdrone surveillances.

Text Book(s):

1. Reg Austin "Unmanned Aircraft Systems UAV design, development and deployment", Wiley,2010.

2. Robert C. Nelson, Flight Stability and Automatic Control, McGraw-Hill, Inc, 1998.

3. Kimon P. Valavanis, "Advances in Unmanned Aerial Vehicles: State of the Art and the RoadtoAutonomy", Springer, 2007

4. Paul G Fahlstrom, Thomas J Gleason, "Introduction to UAV Systems", UAV Systems, Inc,1998

5. Dr. Armand J. Chaput, "Design of Unmanned Air Vehicle Systems", Lockheed MartinAeronautics

MACHINE TOOL DESIGN AND COMPUTER NUMERICAL CONTROL

Course Code: MECOEII702 **L:3 T:0 P:0**

Rationale:

Course Outcomes:

Course Contents:

UNIT I: (6 hours)

Design principles of metal cutting machine tools – classification, kinematics, layouts, machining timecalculations.

UNIT II (8 hours)

Stepped and step-less regulation of speed and feed, Design of speed box and feed box.Design of machine tool structures, power screws, spindles, bed, head stock, guide-ways. Lubricationsystems in machine tools.

UNIT III: (07 hours)

Machine Tool dynamics: free and forced vibrations, Vibration and noise isolation in machine tools,Vibration measurement in machine tools. stability analysis, regenerative chatter.

UNIT IV: (07 hours)

Hydraulic drives,Pneumatic drives and Electrical drives for machine tools. Comparison and selection of drives.

UNIT V: (11 hours)

Types of CNC machine tools, machining centers, 5 axis machining, Design of CNC machine tools,Mechatronic elements, sensors and transducers, tool changers, testing of machine tools, positioningaccuracy and repeatability. Measurements, Laser interferometry, machine tool error analysis, sourcesof error, error compensation strategies, real time error compensation techniques, CNC programming,industrial design, aesthetics and ergonomics

.

References:

1. N. K. Mehta, Machine Tool Design and Numerical Control, 3rd ed., Tata McGraw Hill, 2012.

2. J. N. Acherkan, Machine Tool Design, 1st ed., Vols. 1 to 4, MIR Publishers, 1982.

3. J. F. Blackburn, G. Reetholf, and J. L. Shearer, Fluid Power Control, 1st ed., 1981.

4. G. Boothroyd, Fundamentals of Metal Machining and Machine Tools, 3rd ed., McGraw Hill, 2004.

5. T. Jagadeesha, Fluid Power Control, 1st ed., John Wiley publications, 2013.

6. G. Shleisinger, Testing of Machine tools, 1st ed., Pergamon press, 1982.

7. Leonard Meirovitch, Elements of Vibration Analysis, 1st ed., McGraw Hill, 1986.

8. P. Radhakrishnan, CAD/CAM/CIM, 2nd ed., New Age International Publishing, 2000.

INDUSTRIAL MACHINE VISION

Course Code: MECOEII703 **L:3 T:0 P:0**

Rationale:

Course Outcomes:

Course Contents:

UNIT I: **(11 hours)**

Introduction: Types of inspection tasks, Structure of image processing systems, examplesImage Preprocessing: Gray Scale transformations, Image arithmetic, Linear Filters, Other FiltersPositioning: Positioning of individual object, Orientation of individual object, Robot positioningSegmentation: Regions of interest, Thresholding, Contour Tracing, Edge based methods, Templatematching

UNIT II: **(07 hours)**

Mark Identification: Bar code identification, Character identification, Identifying pin marked digits onmetal, Print quality inspection

UNIT III: **(08 hours)**

Classification: As function approximation, Instance based classifiers, Function based classifiers,Neural network classifiersDimension checking: Simple Gauging, Shape checking on punched parts, injection molded parts,High accuracy gauging of threads, Calibration.

