SNJB's

Late Sau. Kantabai Bhavarlalji Jain

College of Engineering

(Autonomous Institute Affiliated to Savitribai Phule Pune University, Pune)

Shri Neminath Jain Brahmacharyashram (SNJB) (Jain Gurukul)

Neminagar, Chandwad - 423101, Dist. Nashik (MS, India).

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Curriculum Structure and Evaluation Scheme for M. Tech. in Mechanical Engineering

To be implemented for 2024-26 Batch

(With Effect from Academic Year 2024-25)

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(Nashik)
Pin-423101

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Vision of the Institute

Transform young aspirant learners towards creativity and professionalism for societal growth through quality technical education.

Mission of the Institute

1. To transfer the suitable technology, particularly for rural development.
2. To enhance diverse career opportunities among students for building a nation.
3. To acquire the environment of learning to bridge the gap between industry and academics.
4. To share values, ideas, beliefs by encouraging faculties and students for welfare of society.

The vision of the Mechanical Engineering Department

To impart quality technical education in the field of Mechanical Engineering for the benefits of society

Mission of the Mechanical Engineering Department

1. To provide quality education among the students through the curriculum and industrial exposure.
2. To develop a learning environment leading to innovations, skill development and professional ethics through curricular and extracurricular activities for societal growth.

Program Outcomes (POs) for an engineering graduate:

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Table No.1 : Abbreviations

Abbreviation	Meaning
ISE	Internal Assessment Examination
SEE	Semester End Examination
VSEC	Vocational and Skill Enhancement Courses

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Abbreviation	Meaning
PCC	Program Core Courses
PEC	Program Elective Courses
ELC	Research Methodology
	Technical Communication
	Dissertation I
	Dissertation II
	Seminar I
	Seminar II
CCC	Co-Curricular Courses
L	Lecture
PR	Practical
TH	Theory
TW	Term Work
OR	Oral
ME	Mechanical Engineering

A. GENERAL COURSE STRUCTURE :

Table No.2 : Definition of Credit

1 Hour Lecture (L) per week	1 Credit
1 Hour Tutorial (T) per week	1 Credit
2 Hours Practical (P) per week	1 Credit

B. Range of Credits: (M.Tech. or Equivalent) in Tech. : Two-year Post Graduate program in Technology has about 80 credits, the total number of credits proposed for the two-year M.Tech. in **Mechanical Engineering** is kept as **80.**

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Table No.3: Range of Credits

Course Category		Proposed Credits
Programme Core Course (PCC)	Program Courses	19
Programme Elective Course (PEC)		11
Vocational and Skill Enhancement Course (VSEC)	Skill Courses	4
Research Methodology(RM)	Experiential Learning Courses	2
TechnicalCommunication		2
Dissertation I		16
Dissertation II		16
Seminar I		4
Seminar II		4
Co-curricularCourses(CCC)	Liberal Learning Courses	2
Total Credits		**80**

C. Semester wise Credit Distribution Structure for Two Year M.Tech in Mechanical Engineering

Table No.4:Semester wise Credit Distribution Structure

Semester		I	II	III	IV	Total Credits
Program Core Course (PCC)	Program Course	13	6	-	-	**19**
Program Elective Course (PEC)		3	8	-	-	**11**
Vocational and Skill Enhancement Course (VSEC)	Skill Courses	2	2	-	-	**4**
Research Methodology	Experiential Learning Courses	2	-	-	-	**2**
Technical Communication		-	2	-	-	**2**
Dissertation I		-	-	16		**16**
Dissertation II		-	-		16	**16**
Seminar I		-	-	4	-	**4**
Seminar II		-	-	-	4	**4**
Co-curricular Courses (CCC)	Liberal Learning Courses	-	2	-	-	**2**
Total		**20**	**20**	**20**	**20**	**80**

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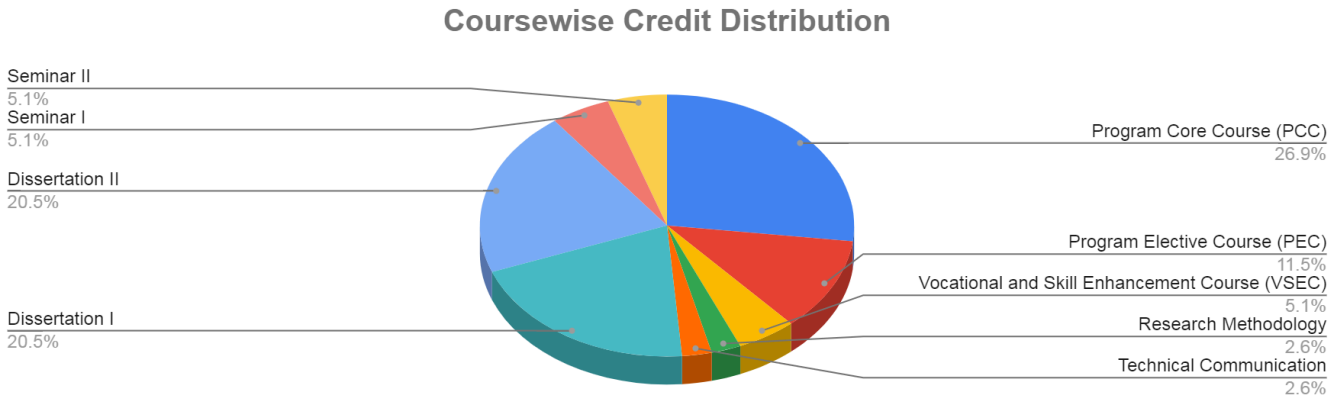

In accordance with the NHEQF, the levels for the PG program are given in the given Table No.5

Table No.5: Level for the PG Program

Level	Qualification Title	Credit Requirements	Semester	Year
6.5	1-Year PG after a 4-year UG	20	I	1
		20	II	1
7	2-Year PG after a 4-year UG such as B.E., B. Tech. etc.	20	III	2
		20	IV	2

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TEACHING AND EVALUATION SCHEME FOR FIRST YEAR M-TECH

Semester – I

Sr. No	Category	Course Code	Course Name	Teaching Scheme					Evaluation Scheme					
				Hours				Credits	Theory Course			Lab Course		Total Marks
				L	T	P	Total Hours		ISE	SEE	TH Marks	TW	PR/ OR	
1	PCC	24-PCC-ME-5-01	Advanced Engineering Thermodynamics	4	-	-	4	**4**	40	60	**100**	**-**	**-**	**100**
2	PCC	24-PCC-ME-5-02	Machining and Forming Processes	3	-	-	3	**3**	40	60	**100**	**-**	**-**	**100**
3	PCC	24-PCC-ME-5-03	Advanced Vibrations and Acoustics	4	-	-	4	**4**	40	60	**100**	**-**	**-**	**100**
4	PCC	24-PCC-ME-5-04	Numerical Methods and Computational Techniques (Laboratory Practice - I)	-	-	4	4	**2**	-	-	**-**	**50**	**50**	**100**
5	PEC	24-PEC-ME-5-01	Programme Elective Course – I	3	-	-	3	**3**	40	60	**100**	**-**	**-**	**100**
6	VSEC	24-VSEC-ME-5-01	Instructional Design and Development	-	-	4	4	**2**	-	-	**-**	**50**	**-**	**50**
7	ELC	24-ELC-ME-5-01	Research Methodology	2	-	-	2	**2**	50	-	**50**	**-**	**-**	**50**
Total				**16**	**-**	**8**	**24**	**20**	**210**	**240**	**450**	**100**	**50**	**600**

Table No.6: Program Elective Course –I

	Course Code-TH	Name of the Course- TH
A	24-PEC-ME-5-01A	Advanced Refrigeration
B	24-PEC-ME-5-01B	CAD- CAE
C	24-PEC-ME-5-01C	Surface Engineering
D	24-PEC-ME-5-01D	Manufacturing Automation

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TEACHING AND EVALUATION SCHEME FOR SECOND-YEAR M-TECH

Semester – II

Sr. No	Category	Course Code	Course Name	Teaching Scheme					Evaluation Scheme					
				Hours				Credits	Theory Course			Lab Course		Total Marks
				L	T	P	Total Hours		ISE	SEE	TH Marks	TW	PR/ OR	
1	PCC	24-PCC-ME-5-05	Mechanical Design Analysis	4	-	-	**4**	**4**	40	60	**100**	-	-	**100**
2	PCC	24-PCC-ME-5-06	Computational Fluid Dynamics (Laboratory Practice - II)	-	-	4	**4**	**2**	-	-	**-**	50	50	**100**
3	PEC	24-PEC-ME-5-02	Program Elective Course – II	4	-	-	**4**	**4**	40	60	**100**	-	-	**100**
4	PEC	24-PEC-ME-5-03	Programme Elective Course – III	4	-	-	**4**	**4**	40	60	**100**	-	-	**100**
5	VSEC	24-VSEC-ME-5-02	Drone Technology and Applications	-	-	4	**4**	**2**	-	-	**-**	50	50	**50**
6	CCC	24-CCC-ME-5-01	Scientific studies of Mind,Matter and Consciousness	2	-	-	**2**	**2**	-	-	**-**	50	-	**50**
7	ELC	24-ELC-ME-5-02	Technical Communication	-	-	4	**4**	**2**	-	-	**-**	50	-	**50**
Total				**14**	**-**	**12**	**26**	**20**	**120**	**180**	**300**	**200**	**100**	**600**

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Table No.7: Program Elective Course –II

	Course Code-TH	Name of the Course- TH
A	24-PEC-ME-5-02A	Advanced Heat Transfer
B	24-PEC-ME-5-02B	Stress Analysis
C	24-PEC-ME-5-02C	Advanced Optimization Techniques
D	24-PEC-ME-5-02D	Mechanical Behavior of Materials

Table No.8: Program Elective Course –III

	Course Code-TH	Name of the Course- TH
A	24-PEC-ME-5-03A	Design of Heat Exchangers
B	24-PEC-ME-5-03B	Tribology in Design
C	24-PEC-ME-5-03C	Soft Computing Techniques
D	24-PEC-ME-5-03D	World Class Manufacturing

Level 6.5 Exit Criteria:

Students who exit at the end of 1st year with the completion of 40 credits shall be awarded a Postgraduate Diploma.