UNIT IV: **(08 hours)**

Image acquisition and illumination: Solid state sensors, Standard video cameras, other cameras,Transmission to computer, Optics, Lighting

UNIT V: **(08 hours)**

Presence Verification: Simple presence verification, simple gauging for assembly verification,presence verification using classifiersObject Features: Basic Features, Shape Descriptors, Gray Level Features

References:

1. Demant, Industrial Image Processing – Visual Quality Control in Manufacturing, 2nd ed., Springer,

2013.

2. Gonzalez, Digital Image Processing Using MATLAB, 2nd ed., Pearson Education, 2010.

3. Gonzalez, and Woods, Digital Image Processing, 3rd ed., Pearson Education, 2008.

4. Batchelor, and Whelan, Intelligent Vision Systems for Industry, Springer Verlag, 1997.

Energy Systems for Sustainable Buildings

Course Code: MECOEII704 **L:3 T:0 P:0**

Rationale:

Course Outcomes:

Resource Management Techniques

Course Code: MECOEII705 **L:3 T:0 P:0**

Rationale:

Course Outcomes:

ADVANCED METROLOGY AND COMPUTER AIDED INSPECTION

Course Code: MECOEII706 **L:3 T:0 P:0**

Rationale:

Course Outcomes:

Course Contents:

UNIT I: **(07 hours)**

Measurement Fundamentals, Measurement Uncertainty according to GUM, Type A Evaluation;Repeated measurements, Regression, Type B Evaluation, Calculation of combined standarduncertainty using Law of Propagation, Numerical Approach, Handling Correlated components,Expanded Uncertainty, Uncertainty and Resolution, Uncertainty and Conformity.

UNIT II: **(06 hours)**

Geometric Dimensioning and Tolerancing: Necessity, Symbols, Calculation of straightness,roundness, Bonus Tolerances.

UNIT III: **(7 hours)**

Coordinate Measuring Machines: Basics, Constructional features, Measurement process,Measurement strategy, Sampling strategy, Measurement Uncertainty

UNIT IV: **(7 hours)**

Surface Texture measurement: Definitions, Stylus instruments, Filters and cut-off, computation ofparameters like Ra, Rq, Rt, Rp, Rz, Rsm, etc., Bearing Area curve, autocorrelation function, Arealparameters

UNIT IV: **(13 hours)**

Machine Vision: Introduction, Image acquisition, File formats and compression, Imaging geometry,Pixel relationships, Preprocessing, Segmentation, Description, Recognition, Interpretation, Casestudies.Scanning microscopes: Principles, Applications.

References:

1. L. Kirkup, and R. B. Frenkel, An Introduction to Uncertainty in Measurement Using the GUM,

Cambridge University Press, 2006.

2. D. Whitehouse, Surfaces and Their Measurement, Hermes Penton Science, London, 2002.

3. J. Hocken, Coordinate Measuring Machines and Systems, 2nd ed., CRC Press, Boca Raton, 2012.

4. C. Demant, B. Streicher-Abel, and P. Waszkewitz, Industrial Image Processing, Springer-Verlag, Berlin, 1999.

Occupational Safety and Disaster Management

Course Code: MECOEII707 **L:3 T:0 P:0**

Rationale:

Course Outcomes:

Course Contents:

AUTOMATION IN MANUFACTURING

Course Code: MECOEII708 **L:3 T:0 P:0**

Course Outcomes: Attheend oftheCourse,the Studentwillbe ableto:

CO1: Discussthe conceptsand levels ofautomationinproduction systems

CO2: Analysetheirperformanceofmanufacturingsystems fordifferentproduction requirements

CO3: Applythe automation concepts to manualline and transfer line

CO4: Analysethe performance ofvarious automatedassemblysystems

CO5: Explaintheelementsofconcurrentengineeringandjustintime productionsystem

DETAILED SYLLABUS

UNIT 1

AutomationinProduction System: Typesofautomation,reasons forautomation, automation principles and strategies, basicelements ofanautomation system:powerto accomplishthe automated process, programof instructions, controlsystem; levels ofautomation, Materialhandlingequipment, automated storage andretrievalsystems. **(10)**

UNIT 2

CNC basics and part programming: Introduction, historical, background, basic components of an NC, steps in NC, verifications of numerical control machine tool programs, classification of NC Machine tool, basics of motion control and feedback for NC M/C, NC part programming, part programming methods, modern machining system, automatically programmed tools, DNC, adaptive control. **(10)**

UNIT 3

Group technology and cellular manufacturing: Part families, parts classifications and coding, production flow analysis, cellular Manufacturing- composite part concept, machine cell design, applications of group technology, grouping parts and machines by rank order clustering technique, arranging machines in a G.T. cell.

(8)

UNIT 4

Flexible manufacturing: Introduction, FMS components, flexibility in manufacturing machine, product, routing, operation, types of FMS, FMS layouts, FMS planning and control issues, deadlock in FMS, FMS benefits and applications. **(6)**

UNIT 4

ProcessPlanningandConcurrentEngineering: Computeraidedprocessplanning,retrievalCAPP system,generativeCAPPsystem;Concurrentengineeringanddesignformanufacturing:principlesof designformanufacturingandassembly,otherproductdesignobjectives-designforproductquality,cost, life cycle;advanced manufacturingplanning.**(8)**

Text Books:

M.P.Groover,*Automation,ProductionSystemsandComputerIntegratedManufacturing*,Pearsonand PHI, 4th Edition,2018.

ReferenceBooks:

1. YoramKoren,*ComputercontrolofManufacturing Systems*,McGraw-HillEducation, InternationalEdition, 2017.
2. P. Radhakrishnanand S. Subramanyam, V. Raju,*CAD/CAM/CIM*, New Age InternationalPvtLtd., 3rd Edition, 2009.

Open Elective-III

MICRO AND NANO MANUFACTURING

Course Code: MECOEIII701 **L:3 T:0 P:0**

Rationale:

Course Outcomes:

CO1	Understand different techniques for the synthesis and characterization of nano-materials
CO2	Design and analyze methods and tools for micro and nano-manufacturing.
CO3	Select micro and nano-manufacturing methods and identify key variables to improve the quality of MEMS.
CO4	Choose appropriate industrially viable process, equipment and tools for a specific product.

Course Contents:

UNIT I: Introduction:

Importance of Nano-technology, Emergence of Nanotechnology, Bottom-up and Top-down approaches, challenges in Nanotechnology, Scaling Laws in Mechanics, fluids, thermodynamics, Electromagnetism, tribology and Examples.

UNIT II: Nano-materials Synthesis and Processing

Methods for creating Nanostructures; Processes for producing ultrafine powders- Mechanical grinding; Wet Chemical Synthesis of nano-materials- sol-gel process, Liquid solid reactions; Gas Phase synthesis of nano-materials.

UNIT III: Structural Characterization

X-ray diffraction, Optical Microscope and their description, Scanning Electron Microscopy (SEM), TEM and EDAX analysis, Scanning Tunneling Microscopy (STM), Atomic force Microscopy (AFM).

UNIT IV: Micro fabrication Techniques
Lithography – LIGA, Thin Film Deposition and Doping, Etching and Substrate Removal, Substrate Bonding, MEMS Fabrication Techniques, Bulk Micromachining, Surface Micromachining, High- Aspect-Ratio Micromachining

UNIT V:Nanofabrication Techniques: Laser based nana manufacturing, E-Beam and Nano-Imprint Fabrication, Epitaxy and Strain Engineering, Scanned Probe Techniques, Self-Assembly and Template Manufacturing.
MEMS devices and applications: Pressure sensor, inertial sensor, Optical MEMS and RF-MEMS, Micro-actuators for dual-stage servo systems.

Text Books:

1. Tai-Ran Hsu, MEMS and Microsystems: Design and Manufacture, McGraw- Hill, 2008
2. Marc Madou, Fundamentals of Microfabrication: The Science of Miniaturization, CRC Press, 2002, Second Edition.
3. Mark James Jackson, Microfabrication and Nanomanufacturing, CRC Press, 2005.