Guidelines for Program Elective Course

Students may choose any course or NPTEL MOOCs course from the department's recommended list. The total credits earned through MOOCs must match the allocated credits for the respective elective. (One credit is awarded for each four-week MOOCs course).

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TEACHING AND EVALUATION SCHEME FOR SECOND-YEAR M-TECH

Semester – III

Sr. No	Category	Course Code	Course Name	Teaching Scheme					Evaluation Scheme					
				Hours				Credits	Theory Course			Lab Course		Total Marks
				L	T	P	Total Hours		ISE	SEE	TH Marks	TW	PR/ OR	
1	ELC	24-ELC-ME-6-03	Dissertation I	-	-	32	32	16	-	-	-	150	150	300
2	ELC	24-ELC-ME-6-04	Seminar I	-	-	8	8	4	-	-	-	50	50	100
Total				**-**	**-**	**40**	**40**	**20**	**-**	**-**	**-**	**200**	**200**	**400**

TEACHING AND EVALUATION SCHEME FOR SECOND-YEAR M-TECH

Semester – IV

Sr. No	Category	Course Code	Course Name	Teaching Scheme					Evaluation Scheme					
				Hours				Credits	Theory Course			Lab Course		Total Marks
				L	T	P	Total Hours		ISE	SEE	TH Marks	TW	PR/ OR	
1	ELC	24-ELC-ME-6-05	Dissertation II	-	-	32	**32**	16	-	-	0	150	150	**300**
2	ELC	24-ELC-ME-6-06	Seminar II	-	-	8	**8**	4	-	-	0	50	50	**100**
Total				**0**	**0**	**40**	**40**	**20**	**0**	**0**	**0**	**200**	**200**	**400**

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SEMESTER I

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24-PCC-ME-5-01 : Advanced Engineering Thermodynamics		
Teaching Scheme: Theory: 4 Hours/Week	**Credit:** 04	**Examination Scheme:** **ISE :** 40 Marks **SEE** : 60 Marks

Prerequisites Courses: Thermodynamics ,Heat Transfer,Refrigeration & Air Conditioning,Energy Engineering

Course Objectives:

- To provide the sufficient knowledge of thermodynamics to apply in real engineering problems
- To familiarize the students about the thermodynamic relations and process and their use to analysis the given thermal application
- To understand the concept of application of thermodynamics such as refrigeration, Gas cycles etc.

Course Outcomes:

After completion of the course, learners should be able to

CO1: **Review** the laws of thermodynamics

CO2: **Explain** the use of Maxwell's relations, Clapeyron equation and apply equations of state for real gasses and compare.

CO3: **Analysis** of second law of thermodynamics for various processes.

CO4: **Analyze** gas turbine cycles.

CO5: **Illustrate** the ideal gas, real gas, its deviation with a compressibility chart.

Course Contents

Unit I	**Review of laws of thermodynamics**	**8 Hours**

First law of thermodynamics for a closed system undergoing a cycle and change of state, Limitation of first law of thermodynamics, Second Law of Thermodynamics cycle heat engine, refrigerator and heat pump, Kelvin- Planck and Clausius statements and their equivalence, Reversibility and Irreversibility, Carnot cycle, Carnot theorem, Absolute thermodynamic temperature scale.

Unit II	**Entropy**	**8 Hours**

Entropy as a property of a system. entropy of pure substance., entropy change in a reversible and irreversible processes, increase of entropy principle, Introduction to Available and

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Unavailable energy: The Entropy Change of Ideal Gases, Reversible Steady-Flow Work, Entropy Change of a System, ΔS system, Mechanisms of Entropy Transfer during Heat and mass transfer, Entropy Generation for closed Systems and Control Volumes

Unit III	**Thermodynamic relations**	**8 Hours**

The Ideal-Gas Equation of State ,Other Equations of State:Van der Waals Equation of State Beattie-Bridgeman Equation of State,Benedict-Webb-Rubin Equation of State, Virial Equation of State,Maxwell's equation, joule- kelvin effect,clausius-clapeyron equation.

Unit IV	**Properties of Steam**	**8 Hours**

Properties of Steam:

Dryness fraction, enthalpy, internal energy and entropy, steam table and Mollier chart, first law applied to steam processes.

Vapour Power Cycles and Gas Power Cycles:

Carnot vapour cycle, Rankine cycle, Ideal reheat, Rankine cycle, Introduction to cogeneration.Air standard assumptions, Otto cycle, Diesel cycle, dual cycle, Stirling cycle, Ericsson cycle, Atkinson cycle, Brayton cycle.

Unit V	**Refrigeration Cycle**	**8 Hours**

The Reversed Carnot Cycle, The Ideal Vapor-Compression Refrigeration Cycle,Actual Vapor-Compression Refrigeration Cycle, Selecting the Right Refrigerant, Innovative Vapor- Compression Refrigeration Systems, Multistage Compression Refrigeration Systems, Multipurpose Refrigeration Systems with a Single Compressor Liquefaction of Gases,Gas Refrigeration Cycles, Absorption Refrigeration Systems

Unit VI	**Fuels and Combustion**	**8 Hours**

Types of fuels, calorific values of fuel and its determination, combustion equation for hydrocarbon fuel, determination of minimum air required for combustion and excess air supplied conversion of volumetric analysis to mass analysis, fuel gas analysis. Stoichiometric A/F ratio, lean and rich mixture, products of combustion, properties of engine fuels

Learning Resources

Reference Books :

R1. G. J. Van Wyle, R. E. Sonntag, " Fundamental of Thermodynamics", John Wiley & Sons, 5th edition,

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1998.
R2. M. J. Moran, H. N. Shaprio, "Fundamentals of Engineering Thermodynamics", John Wiley and Sons,4th edition, 2004.

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24-PCC-ME-5-02: Machining and Forming Processes		
Teaching Scheme: Theory: 3Hours/Week	**Credit:** 03	**Examination Scheme:** **ISE :** 40 Marks **SEE** : 60 Marks
Prerequisites Courses: Manufacturing Processes,workshop Technology I,Machining Science and Technology,Engineering Materials		
Course Objectives: ● To provide the sufficient knowledge of machining and forming processes to apply in real engineering problems ● To familiarize the students about the fundamental principles of machining and forming ● understand the importance of machining and forming process applied to industrial applications		
Course Outcomes: After completion of the course, learners should be able to CO1: **Classify** conventional and non-conventional machining processes. CO2 **Understanding** mechanism of metal cutting, introduction to tool life,cutting fluids.. CO3: **Describe** the mechanism and mechanics of grinding processes,various non-conventional machining processes. CO4: **Understanding** Rolling, extrusion and wire drawing processes. CO5: **Understanding** Forging processes. CO6: **Understanding** Sheet metal working processes.		
Course Contents		
Unit I	**Conventional Machining**	**6 Hours**
Machine Tools and machining operation: Introduction, generating motions of machine tools, machines using single point tools, machines using multipoint tools, machines using abrasive wheels, summary of machine tool characteristics and machining equations		
Unit II	**Metal Cutting**	**6 Hours**
Mechanics of Metal Cutting: Introduction, terms and definitions, chip formation, forces acting on the cutting tool chip thickness, friction in metal cutting.		

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Tool life and tool Wear: Introduction, Cutting Fluid and Surface roughness: application of cutting fluids		
Unit III	**Grinding & Non-conventional Machining Processes**	**6 Hours**
Grinding: Introduction, grinding wheel, effect of grinding conditions on wheel behavior, determination of the density of active grains. **Non-conventional Machining Processes:** Introduction, range of nonconventional machining processes, ultrasonic machining, water-jet machining, abrasive-jet machining, chemical machining, electrochemical machining		
Unit IV	**Rolling & Extrusion**	**8 Hours**
Rolling: Forces and Geometrical Relationships in rolling, Analysis of Rolling load and variables, Problems and Defects in rolled products, Theories of cold and hot rolling, Rolling mill control. **Extrusion:** Analysis of extrusion, Deformation, Lubrication and defects in extrusion, production of seamless pipe and tubing, drawing of rods, wires and tubes: Analysis of wire and tube drawing, residual stresses in rod, wire and tubes. Sheet metal forming: Forming limit criteria and Defects in formed components.		
Unit V	**Forging**	**6 Hours**
Forging in plain stain, calculations of forging loads in Closed die forging, residual stresses in forgings, Forging defects		
Unit VI	**Sheet Metal Processes**	**6 Hours**
Basic applications: shearing processes like blanking, piercing, and punching. Drawing processes like shallow and deep drawing of cylindrical and rectangular bodies forming and bending including estimation and control of spring back.		
Learning Resources		
Reference Books : **R1.** G. Boothroyd and W.A. Knight, *Fundamentals of Machining and Machine Tools*, 2nd Edition, Mercell Dekker, New York, 1989. **R2.** A. Ghosh and A.K. Mullick, *Manufacturing Science*, Affiliated East-West Press, 1985.		