Reference Books:

1. Gabor L. Hornyak, H.F Tibbals, Joydeep Dutta & John J Moore, Introduction to Nanoscience and Nanotechnology, CRC Press, 2009.
2. Ray F. Egerton, Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM, Springer, 2005.
3. Robert F Speyer, Thermal Analysis of Materials, Marcel Dekker Inc. New York, 1994.

B.D. Cullity, Elements of X-Ray Diffraction, Prentice Hall, 2002, 3rd edition

Environmental Pollution and Abatement

Course Code: MECOEIII702 **L:3 T:0 P:0**

Course Outcomes:

Software Project Management

Course Code: MECOEIII703 **L:3 T:0 P:0**

Rationale:

- This course describes the key aspects of a software project.
- It introduces the basic principles of Engineering Software Projects. Most, if not all, students' complete projects as part of assignments in various courses undertaken. These projects range in size, subject and complexity but there are basic project essentials that need to be understood and practiced for successful team project outcomes.
- The course provides an understanding of the purpose, methods and benefits of process management by exposing the student to the concepts, practices, processes, tools and techniques used in process management for software development.

Course Outcomes:

CO1	To understand the basic concepts, terminologies and issues of software project management.
CO2	To apply appropriate methods and models for the development of solutions.
CO3	To analyze the cost-benefits of calculations so as to optimize the selection strategy
CO4	To evaluate methods, models and technologies towards achieving project
CO5	To design and evaluate network planning models with criticality

Course Contents:

Unit I

Introduction to Software Project Management- Software Projects - ways of categorizing software projects – problems with software projects - Project Life Cycle– Management - Setting objectives –Stakeholders - Project Team- Step-wise.

UNIT II

An overview of project planning -project Evaluation –Selection Of Appropriate Project Objectives- Software Effort Estimation Techniques, Function Point Analysis-Object Point-COCOMO.

Unit III

Activity planning -- project schedules - sequencing and scheduling projects - Network planning model – AON and AOA-identifying critical activities-Crashing And Fast Tracking-,Risk management—Categories , Risk planning, Management and Control - Evaluating risks to the schedule.

UNIT IV

PERT- Resource Allocation, Monitoring and Tracking - Monitoring and control - allocation - identifying resource requirements - scheduling resources - creating critical paths- publishing schedule - cost schedules- sequence schedule

Unit V

Monitoring and control – Visualizing Progress, Earned value analysis, managing people and organizing teams-organizational structures- Planning for small projects. Case Study: PMBOK , Agile Development

TEXT BOOK(S)

1. Mike Cotterell, Bob Hughes. Software Project Management, Fifth Edition, Tata McGraw-Hill; 2012.

REFERENCE(S)

1. Roger S. Pressman. Software Engineering – A Practioner's Approach, Eighth Edition, Tata McGraw-Hill publishers; 2014.

2. Jalote P. Software Project Management in practice, Second edition, Person Education; 2003

Financial Engineering

Course Code: MECOEIII704 L:3 T:0 P:0

Rationale:

- This course serves as an introduction to financial engineering including cash flows, financial decision making etc
- It gives a thorough yet highly accessible mathematical coverage of standard and recent topics of introductory investments: fixed-income securities, modern portfolio theory, optimal portfolio growth and valuation of multi-period risky investments.

Course Outcomes:

CO1	Apply basic concepts to understand and evaluate cash flows
CO2	Evaluate and arrive at a financial investment decision employing the underlying knowledge of stocks and derivatives
CO3	Analyse and design Portfolio selection methods
CO4	Understand capital market theory for stock performance evaluation

Course Contents:

Unit I

Cash Flows and Fixed income securities: Investments and markets - Principal and interest - Present and future values of streams - IRR. Fixed income securities - Market value for future cash - Bond value - Bond details – Yields – Convexity– Duration - Immunization. Bond portfolio management - Level of market interest rates, Term structure of interest-rate theories.

Unit II

Stocks and Derivatives: Common stock valuation - Present value of cash dividends - Earnings approach - Value versus price

UNIT III

Efficient markets theory - Technical analysis. Analysis of financial statements. Derivatives - futures and options. Black Scholes formula - Utility functions - Applications in financial decision making.

Unit 1V

Portfolio analysis and capital market theory: Covariance of returns – Correlation - Portfolio return - Portfolio standard deviation - Two asset case - Efficient frontier - Optimum portfolio.

UNIT V

Capital market theory - Capital market line - Sample diversifications to reduce risk - Characteristic line - Capital asset pricing model. Arbitrage price theory - Stock performance evaluation.

TEXT BOOK(S)

1. David Luenberger, Investment Science. Second Edition, Oxford University Press; 2013
2. Jack Clark Francis, Richard W. Taylor. Investments, Schaum's Outlines, Tata McGraw Hill ;2006.

INFORMATION SYSTEMS

Course Code: MECOEIII705 **L:3 T:0 P:0**

Rationale:

- This course is to expose the students to the managerial issues relating to information systems and also understand the role of Business Process Reengineering technique in an organization.
- The course also focus on the management of information technology to provide efficiency and effectiveness or strategy decision making.

Course Outcomes:

CO1	Understand the fundamental concepts of Information Systems in business.
CO2	Understand and analyse the strategic role played by Information Systems in e-commerce.
CO3	Analyse management challenges in Global Businesses predominantly dependent on IS functions.

Course Contents:

Unit I

Introduction to IS -Fundamental concepts-IS in Business- Role of IS –Information system and technologies – Components of IS –resources and acivities –Types of IS- E business Applications –Role of BI and Analytics in IS-Functional Business Systems - Marketing Systems, Manufacturing systems, Human Resource Systems, Accounting Systems and Financial Management Systems.

UNIT II

Cross-Functional Enterprise Systems Cross-Functional Enterprise Applications, Enterprise Application Integration, Transaction Processing Systems and Enterprise Collaboration Systems. Enterprice Business Systems CRM, ERP, SCM , Case Studies

Unit III

Electronic Commerce Systems : Scope of e-Commerce, Essential e-Commerce Processes and Electronic Payment Processes - E-commerce Applications & Issues -Decision Support Systems-Business and Decision Support, Decision Support Trends, Management Information Systems, Online Analytical Processing, Decision Support Systems, Executive Information Systems, Enterprise Portals and Decision Support - Knowledge Management Systems.

UNIT IV

Artificial Intelligence Technologies and its application in Business- Strategic role of IT-Competing with IT, value chain ,reengineering, virtual organization ,knowledge creation - Organizational Planning, The Scenario Approach, Planning for Competitive Advantage, SWOT Business Models and Planning, Business IT Planning, -Business/ IT Strategies and Business

Application Planning- Developing and Implementing Business Systems - Implementation Challenges- barriers - change management-: Case Studies

Unit V

Management challenges-Security, Ethical and Societal Challenges- Ethical Responsibility of Business Professionals, Computer Crime, Privacy Issues, Health Issues, and Societal Solutions-Security Management of IT- Tools of security Management, Internetworked Security Defenses, other security measures –system controls and audits- Enterprise and Global Management of IT-Managing the IS Function and Failures in IT Management - Global IT Management, Cultural, Political and Geo -economic Challenges, Global Business/IT Strategies, Global Business/IT Applications, Global IT Platforms, Global Data Access Issues and Global Systems Development –Case studies

TEXT BOOKS:

1. O'Brien JA, Marakas GM. Management information systems. McGraw-Hill Irwin; 2006.
2. Brien,Marakas G M and Behi R , MIS,9th edition, Tata McGraw Hill Special Indian Edition;2010.

REFERENCES:

1. Laudon K, Laudon JP. Management Information Systems;2010

Managerial Statistics

Course Code: MECOEIII706 **L:3 T:0 P:0**

Rationale:

- To impart the knowledge of basic statistical tools for analysis and interpretation of qualitative and quantitative data for decision making

Course Outcomes:

CO1	Apply basic probability and statistics concepts for various business problems
CO2	Perform test of hypothesis
CO3	Compute and interpret the result of regression and correlation analysis for forecasting
CO4	Solve real time problems by applying different decision making methods

Course Contents:

Unit I

Quantitative methods: Basic terminology in probability, probability rules, conditions of statistical dependence and independence, Bayes Theorem, Discrete Random Variables review of probability distributions, measure of central tendency.