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24-PCC-ME-5-03 : Advanced Vibrations and Acoustics		
Teaching Scheme: Theory: 4 Hours/Week	**Credit:** 04	**Examination Scheme:** **ISE :** 40 Marks **SEE** : 60 Marks
Prerequisites Courses: ,Theory of Machines,Dynamics of Machinery,Solid Mechanics,Design of Machine Elements		

Course Objectives:

- To provide the sufficient knowledge of mechanical vibrations to apply in real engineering problems
- To familiarize the students about the fundamental principles of mechanical vibrations
- To understand the importance of vibrations in the background of wear and tear of the machine components, noise reductions and conditioning monitoring

Course Outcomes:

After completion of the course, learners should be able to

CO1: To develop in our students the ability to engage themselves to solve vibration problems.

CO2: To be creative problem solvers whilst dealing with machinery involving periodic phenomena

CO3: To integrate empirical analysis and add to the world of field expertise where possible

CO4: To adapt to recent advances in knowledge

Course Contents

Unit I	**Multi Degree Freedom System**	**8 Hours**

Multi Degree Freedom System:

Free Vibration equation of motion. Influence Coefficient i) Stiffness Coeff. (ii) Flexibility Coefficient. Generalized coordinates, and Coordinate couplings. Lagrange's Equations Matrix Method Eigen Values Eigen Vector problems. Model Analysis.Forced Vibrations of undamped system and modal analysis.

Multi Degree System Numerical Methods:

(i)Rayleigh's Method, (ii)Rayleigh-Ritz Method (iii) Holzer's Method (iv)Methods of Matrix iterations (v) Transfer Matrix Method, Impulse response and frequency response functions.

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Unit II	**Continuous System:**	**8 Hours**
Vibrations of String, Bars, Shaftsand beams, free and forced vibration of continuous systems.Transient vibrations: Response of a single degree of freedom system to step and any arbitrary excitation, convolution(Duhamel's) integral impulse response functions. **Vibration Measurement:** FFT analyzer, vibration exciters, Signals analysis. Time domain & Frequency domain analysis of signals. Experimental modal analysis, Machine Conditioning and Monitoring, Fault diagnosis. Example of Vibration tests- Industrial case studies		
Unit III	**Vibration Control**	**6 Hours**
Balancing of rotating machine, In-situ balancing of rotors, control of natural frequency introduction of damping, vibration isolation & vibration absorbers.		
Unit IV	**Random Vibration**	**6 Hours**
Expected values auto and cross correlation function, Spectral density, response of linear systems, analysis of narrow band systems.		
Unit V	**Non-Linear Vibrations**	**8 Hours**
Systems with non-linear elastic properties, free vibrations of systems with non-linear elasticity and damping, phase-plane technique, Duffing's equation ,Jump phenomenon ,Limit cycle, Perturbation method.		
Unit VI	**Noise and Its Measurement**	**8 Hours**
Sound waves,governing equations, its propagation**,** Fundamentals of Noise, Decibel, Sound Intensity, Sound fields, reflection absorption and transmission. Noise measurement,Soundmeter,allowed exposure levels and time limit by B.I.S.,Octave Band analysis of sound, Fundamentals of Noise control, source control, path control, enclosures, noise absorbers, noise control at receiver.		
Learning Resources		
Reference Books :		
R1. Theory of Vibrations with Applications: W T Thomson, Pearson Publications.		

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R2. Mechanical Vibrations: S S Rao Pearson Publications.

R3. Principles of Vibration Control:Asok Kumar Mallik, Affiliated East- West Press.

R4. Mechanical Vibrations: A H Church, John Wiley & Sons Inc.

R5. Mechanical Vibration Analysis:Srinivasan, McGraw Hill.

R6. Mechanical Vibrations: G K Groover.

R7. Vibration and Noise for Engineers: KewalPujara ,Dhanpat Rai & co.

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<table>
<tr><th colspan="3">24-PCC-ME-5-04 : Numerical Methods and Computational Techniques</th></tr>
<tr><td>Teaching Scheme:
Practical: 4 Hours/Week</td><td>Credit: 02</td><td>Examination Scheme:
TW : 50 Marks
PR/OR :50 Marks</td></tr>
<tr><td colspan="3">Prerequisites Courses: Numerical Methods and optimisation,Engineering Mathematics,C Language,Matlab</td></tr>
<tr><td colspan="3">Course Objectives: : The course aims to provide the knowledge of computer programming to write the codes for the numerical methods learned in “Numerical Analysis” using C language and/or MATLAB.</td></tr>
<tr><td colspan="3">Course Outcomes: Upon successful completion of the course, students will be able to:
CO1: Write computer programs to solve engineering problems with MATLAB and/or C Language
CO2: Implement numerical methods in MATLAB /C Language.
CO3: Analyze the stability of the algorithm.
CO4: Analyze and evaluate the accuracy of common numerical methods.
CO5: Ability to use approximation algorithms in real world problems.</td></tr>
<tr><th colspan="3">Course Contents</th></tr>
<tr><td></td><td>Module 1</td><td>6 hours</td></tr>
<tr><td colspan="3">Gaussian elimination, Jacobi, Gauss Seidel methods.</td></tr>
<tr><td></td><td>Module 2</td><td>6 hours</td></tr>
<tr><td colspan="3">Bisection method, fixed point iteration scheme, Newton-Raphson method, secant method.</td></tr>
<tr><td></td><td>Module 3</td><td>6 hours</td></tr>
<tr><td colspan="3">Lagrange’s interpolation formula, Newton’s divided difference formula.</td></tr>
<tr><td></td><td>Module 4</td><td>6 hours</td></tr>
<tr><td colspan="3">Trapezoidal rule, Simpson’s 1/3,3/8-rules.</td></tr>
<tr><td></td><td>Module 5</td><td>8 hours</td></tr>
<tr><td colspan="3">Euler’s method modified Euler’s method, Runge-Kutta method, Milne’s method, Adams-predictor-corrector method.</td></tr>
</table>

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Learning Resources
Reference Books : **R1.** W. H. Press, B. P. Flannery, S. A. Teukolsky, W. T. Vetterling, "Numerical Recipes in C", Cambridge University Press, 1st edition,1988. **R2.** M. Pal, Numerical Analysis for Scientists and Engineers: Theory and C Programs, Narosa, 2008.

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24-PEC-ME-5-01A : Advanced Refrigeration

Teaching Scheme: Theory: 3 Hours/Week	**Credit:** 03	**Examination Scheme:** **ISE :** 40 Marks **SEE** : 60 Marks

Prerequisites Courses:
Engineering Thermodynamics,Heat Transfer, Refrigeration and Air conditioning

Course Objectives:

- To vapor compression refrigeration and multi-stage vapor compression systems.
- To Study and identify various types of refrigerants and their properties
- To Illustrate Nomenclature, Refrigerants, alternative refrigerants
- Design and analyze vapor absorption system
- select refrigerant control techniques, and do piping designing for refrigeration plant

Course Outcomes:
After completion of the course, learners should be able to
CO1 : **Formulate and solve** vapor compression refrigeration and multi-stage vapor compression systems.
CO2: **Study and identify** various types of refrigerants and their properties., such as zeotropic, azeotropic etc.,
CO3: **Illustrate** Nomenclature, Refrigerants, alternative refrigerants, CFC/HCFC phase-out regulations, action with lubricating oil, retrofitting, refrigerant blends, and effects on refrigeration components.
CO4: **Design** and analyze vapor absorption system
CO5: **select** refrigerant control techniques, and do piping designing for refrigeration plant

Course Contents

Unit I	**Vapour Compression refrigeration**	**6 Hours**

Vapour compression refrigeration, actual cycle, second law efficiency, multistage compression with intercooling, Multi-evaporator systems, Cascade systems.

Unit II	**Compressor**	**6 Hours**

Performance characteristics and capacity control of reciprocating and centrifugal compressors, screw compressor and scroll compressor.