UNIT II

Sampling and sampling distributions: Introduction to sampling, random sampling, design of experiments, introduction to sampling distributions

Estimation: point estimates, interval estimates and confidence intervals, calculating interval estimates of mean from large samples, using t test, sample size estimation.

Unit III

Testing hypothesis: Introduction, basic concepts, testing hypothesis, testing when population standard deviation is known and not known, two sample tests. Chi-square and analysis of variance: introduction, goodness of fit, analysis of variance, inferences about a population variation

Unit IV

Regression and correlation: Estimation using regression line, correlation analysis, finding multiple regression equation, modelling techniques,

UNIT V

Non-parametric methods and time series and forecasting: Sign test for paired data, rank sum test, rank correlation, Kolmogrov – Smirnov test, variations in time series, trend analysis, cyclic variation, seasonal variation and irregular variation. Decision theory: Decision tree analysis.

Textbooks:

1. Levin R. I. and Rubin D. S. - 'Statistics for management' - Pearson Education – 2007 - 5th Edition
2. Montgomery D. C. and Runger G. C. - 'Applied Statistics and Probability for Engineers' - John Wiley & Sons - 2002 - 3rd Edition

Reference Books:

1. Bain.L. J. and Engelhardt M. - 'Introduction to Probability and Mathematical Statistics' - Duxbury Press - March 2000 - 2nd Edition
2. Hinkelmann K. and Kempthorne O. - 'Design and Analysis of Experiments : Volume I' - John Wiley & Sons, Inc. - December 2007 - 2nd Edition
3. Johnson R. A. and Wichern D. W. - 'Applied Multivariate Statistical Analysis' - Prentice-Hall, Inc. - December 2001 - 5th Edition
4. Myers R. H. - 'Classical and Modern Regression with Applications' - PWS-Kent Publishing Company - March 2000 - 2nd Edition
5. Devore J. L. - 'Probability and Statistics for Engineering and the Sciences' - Brooks/Cole Publishing Company - December 1999 - 5th Edition
6. Freund J. E. and Walpole R. E. - 'Mathematical Statistics' - Prentice-Hall Inc. - October 1986 - 4th Edition

Financial Management

Course Code: MECOEIII707 **L:3 T:0 P:0**

Rationale:

- Understand the overview of financial management
- Inculcate methods and concepts on valuation
- Familiarize with working capital management, financial analysis and planning

Course Outcomes:

CO1	Understand and apply time value concept of money and use this for investment criteria decisions
CO2	Evaluate the risk and return for various alternatives of investment
CO3	Apply the capital budgeting techniques and evaluate the investment decisions.
CO4	Understand working capital management, cash and liquidity management and financial statements.

Course Contents:

Unit I

Introduction: Financial Management an overview – Financial Decisions in a firm – Goal of FM – Function of the financial system. [10 hours]

Unit II

Fundamental Valuation Concepts: Time value of money – Risk and Return. Capital Budgeting: Techniques of capital budgeting investment criteria– NPV – Benefit Cost Ratio – IRR – Payback Period – ARR – Investment appraisal in Practice – Estimation of Project cost flows. [14 hours]

Unit III

Working Capital Management: Current Assets – Financing Ruling – Profit Criterion. Cash and

Liquidity Management. Working Capital Financing.

UNIT IV

Financial Analysis and Planning**:** financial instruments, sources of long-term, intermediate term and short term finance.

UNIT V

Analyzing Financial Performance – Break – even analysis and Leverages – Financial Planning and Budgeting. Mergers and Takeovers-International trade. [15 hours]

Textbooks:

1. Chandra, P., 'Financial Management: Theory and Practice', 9e, TMH, 2017.
2. Denzil Watson & Antony Head, 'Corporate Finance- Principles and Practice', 2e, Pearson Education Asia, 2016.
3. R L Varshney& K L. Maheshwari, 'Managerial Economics', S Chand & Sons, 22e, 2014.