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Unit III	**Evaporator & Condensers**	**6 Hours**
Design, selection of evaporators, condensers, system balance, control systems, motor selection.		
Unit IV	**Refrigerants**	**6 Hours**
History, Nomenclature, Refrigerants, alternative refrigerants, CFC/HCFC phase-out regulations, action with lubricating oil, retrofitting, refrigerant blends, effects on refrigeration components. Thermoelectric and nonconventional refrigeration systems, adiabatic de- magnetization		
Unit V	**Vapor absorption refrigeration**	**8 Hours**
Vapor absorption refrigeration, Li-Br and aqua ammonia system, calculation of mass flow rate and system performance, energy balance, controls, analysis of rectifier and analyzer, single effect and double effect systems,vapour transformer.		
Unit VI	**Controls and Piping in Refrigeration system**	**8 Hours**
Refrigeration controls, Expansion devices: design and selection, refrigeration system piping design		
Learning Resources		
Reference Books :		

R1. Stoecker W. F. and Jones J. P.,*Principles of Refrigeration and air-conditioning*, McGraw Hill
R2. Arora C. P., *Refrigeration and air-conditioning***,** Tata McGraw Hill.
R3. Gosney W. B., *Principles of refrigeration*, Cambridge University Press.
R4. Stoecker W. F., *H. B. of Industrial refrigeration*, McGraw Hill Companies, Inc.
R5. Dossat R. J., Principles of Refrigeration, Pearson Education
R6. ASHRAE H. B. – Refrigeration
R7. ASHRAE H. B. – Fundamenta

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24-PEC-ME-5-01B: CAD-CAE

Teaching Scheme: Theory: 3 Hours/Week	**Credit:** 03	**Examination Scheme:** **ISE :** 40 Marks **SEE** : 60 Marks

Prerequisites Courses: Solid Modeling and Drafting,Computer Aided Engineering,Heat Transfer,Fluid Mechanics,Dynamics of Machinery,Numerical Methods and Optimisation.

Course Objectives:

- To Demonstrate - Polynomial and spline interpolation, Bezier curves, B-splines to surfaces representation, patches and composite surfaces.
- To Design and create Solid model assembly of thermal and fluid engineering system in CAD software
- To Analyze simple Engineering problems by selecting appropriate Mesh generation.
- To Modeling and Meshing of Thermal and Fluid Flow equipment in CAD..
- To Simulate and demonstrate Thermal and Fluid systems by using ANSYS, EES, MATLAB etc.
- To Understand and simulate computer aided manufacturing

Course Outcomes:

After completion of the course, learners should be able to

CO1: **Demonstrate** - Polynomial and spline interpolation, Bezier curves, B-splines to surfaces representation, patches and composite surfaces.

CO2: **Design and create** Solid model assembly of thermal and fluid engineering systems in CAD software.

CO3: **Analyze** simple Engineering problems by selecting appropriate Mesh generation.

CO4: **Modeling and Meshing** of Thermal and Fluid Flow equipment in CAD.

CO5: **Simulate and demonstrate** Thermal and Fluid systems by using ANSYS, EES, MATLAB etc.

CO6: **Understand and simulate** computer aided manufacturing

Course Contents

Unit I	**Solid Modeling**	**6 Hours**

Overview of CAD Applications, Curves - Polynomial and spline interpolation, Bezier curves, B-splines, Introduction to surfaces representation, patches and composite surfaces.
Solid Modeling: Representation of Solids, Topology, Wireframe, Boundary representation (B-Rep), CSG, Solid modeling operations.

Unit II	**Computer Graphics**	**6 Hours**

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Computer Graphics: Mathematical principles for 2D and 3D visualization, Matrix transformations,Modeling, viewing, projection and rendering, OpenGL graphics library, CAD data formats and exchange.
Meshing – Mesh topology, Data structures, Introduction to Mesh generation algorithms, Surface meshes, Element types and quality criteria.

Unit III	**Modeling and Meshing**	**6 Hours**
Modeling and Meshing of Thermal and Fluid Flow equipment.		
Unit IV	**Lab simulations for Thermal and Heat Transfer**	**6 Hours**
Computer Aided Engineering: Lab simulations for Thermal and Heat Transfer, Computational Fluid Dynamics: Lab simulations for Fluid Flow.		
Unit V	**lab simulation Thermal and Stress Analysis.**	**6 Hours**
Computer Aided Engineering: Multi physics lab simulation for Thermal and Stress Analysis.		
Unit VI	**lab simulation flow induced vibrations.**	**6 Hours**
Computer Aided Engineering: Multiphysics lab simulation for flow induced vibrations.		

Learning Resources

Reference Books :

R1. Ibrahim Zeid and R Sivasubramanian, CAD/CAM: Theory and Practice, McGraw-Hill, Special Indian Edition, 2009
R2. Ibrahim Zeid, Mastering CAD / CAM, McGraw-Hill, 2nd Edition, 2006
R3. Micheal E. Mortenson, Geometric Modeling,Industrial Press, 3rd Edition, 2006
R4. Peter Shirley, Michael Ashikhmin and Steve Marschner, Fundamentals of materia Computer Graphics, A K Peters/CRC Press, 3rd Edition, 2009
R5. David Rogers and J.A. Adams, Mathematical Elements for Computer Graphics, McGraw- Hill, 2nd Edition,2002

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24-PEC-ME-5-01C : Surface Engineering		
Teaching Scheme: Theory: 3 Hours/Week	**Credit:** 03	**Examination Scheme:** **ISE :** 40 Marks **SEE** : 60 Marks
Prerequisites Courses: Material science and technology,composite materials,manufacturing technology		

Course Objectives:

- To provide the sufficient knowledge of thermodynamics to apply in real engineering problems
- To familiarize the students about the thermodynamic relations and process and their use to analysis the given thermal application
- To understand the concept of application of thermodynamics such as refrigeration, Gas cycles etc.

Course Outcomes:

After completion of the course, learners should be able to

CO1: **Learn** the importance and need of surface engineering.
CO2: **Describe** various surface cleaning and modification techniques.
CO3: **Understand** the concepts of surface integrity.
CO4: **Compare** various surface coating technologies
CO5: **Select** appropriate method of coating for a given application.
CO6: **Apply** measurement techniques and carry out characterization of coated surfaces.

Course Contents

Unit I	**Introduction**	**6 Hours**

Definition, Significance, Role of surface Engineering in creating high performance product, Functional characteristics of a surface, Nature of surfaces: Deformed layer, Beilby layer, chemically reacted layer, Physisorbed layer, Chemisorbed layer; Classification of Surface Engineering Techniques

Unit II	**Surface Preparation Techniques**	**6 Hours**

Factors affecting selection of cleaning process, Significance of surface preparation, Classification of cleaning processes, Chemical cleaning processes; Mechanical Processes; Substrate considerations, Surface

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contaminants or soils: Various types and their removal, Tests for cleanliness.		
Unit III	**Surface Integrity**	**6 Hours**
Definition, Importance, Surface alterations, Factors in Surface Integrity: Visual, Dimensional Residual stress, Tribological, Metallurgical; Measuring Surface Integrity effects: Minimum and Standard data set, Macroscopic and microscopic examination.		
Unit IV	**Surface Modification Techniques**	**6 Hours**
Classification, Thermal treatments: Laser and electron beam hardening, Mechanical treatments: Short peening: Peening action, surface coverage and peening intensity, Types and sizes of media, Control of process variables, equipment; Ion Implantation: Basic Principle, Advantages and disadvantages, equipment.		
Unit V	**Surface Coating Techniques**	**6 Hours**
Thermal Spraying: Types and applications; Chemical Vapour Deposition: Principles, Reactions, Types and applications; Physical Vapour Deposition: Basic principle, Evaporation, Sputtering, Ion Plating, Applications; Electroplating: Principle of working and applications; Types of Coatings: Hard, Soft, Single layer, Multi-layer		
Unit VI	**Characterization of Coatings**	**6 Hours**
Physical characteristics and their measurements: Coating thickness, Surface Morphology and Microstructure. Mechanical properties and their Measurements: Hardness, Adhesion, Friction and Wear.		
Learning Resources		
Reference Books :		
R1. Budinski K. G.; Surface Engineering for Wear Resistance; Prentice Hall **R2.** Burakowski T. and T. Wierschon; Surface Engineering of Metals: Principles, Equipment, Technologies; CRC Press		

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24-PEC-ME-5-01D : Manufacturing Automation		
Teaching Scheme: Theory: 3 Hours/Week	**Credit:** 03	**Examination Scheme:** **ISE :** 40 Marks **SEE** : 60 Marks
Prerequisites Courses: Hydraulics and Pneumatic,Fluid Mechanics,Mechatronics,Electronics and electrical Engineering,Robotics and Automation,Production technology,Manufacturing Process		

Course Objectives:

- To know about the Automation and types of Automations in the industries.
- To understand the different Automated flow lines in the Industries.
- To perform one or more processing and/or assembly operations on a starting raw material, part, or set of parts.
- To perform a sequence of automated or mechanized assembly operations Flexible manufacturing system (FMS)—a highly automated machine cell that produces part
- To know product families often consists of workstations comprising CNC machine tools.

Course Outcomes:

After completion of the course, learners should be able to

CO1: Students will **Understand** the process of automation and types

CO2: Students will get **Exposure** to a workstation, which refers to the location in the factory where some well-defined task or operation is accomplished by an automated machine.

CO3: Understand Worker-and-machine combination or a worker using hand tools

CO4: Understand the Automated Material handling equipments and types

CO5: Student gets **Exposure** on portable power tools.

Course Contents		
Unit I	**Automation in Manufacturing**	**6 Hours**
Types and strategies of automation, pneumatic and hydraulic components circuits, Automation in machine tools, Mechanical Feeding and to changing and machine tool control transfer the automation.		
Unit II	**Automated flow lines**	**8 Hours**
Methods or work part transport transfer Mechanical buffer storage control function, design and		

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fabrication consideration. Analysis of Automated flow lines: General terminology and analysis of transfer lines without and with buffer storage, partial automation, implementation of automated flow lines .		
Unit III	**Assembly system and line balancing**	**6 Hours**
Assembly process and systems assembly line, line balancing methods, ways of improving line balance, flexible assembly lines.		
Unit IV	**Automated material handling**	**6 Hours**
Types of equipment, functions, analysis and design of material handling systems conveyor systems, automated guided vehicle systems.		
Unit V	**Automated storage systems**	**6 Hours**
Automated storage and retrieval systems; work in process storage, interfacing handling and storage with manufacturing**.**		
Unit VI	**Fundamentals of Industrial controls**	**6 Hours**
Review of control theory, logic controls, sensors and actuators, Data communication and LAN in manufacturing. Business process Re-engineering: Introduction to BPE logistics, ERP, Software configuration of BPE.		
Learning Resources		
Reference and Text Books :		

Reference Books :

R1. Nick Dawkins - Automation and Controls

R2. Tien-Chien Chang, Richard A. Wysk and Hsu-Pin Wang - Computer Aided Manufacturing, Pearson 2009

R3. Peter G. Martin and Gregory Hale - Automation Made Easy

Text Books:

T1. M.P.Groover 3e - Automation, Production Systems and Computer Integrated Manufacturing, PHI,2009.

T2. Frank Lamb - Industrial Automation , Mc Graw Hill,2013

T3. W. Buekinsham – Automation.

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<table>
<tr><th colspan="4">24-VSEC-CS-5-01 : Instructional Design and Development</th></tr>
<tr><td colspan="2">Teaching Scheme:
Practical: 4 Hours/Week</td><td>Credit: 02</td><td>Examination Scheme:
TW : 50 Marks</td></tr>
<tr><td colspan="4">Course Objectives:
● Learn about instructional design models and educational pedagogies.
● Use digital tools to apply reflective and experiential learning techniques.
● Utilize digital platforms to foster collaborative and interactive learning environments.
● Engage students in inquiry-based and integrative learning using digital tools.</td></tr>
<tr><td colspan="4">Course Outcomes:
After completion of the course, learners should be able to
CO1: Learn about the instructional design model and various pedagogical approaches used in education.
CO2: Apply reflective and experiential learning techniques using digital tools to enhance learning outcomes.
CO3: Utilize various digital platforms to foster collaborative and interactive learning environments.
CO4: Utilize various digital platforms to engage students through inquiry-based learning and integrative instructional models.
CO5: Demonstrate proficiency in integrating technology-enhanced instructional strategies.</td></tr>
<tr><td colspan="4">Course Contents</td></tr>
<tr><td>Unit I</td><td>Introduction to Instructional Design</td><td>4 Hours</td><td>Book No.: T1, T2</td></tr>
<tr><td colspan="4">Discipline of Instructional Design, ADDIE model of Instructional Design, Overview of Pedagogical Approaches, Students Learning Through Five Pedagogical Approaches In Education (R-2I-2C)</td></tr>
<tr><td colspan="4">Assignment:
1. Design a comprehensive lesson plan for the given scenario: A computer science instructor aims to improve student engagement and understanding of "Dynamic Programming" using the ADDIE model and integrating five pedagogical approaches.</td></tr>
<tr><td colspan="2">*Mapping of Course Outcomes</td><td colspan="2">CO1, CO5</td></tr>
<tr><td>Unit II</td><td>Reflection Approach</td><td>4 Hours</td><td>Book No.:T2</td></tr>
<tr><td colspan="4">Introduction To Experiential Learning Cycle, Kolb's Experiential Learning Cycle, Benefits And Challenges Of Using The Reflective Pedagogical Approach Study of Reflective Tools and Techniques like Google</td></tr>
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<table>
<tr><td colspan="4">Forms/Docs, Mentimeter: KWL (Know, Want to know and Learned) Method, Flashcard etc.</td></tr>
<tr><td colspan="4">Assignment Create a digital KWL chart using Google Docs to explore Renewable Energy Sources.
1. Develop interactive flashcards to explore various aspects of global climate change, encouraging self-assessment and deeper reflection on its causes, impacts, and mitigation strategies.</td></tr>
<tr><td colspan="2">*Mapping of Course Outcomes</td><td colspan="2">CO1, CO2, CO5</td></tr>
<tr><td>Unit III</td><td>Constructivist and Collaborative Approaches</td><td>4 Hours</td><td>Book No.: T2</td></tr>
<tr><td colspan="4">Significance of Collaborative and Constructive approaches, Collaborative learning model: Personal Learning Networks, Peer Learning Networks, Types of constructivism, The Role of teachers in a constructivist classroom, Study of Collaborative and Constructivist and Tools like Copilot, WhiteBoard, Padlet, CodePen, Edpuzzle etc.</td></tr>
<tr><td colspan="4">Assignments:
1. Explore sustainable rural development through collaborative reflections and idea sharing on the interactive board.
2. Develop a collaborative coding project using an online collaborative platform to explore AI-assisted programming techniques.
3. Create a collaborative brainstorming session using any White board tools to design a sustainable city plan, integrating urban development and environmental conservation strategies</td></tr>
<tr><td colspan="2">*Mapping of Course Outcomes</td><td colspan="2">CO1, CO3, CO5</td></tr>
<tr><td>Unit IV</td><td>Inquiry-Based and Integrative Approaches</td><td>4 Hours</td><td>Book No.: T2</td></tr>
<tr><td colspan="4">Definition and Theoretical Foundations of Inquiry-Based Learning, Phases of Inquiry-based learning, 7 E -Instructional model, Significance of Integrative Approach, The role of teacher in integrative approach, Challenges to Integrative Pedagogical Approach, Study of Tools for Inquiry-Based and Integrative Approaches like Kahoot, Edmodo, Slido, Socrative; Activity-Based Learning, Game Pedagogy, MindMeister etc.</td></tr>
<tr><td colspan="4">Assignments:
1. Conduct a collaborative ideation session using an online interactive tool to generate innovative ideas for digital solutions addressing current societal challenges.
2. Develop an online quiz(any inquiry based tool) to test knowledge of significant historical events, enhancing engagement and retention through gamified learning.
3. Create and conduct an interactive poll to gather opinions on current global affairs, analyzing</td></tr>
</table>

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diverse perspectives and trends in real time. **4. Develop an online quiz(any integrative tool) to evaluate comprehension of the Industrial Revolution, emphasizing technological innovations, economic changes, and social impacts.**	
***Mapping of Course Outcomes**	**CO1, CO4, CO5**
Learning Resources	
Text Books	
T1. Abbie H. Brown, Timothy D. Green, "The Essentials of Instructional Design: Connecting Fundamental Principles with Process and Practice" 5th Edition, 978-1032518497 **T2. A compilation of online presentations delivered during the webinar on "The Making of Teacher-Experts in the New Normal: Deepening the Understanding of Pedagogical Approaches" last 22 June 2022, "Pedagogical Approaches In Education, Theories, Practices, and Applications in the Classrooms" - link**	
Additional Resources: (Books, e-Resources) https://www.aihr.com/blog/addie-model/ https://www.skillshub.com/what-are-kolbs-learning-styles/ https://pdfs.semanticscholar.org/c3e2/36c0a1e16d9769b611be32f12bec92f48845.pdf	

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24-ELC-ME-5-01: Research Methodology		
Teaching Scheme: Theory: 2 Hours/Week	**Credit:** 02	**Examination Scheme:** **ISE :** 50 Marks
Prerequisites Courses: Technical Communication,Report Writing,Technical Project		
Course Objectives: ● To Understand the concept of research, paper writing, similarities, etc ● To familiarize the students about the statistical methods, data interpretation , error analysis ● To carry out analysis on the a published paper		
Course Outcomes: After completion of the course, learners should be able to CO1: Understand and Describe importance of research CO2: Classify and select appropriate resources for Research.. CO3: Analyze the contents of literature and identify further scope. CO4: Formulate a Research Problem. CO5: Develop effective written and oral Presentation skills.		
Course Contents		
Unit I	**Basic Concept in Research Methodology**	**6 Hours**
Research Concepts – concepts – meaning – objectives – motivation. Types of research – descriptive research – conceptual research – theoretical research – applied research – experimental research.		
Unit II	**Research process**	**6 Hours**
Research process – Criteria for good research – Problems in Indian context. Formulation of Research Task – Literature Review – Importance & Methods – Sources – Quantification of Cause Effect Relations – Discussions– Field Study – Critical Analysis of Facts Generated		
Unit III	**Research Proposals**	**6 Hours**
Hypothetical proposals for future development and testing, selection of Research tasks. Applications of statistical methods in research		

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Unit IV	**Mathematical Modeling and Simulation**	**6 Hours**
Mathematical modeling and simulation – Concepts of modeling – Classification of mathematical models – Modeling with – Ordinary differential equations – Difference equations – Partial differential equations – Graphs – Simulation – Process of formulation of model based on simulation		
Unit V	**Technical Writing and reporting of research**	**6 Hours**
Interpretation and report writing – Techniques of interpretation – Precautions in interpretation- Significance of report writing – Different steps in report writing – Layout of research report – Mechanics of writing research report – Layout and format – Style of writing – Typing – References – Tables – Figures – Conclusion – Appendices.		
Learning Resources		
Reference Books :		
R1. "Research Methods", Trochim, William M.K., 2/e, Biztantra, Dreamtech Press, New Delhi, ISBN: 81-7722-372-0, 2003 R2. "Applied Statistics & Probability for Engineers", Montgomery, Douglas C. &Runger, George C., 3/e, Wiley India, 2007 R3. Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition **MOOC Courses links :** ● https://www.coursera.org/learn/research-methods ● https://onlinecourses.swayam2.ac.in/cec20_hs17/preview		

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SEMESTER II

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24-PCC-ME-5-05 : Mechanical Design Analysis		
Teaching Scheme: Theory: 4 Hours/Week	**Credit:** 04	**Examination Scheme:** **ISE :** 40 Marks **SEE** : 60 Marks
Prerequisites Courses: Solid Mechanics,Theory of Machines,Design of Machine Elements		

Course Objectives:

- To provide the technical understanding the concepts of Mechanical design in the background of real engineering problems
- To familiarize the students about the importance of Mechanical design apply to industrial applications
- To understand the Analysis of design

Course Outcomes:

After completion of the course, learners should be able to

CO1: To **Analyze** variance, factorial design and regression and understand reliability theory, design and analysis of reliability.