Reference Books:

1. Stephen Blyth, 'An Introduction to Corporate Finance ', McGraw Hill Book Company, 2014.
2. Eugene F. Brigham & Louis C.Gapenski, 'Financial Management – Theory and Practice', 14e, 2015.

ADDITIVE MANUFACTURING

Course Code: MECOEIII708 **L:3 T:0 P:0**

Rationale:

- To provide comprehensive knowledge of the wide range of additive manufacturing processes, capabilities, and materials.
- To familiarize with materials science for additive manufacturing, process evaluation, applications, and quality and reliability.
- To impart knowledge about the software tools and techniques used for additive manufacturing.
- To create physical objects that facilitate product development/prototyping requirements.

Course Outcomes:

CO1	Illustrate the significance and principles of additive manufacturing
CO2	Select the suitable additive manufacturing process for a product/application and appropriate materials for the selected additive manufacturing process.
CO3	Demonstrate the methodology of CAD tools and CAD interface with additive manufacturing systems
CO4	Design and develop 3D-printed physical prototypes.

Course Contents:

Unit 1

Introduction: Methods and Systems

Introduction: Introduction to layered manufacturing, Importance of Additive Manufacturing, Introduction to reverse engineering: Traditional manufacturing vis Additive Manufacturing, Additive Manufacturing in Product Development, 3D Printers and Printable Materials, 3D Printer Workflow and Software. [3 hours]

Unit 2

Classification of additive manufacturing processes: Common additive manufacturing technologies: Fused Deposition Modeling (FDM), Selective Laser Sintering (SLS), Stereo Lithography (SLA), Selection Laser Melting (SLM), Digital Laser Processing (DLP), Jetting, Laser Engineering Net Shaping (LENS), Laminated Object Manufacturing (LOM), Electron Beam Melting (EBM),

Wire Arc Additive Manufacturing (WAAM), Ultrasonic Additive Manufacturing, 4D Printing Capabilities, materials, costs, advantages and limitations of different systems. [7 hours]

Unit 3

Material and Process Evaluation

Material science for additive manufacturing: Mechanisms of material consolidation: FDM, SLS and SLM technologies. Polymers coalescence, sintering, photopolymerization, solidification rates, Meso and macro structures. [3 hours]

Unit 4

Process evaluation: process-structure relationships, structure-property relationships. [3 hours]

Post-processing: Defects in FDM, SLS, and SLM, Residual stress and distortion, Heat treatment, shot peening, HIPS, Micro finishing of AM parts, Support material removal, surface texture

improvements, property enhancement using thermal and non-thermal techniques; Critical process parameters: geometry, temperature, composition, phase transformation [4 hours]

Unit 5

CAD in Additive Manufacturing

CAD Modelling for 3D Printing: 3D Scanning and Digitization, data handling & Reduction Methods. [3 hours]

AM Software: data formats and standardization, Slicing algorithms: uniform flat layer slicing, adaptive slicing. [3 hours]

Process-path generation: Process-path algorithms, rasterization, part Orientation, and support generation. [4 hours]

Textbooks:

1. Gibson, I., Rosen, D.W. and Stucker, B., "Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2015.
2. Ben Redwood, Filemon Schoffer, Brian Garret, "3D Printing Handbook, Technologies design and Applications" 3D Hubs B. V., 2018.

Reference Books:

1. Joan Horvath, Rich Cameron, "Mastering 3D Printing in the Classroom, Library and Lab", Apress, 2018.

2. Chua, C.K., Leong K.F. and Lim C.S., “Rapid prototyping: Principles and applications”, 2/e, World Scientific Publishers, 2010.
3. Liou, L.W. and Liou, F.W., “Rapid Prototyping and Engineering applications: A tool box for prototype development”, CRC Press, 2011.
4. Kamrani, A.K. and Nasr, E.A., “Rapid Prototyping: Theory and practice”, Springer, 2006.
5. Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRC press, 2000.