CO2: **Ability to Analyze** behavior of mechanical elements under fatigue and creep

CO3: To **Study** optimization and its methods.

CO4: To **Study** composite materials and its characteristics.

CO5: To **Design** mechanical components for various materials and process

Course Contents		
Unit I	**Fundamentals of Failure**	**8 Hours**
Failure Analysis, Limit design, Fundamentals of fracture mechanics. Fatigue designing for finite life, contact stresses and surface failures, oil films and their effects		
Unit II	**Impact Dynamics**	**8 Hours**
Impact: Energy methods, longitudinal stress waves in elastic media impact on beams, torsional impact on shafts and longitudinal impacts on helical springs.		

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Unit III	**Thermal Properties and Stresses**	**8 Hours**
Effect of short term and long term properties of materials on design, creep and stress relaxation. Elementary analysis of thermal stresses, thermal fatigue		
Unit IV	**Design with Composite Materials**	**8 Hours**
Polymers and F.R.P. as materials form Mechanical components. Reliability based design: Definition normal exponential and Weibull distributions system reliability. Reliability based on strength.		
Unit V	**Optimum Design**	**8 Hours**
Basis concepts, introduction to various techniques of optimization, optimum design of simple mechanical components.		
Unit VI	**Design of Power Transmission Systems**	**8 Hours**
Analysis and design of power transmission systems and elements such as: Spur, helical, bevel and worm gear drives, speed reducers and gear boxes, epicyclic gear drives, selection of ball and roller bearings.		
Learning Resources		
Reference Books :		

R1. Arthur H.Burr & John.Cheatham,"Mechanical Analysis and Design",Prentice-Hallof India (1997).
R2. Kenneth Edwards &Robert B. Makee,"Fundamentals of Mechanical Component Design", McGraw Hill International ed. 1991.
R3. Joseph Edward Shigley & Charles R. Mischke, "Mechanical Engineering Design", Mc. Graw Hill (1989).
R4. M. F. Spotts"MechanicalDesignAnalysis",PrenticeHall.

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24-PCC-ME-5-06 : Computational Fluid Dynamics (Laboratory Practice - II)		
Teaching Scheme: Practical: 4 Hours/Week	**Credit:** 02	**Examination Scheme:** **TW :** 50 Marks **PR/OR** : 50 Marks

Prerequisites Courses: Fluid Mechanics,Heat Transfer,Computer aided Engineering,Ansys

Course Objectives:

- To develop skills in computational fluid dynamics to address engineering problems.
- To understand the basic structure and capabilities of current commercial CFD codes.
- To apply CFD codes in the design of fluid systems and components

Course Outcomes:

After completion of the course, learners should be able to

CO1: **Demonstrate** modeling of double pipe heat exchanger, simple exhaust system and airfoil using ANSYS Design Modeler (L3)

CO2: **Solve** steady, unsteady state heat conduction in slabs and steady state heat conduction through fins (L3)

CO3: **Solve** problems of laminar forced convection over flat plate, cylinder and through a pipe (L3)

CO4: **Solve** problems of turbulent forced convection over flat plate, cylinder, airfoil and through a pipe/helical pipe (L3)

CO5: **Analyze** heat transfer to a fluid by natural convection from a flat plate, radiation heat transfer between two parallel plates

Course Contents

Note: Any Ten of the following exercises are to be performed

1. Demonstration of double pipe heat exchanger modeling using ANSYS Design Modeler
2. Demonstration of simple exhaust system modeling using ANSYS Design Modeler
3. Demonstration of airfoil modeling using ANSYS Design Modeler
4. Steady state heat transfer through a rectangular slab
5. Steady state heat transfer through a composite rectangular slab
6. Unsteady state heat conduction in a rectangular slab
7. Heat transfer from a rectangular fin
8. Heat transfer from a triangular fin

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9. Laminar forced convection in a pipe 10. Turbulent forced convection in a pipe 11. Forced convection heat transfer across a horizontal cylinder 12. Natural convection heat transfer from a vertical plate 13. Flow over an airfoil
Learning Resources
CFD Software: ANSYS References (weblinks) https://www.youtube.com/watch?v=p-Ch3gGgeuE (Experiment 14) https://www.youtube.com/watch?v=grZ9FesmW6I (Experiment 16)

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24-PEC-ME-5-02A: Advanced Heat Transfer		
Teaching Scheme: Theory: 4 Hours/Week	**Credit:** 04	**Examination Scheme:** **ISE :** 40 Marks **SEE** : 60 Marks
Prerequisites Courses: Engineering Thermodynamics ,Heat Transfer,Fluid Mechanics		

Course Objectives:

- To provide the technical understanding the concepts of heat transfer and fluid mechanics
- To familiarize the students about the importance of heat transfer and fluid mechanics processes apply to industrial applications
- To understand the heat transfer and fluid mechanics applications apply to other domain of thermal engineering in general

Course Outcomes:

After completion of the course, learners should be able to

CO1: **Analyze** steady state and transient heat conduction problems of real life Thermal systems

CO2 **Analyze** extended surface heat transfer problems and problems of phase change heat transfer like boiling and condensation

CO3: **Apply** the basic principles of classical heat transfer in real engineering application

CO4: **Analyze** the analytical and numerical solutions for heat transfer problems.

CO5: **Understand** the basic concepts of turbulence and their impact on heat transfer

CO6 : **Analyze** convective heat transfer in common geometries like tube, plate, cylinder

Course Contents		
Unit I	**Steady State and Transient Heat Conduction**	**8 Hours**
Concept of continuum and definition of a fluid. Body and surface forces, stress tensor, Scalar and vector fields, Eulerian and Lagrangian approach.		
Unit II	**Boiling and Condensation**	**8 Hours**
Motion of fluid element - translation, rotation and vorticity; strain rate tensor, continuity equation, stream function and velocity potential. Transport theorems, constitutive equations.		

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Unit III	**Boundary Layer Theory**	**8 Hours**
Derivation of Navier Stokes equations for compressible flow. flow over a flat plate, cylinders and spherical bodies, theory of hydrodynamic lubrication. **Boundary layer:** derivation, exact solutions, Non dimensionalisation of Boundary layer equation, Blasius (similarity solution).		
Unit IV	**Modes & Method of Heat Transfer**	**8 Hours**
Brief introduction to different modes of heat transfer: conduction: general heat conduction equation-initial and boundary conditions. **Finite difference methods for conduction**: 1d & 2d steady state and simple transient heat conduction problems-implicit and explicit methods.		
Unit V	**Transient heat conduction**	**8 Hours**
Transient heat conduction: lumped system analysis, Heisler charts, semi-infinite solid, use of shape factors in conduction, 2d transient heat conduction, product solutions.		
Unit VI	**Convection and Boiling**:	**8 Hours**
Convection and Boiling: Flow over a flat plate: Application of empirical relations to variation geometries for laminar and turbulent flows. hydrodynamic *&* thermal entry lengths;use of empirical correlations. Approximate analysis on laminar free convective heat transfer, combined free and forced convection. Boiling curve, correlations, assumptions & correlations of film condensation for different geometries		
Learning Resources		
Reference and Text Books :		
R1. F.M.White ,K.Muralidhar and Bishwas, Advance Engineering fluid mechanics, Alpha science International limited **R2.** Fox and McDonald, *Introduction to Fluid Mechanics*, J.H. Wiley and Sons. **R3.** YunusA.Cengal, *Heat and Mass Transfer* – A practical Approach, 3rd edition, Tata McGraw - Hill, 2007. **T1.** S. P.Sukhatme, *A Textbook on Heat Transfer*		

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24-PEC-ME-5-02B: Stress Analysis		
Teaching Scheme: Theory: 4 Hours/Week	**Credit:** 04	**Examination Scheme:** **ISE :** 40 Marks **SEE** : 60 Marks
Prerequisites Courses: Strength of Materials,Design of Machine Elements		

Course Objectives:

1. To understand and analysis stress and strain at a point in deformable solids.
2. To understand different approaches to obtain stresses, strains and deformations induced in the solids.
3. To solve thin section members for bending and torsion.
4. To evaluate stresses, deflection due to line or point contact in solids.

Course Outcomes:

After completion of the course, learners should be able to

CO1: **Formulate and Analyze** Stress Field equations such as equilibrium equations, compatibility and constitutive relationship
CO2: **Formulate and Analyze** Stresses in pressurized cylinder and rotating disc.
CO3: **Apply** Energy methods to evaluate stresses and strains.
CO4: **Analyze** and Determine the Torsion and Bending of thin wall section
CO5: **Analyze** and estimate contact stresses in conforming and non-conforming shapes.
CO6: **Understand** experimental methods for stress evaluation estimate the same using resistance strain gauging technique and Photoelasticity technique.

Course Contents

Unit I	**Theory of Elasticity**	**6 Hours**

Analysis of Stresses and Analysis of Strain. Stress Tensor, Compatibility equations in two and three dimensions, Airy's stress functions in rectangular and Polar coordinate systems.

Unit II	**Pressurized Cylinders and Rotating Disks,**	**6 Hours**

Governing equations, stress in thick walled cylinders under internal and external pressure, shrink fit compound cylinders, stresses in rotating flat solid disk, flat disk with central hole, disk of uniform strength.

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Unit III	**Energy Methods**	**6 Hours**
Energy method for analysis of stress, strain and deflection Theorem's - theorem of virtual work, theorem of least work, Castiglioni's theorem.		
Unit IV	**Thin wall Members:**	**6 Hours**
Torsion of thin walled members of the open cross section. Torsion of Multiply Connected Thin-Walled Sections Concept of shear center in symmetrical and unsymmetrical bending, Shear center for thin wall beam cross section, open section with one axis of symmetry.		
Unit V	**Contact stresses**	**6 Hours**
Geometry of contact surfaces, method of computing contact stresses and deflection of bodies in point contact, Stress for two bodies inline contact with load normal to contact area and load normal and tangent to contact area, For cases like - gear contacts, contacts between cam and follower, ball bearing contacts.		
Unit VI	**Experimental stress analysis**	**6 Hours**
Dimensional analysis, analysis techniques, strain gauges, types of strain gauges, materials, configuration, instrumentation, characteristics of strain gauge measurement, theory of photo-elasticity, elements of polariscope, simple and circular polariscope, fringes in dark and white field, isoclinic and isochromatic fringe patterns, evaluation of stresses from these fringe patterns.		
Learning Resources		
Reference Books : **R1.** Advanced Mechanics of Solids, L S Srinath, Tata McGrawHill **R2.** Advanced Strength of Materials,Vol.1, 2–Timoshenko, CBS **R3.**Advanced Strength of Materials–Den Hartog **R4.**Experimental Stress Analysis–Dally & Riley		
Text Books: **T1.** Theory of Elasticity–Timoshenko and Goodier, McGrawHill **T2.** Advanced Strength and Applied Stress Analysis–Richard G. Budynas, McGrawHill **T3.** Advanced Mechanics of Materials–Boresi, Schmidt, Sidebottom,Willey		

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24-PEC-ME-5-02C: Advanced Optimization Techniques		
Teaching Scheme: Theory: 4 Hours/Week	**Credit:** 04	**Examination Scheme:** **ISE :** 40 Marks **SEE** : 60 Marks

Prerequisites Courses: Calculus, linear algebra, Engineering Mathematics,Numerical Methods and optimization

Course Objectives:

- Develop proficiency in mathematical methods and techniques
- apply optimization techniques to solve both linear and non-linear programming problems
- Understand and apply dynamic programming methods to solve complex industrial management problems
- Develop the capability to simulate and analyze thermal engineering systems
- comprehensive understanding of integer and stochastic programming

Course Outcomes:

After completion of the course, learners should be able to

CO1: Enables to acquire mathematical methods and apply in engineering disciplines.

CO2: Apply methods of optimization to solve a linear,non-linear programming problem by various Methods

CO3: Optimize engineering problem of nonlinear-programming with/without constraints, by using this technique.

CO4: Use of dynamic programming problems in controlling industrial management.

CO5: Simulate Thermal engineering system problem.

CO6: Understand integer programming and stochastic programming to evaluate advanced optimization techniques.

Course Contents

Unit I	**Single Variable Nonlinear Unconstrained Optimization**	**6 Hours**

One dimensional Optimization methods, Unimodal function, elimination method, Fibonacci method, golden section method, interpolation methods- quadratic & cubic interpolation methods.

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Unit II	**Multi Variable Nonlinear Unconstrained Optimization**	**6 Hours**
Direct search method – Univariant Method – pattern search methods – Powell's – Hook – Jeeves, Rosenbrock search methods – gradient methods, gradient of function, steepest decent method, Fletcher reeves method. Variable metric method.		
Unit III	**Geometric & Dynamic Programming**	**6 Hours**
Geometric Programming: Polynomials – arithmetic – geometric inequality – unconstrained G.P– constrained G.P **Dynamic Programming:** Multistage decision process, principles of optimality, examples, conversion of final problem to an initial value problem, application of dynamic programming, production inventory. Allocation, scheduling replacement.		
Unit IV	**Linear Programming & Simulation**	**6 Hours**
Linear Programming: Formulation – Sensitivity analysis. Change in the constraints, cost coefficients, coefficients of the constraints, addition and deletion of variable constraints. **Simulation**: Introduction – Types – Steps – application – inventory – queuing – thermal system.		
Unit V	**Integer & Stochastic Programming**	**6 Hours**
Integer Programming: Introduction – formulation – Gomory cutting plane algorithm – Zero or one algorithm, branch and bound method. **Stochastic Programming:** Basic concepts of probability theory, random variables – distributions – mean, variance, Correlation, co variance, joint probability distribution, stochastic linear, dynamic programming.		
Learning Resources		
Reference Books :		
R1. Optimization theory & Applications/ S.S Rao/ New Age International **R2.** Optimization Techniques theory and practice / M.C Joshi, K.M Moudgalya/ Narosa Publications. **R3.** Operation Research/H.A. Taha/TMH **R4.** Optimization in operations research/R. LRardin		

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24-PEC-ME-5-02D: Mechanical Behavior of Materials		
Teaching Scheme: Theory: 4 Hours/Week	**Credit:** 04	**Examination Scheme:** **ISE :** 40 Marks **SEE** : 60 Marks

Prerequisites Courses:
Material Science and Engineering,Mechanics of Materials,Engineering Mechanics,Manufacturing Processes,Engineering Mathematics.

Course Objectives:

- **Understand Modern Materials**: Gain knowledge of advanced materials like dual-phase alloys, HSLA, composites, and nano-materials.
- **Analyze Stress-Strain Behavior**: Learn to interpret stress-strain responses under various loading conditions using yield criteria and transformations.
- **Master Material Testing**: Develop skills in performing and analyzing uni-axial, biaxial tension, and bending tests, considering effects like temperature and the Bauschinger effect.
- **Explore Work Hardening**: Understand strain hardening and apply models for predicting material behavior under complex loading.
- **Study Elastic-Plastic and Visco-Plastic Behavior**: Learn about elastic-plastic deformation, residual stresses, and visco-elasticity through theoretical models.
- **Apply Theoretical Models**: Utilize models to predict material behavior under varying conditions, enhancing material selection and design decisions.

Course Outcomes:

After completion of the course, learners should be able to

CO1: **Apply** the mechanics of modern materials in recent engineering applications.
CO2: Solve the basics problems of finding stresses and strains at a point under complex loading conditions
CO3: **Study** material behavior under forms of loading other than uniaxial tension
CO4: **Identify and investigate** engineering problems involving plastic deformation during strain hardening.
CO5: **Realize** the plastic and elastic- plastic behavior of materials under different loading conditions
CO6: **Formulate** the mathematical modelling of Visco-Elastic materials and apply to engineering materials for behavioural study

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Course Contents		
Unit I	**Modern Materials in Design Engineering**	**6 Hours**
Dual phase alloy, HSLA, lightweight non-ferrous alloy and their full range stress strain behavior subjected quasi-static and high strain rate loading, Composites and its orthotropic properties, Plastics, Smart materials, Nano-materials – types, applications and its properties		
Unit II	**Response of metals and alloys under applied loading**	**6 Hours**
Stress, strain transformations, Mohr's circle, Isotropic elasticity, Anisotropic elasticity, Anisotropic thermal expansion, Octahedral shear stress, Yield criteria, Yield surface, Yield curve.		
Unit III	**Tensile testing**	**6 Hours**
Uni-axial and biaxial tension test, Full range stress-strain curves, True stress-strain curve, Bridgman correction, Temperature rise, Bauschinger effect, Combined bending and torsion test, Three points bend test, Elastic recovery		
Unit IV	**Stress- Strain relations for work hardening materials**	**6 Hours**
Experimental studies of plastic deformations under simple and complex loading, Strain hardening, Power law approximations, Isotropic, Kinematic and combined hardening models, Theory of plastic flow, Strain-rate and temperature dependence of flow stress		
Unit V	**Plastic and Elastic-Plastic Behaviour**	**6 Hours**
Deformation theory of plasticity, Thermo-plasticity, Behaviour of metals with initial deformations. Equations of Elastic-Plastic Equilibrium, Residual stresses and strains, Plastic-rigid body, Elastic-Plastic bending and torsion, Elastic-Plastic bodies under variable loading		
Unit VI	**Elasto-Visco-Plasticity**	**6 Hours**
Visco-elasticity, Rheological models, Maxwell model, Voigt model, Voigt–Maxwell model, Natural decay, Dependence of damping and elastic modulus on frequency, Thermo-Elastic effect, Low temperature and high temperature Visco-plastic deformation models, Rubber elasticity, Damping, yielding, effect of strain rate, Crazing.		

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Learning Resources
Reference Books :
R1. Fundamentals of Materials Science and Engineering, William D. Callister, Jr., John Wiley & Sons, **R2.** Mechanical Metallurgy, George E. Dieter, McGraw Hill Book Company, 1988 **R3.** Theory of Plasticity, J. Chakrabarty, Elsevier, 2006 **R4.** Foundations of Theory of Plasticity, L. M. Kachanov, Dover Publications, 2004 **R5.** Plasticity for Structural Engineers, W.F. Chen, Da-Jian Han, Springer **R6.** Mechanical Behaviour of Materials, W.F.Hosford, Cambridge University Press, 2005

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24-PEC-ME-5-03A: Design of Heat Exchangers		
Teaching Scheme: Theory: 4 Hours/Week	**Credit:** 04	**Examination Scheme:** **ISE :** 40 Marks **SEE** : 60 Marks
Prerequisites Courses: Engineering Thermodynamics,Heat Transfer,Solid Mechanics,Design of machine Element		
Course Objectives: ● Student should able to understand types of heat exchangers,working of heat exchangers ● Analysis and performance calculation of heat exchangers ● design of heat of exchangers for industrial applications		
Course Outcomes: After completion of the course, learners should be able to CO1: **Demonstrate** and of heat exchanger design methodology, and design considerations CO2: **Analyze** performance of Heat exchanger by applying basic design theory. CO3: **Design** and conduct experiment on one from double pipe, shell and tube, tube fin, plate type and plate-fin heat exchanger. CO4: **Demonstrate** selection criteria of HEX and conduct an independent research to suggest suitable HEX. CO5: **Model and illustrate** heat exchanger based on I-law and irreversibility. CO6: **Study and analyze** losses in HEX, and upcoming advancements.		
Course Contents		
Unit I	**Basic Introduction**	**6 Hours**
Classification, overview of heat exchanger design methodology, Design specifications, thermo hydraulic design, and other considerations.		
Unit II	**Basic Design Theory**	**6 Hours**
LMTD method, ε-NTU method, P-NTU method, ψ-P method and P1- P2 method.		
Unit III	**Heat Exchanger Design Procedures**	**6 Hours**
Design of double pipe, shell and tube, tube fin,plate type and plate-fin heat exchanger.		

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Unit IV	**Selection of Heat Exchangers**	**6 Hours**
selection criteria, general selection guidelines of shell and tube heat exchanger, plate type heat exchanger		
Unit V	**Thermodynamic Modeling and Analysis**	**6 Hours**
modeling of heat exchanger based on I-law and Irreversibility.		
Unit VI	**Header Design**	**6 Hours**
Flow maldistribution, fouling and corrosion, advances in heat exchanger		
Learning Resources		
Reference Books :		
R1. S. Kakac, Heat *Exchangers – Thermal Hydraulic Fundamentals and Design*, Hemisphere, Mc Graw-Hill. **R2.** D. Q. Kern and A. D. Kraus; *Extended Surface Heat transfer*, McGraw-Hill. **R3.** W. M. Kays and A. C. London, *Compact Heat Exchangers*, McGraw-Hill.		

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4-PEC-ME-5-03B: Tribology in Design		
Teaching Scheme: Theory: 3Hours/Week	**Credit:** 03	**Examination Scheme:** **ISE :** 40 Marks **SEE** : 60 Marks

Prerequisites Courses:
Fluid Mechanics, Engineering Metallurgy, Strength of Materials

Course Objectives:

- To provide necessary concepts, knowledge and skills in Engineering Tribology with design aspect
- To impart friction, wear and lubrication theory and their appropriate use in design and maintenance of machine components
- To provide hands on training with design of bearing, friction ,wear test rig for laboratory purpose

Course Outcomes:

After completion of the course, learners should be able to

CO1: **Apply** theories of friction and wear to various practical situations by analyzing the physics of the process.
CO2: **Select** materials and lubricants to suggest a tribological solution to a particular situation.
CO3: **Design** a hydrodynamic bearing and measure the performance parameters using various bearing charts.
CO4: **Analyze** the behavior of bearing in different lubrication regimes
CO5: **Determine** the load carrying capacity in air lubricated bearing
CO6: **Understand** the tribological aspects in different applications and understand the solution to avoid wear and friction.

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Course Contents

Unit I	**Friction and wear**	**6 Hours**

Friction control and wear prevention, Boundary lubrication, Tribological properties of bearing materials and lubricants, Theories of friction and wear, Instabilities and stick-slip motion

Unit II	**Lubrication of bearings**	**6 Hours**

Mechanics of fluid flow, Reynold's equation and its limitations, Idealized bearings, Infinitely long plane pivoted and fixed show sliders, Infinitely long and infinitely short (narrow) journal bearings, Lightly loaded infinitely long journal bearing (Petroff's solution), Finite bearings - hydrostatic, hydrodynamic and thrust oil bearings, Heat in bearings

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Unit III	**Hydrostatic squeeze film**	**6 Hours**
Circular and rectangular flat plates, variable and alternating loads, piston pin lubrication, application to journal bearings		
Unit IV	**Elasto-hydrodynamic lubrication**	**6 Hours**
Pressure-viscosity term in Reynold's equation, hertz theory, Ertel-Grubin equation, lubrication of spheres		
Unit V	**Air lubricated bearings**	**6 Hours**
Tilting pad bearings, hydrostatic, hydrodynamic and thrust bearings with air lubrication		
Unit VI	**Tribological aspects of Rolling motion**	**6 Hours**
Mechanics of tire-road interaction, road grip and rolling resistance, tribological aspects of wheel on rail contact, tribological aspects of metal rolling, drawing and extrusion		
Learning Resources		
Reference Books :		
R1. Principles of Lubrication, Camaron, Longman's Green Co. Ltd. **R2.**The Design of Aerostatic Bearings – J. W. Powell **R3.**Theory Hydrodynamic Lubrication, Pinkush and Sterrolicht **R4.** Principles of Lubrication, Camaron, Longman's Green Co. Ltd.		

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24-PEC-ME-5-03C: Soft Computing Techniques		
Teaching Scheme: Theory: 4 Hours/Week	**Credit:** 04	**Examination Scheme:** **ISE :** 40 Marks **SEE** : 60 Marks

Prerequisites Courses: Data Structures and Algorithms & Mathematics for Computer Science

Course Objectives:

- Provide an understanding of the different paradigms of soft computing such as fuzzy logic, neural networks, and genetic algorithms.
- Explore the applications of fuzzy logic in control systems and decision making.
- Provide an in-depth understanding of artificial neural networks and deep learning.
- Explore the applications of evolutionary algorithms in optimization problems.
- Explain how different soft computing techniques can be integrated to solve complex problems.
- Provide an understanding of the latest research and developments in soft computing.

Course Outcomes:

After completion of the course, learners should be able to

CO1: Students will be able to differentiate between traditional computing and soft computing techniques.

CO2: Students will learn to apply fuzzy logic to solve control system problems and make decisions under uncertainty.

CO3: Students will gain a solid foundation in neural network architectures and learning algorithms.

CO4: Students will learn to apply evolutionary algorithms to solve optimization problems effectively.

CO5 :Students will be able to design and implement hybrid systems combining fuzzy logic, neural networks, and genetic algorithms.

CO6: Students will be able to apply advanced soft computing techniques to complex problems.

Course Contents

Unit I	**Soft Computing Basic Introduction**	**8 Hours**

Overview of Soft Computing: Definition, importance, and comparison with traditional hard computing methods.

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Components of Soft Computing: Key concepts of fuzzy logic, neural networks, genetic algorithms, and evolutionary computation techniques.		
Unit II	**Fuzzy Logic**	**8 Hours**
Fuzzy Sets and Systems: Understanding fuzzy sets, operations on fuzzy sets, and fuzzy relations. **Fuzzy Logic Controllers:** Design principles, implementation, and practical applications. **Fuzzy Inference Systems:** Mamdani and Sugeno models, defuzzification methods.		
Unit III	**Artificial Neural Networks**	**8 Hours**
Introduction to ANN: Basic concepts, models, and biological inspiration behind neural networks. **Learning and Training:** Methods of supervised, unsupervised, and reinforcement learning. **Types of Neural Networks:** Overview of feedforward, recurrent, convolutional, and deep neural networks.		
Unit IV	**Evolutionary Algorithms**	**8 Hours**
Introduction to Evolutionary Computation: Overview of genetic algorithms, evolution strategies, and genetic programming. **Genetic Algorithms:** Basic concepts including selection, crossover, mutation, and fitness functions. **Advanced Algorithms:** Concepts of differential evolution, particle swarm optimization, and ant colony optimization.		
Unit V	**Hybrid Systems**	**8 Hours**
Combining Techniques: Integration of neuro-fuzzy systems, genetic-neural systems, and fuzzy-genetic systems. **Design and Implementation:** Methodologies for combining soft computing techniques.		
Unit VI	**Advanced Topics in Soft Computing**	**8 Hours**
Deep Learning: Introduction, architectures, and frameworks of deep learning. Reinforcement Learning: Principles, Markov decision processes, and Q-learning. **Recent Advances and Trends:** Latest research, emerging technologies, and future directions in soft computing.		

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Learning Resources
Reference & Text Books :
Text Books : **T1.** S. N. Sivanandam and S. N. Deepa, "Principles of Soft Computing," 3rd Edition, Wiley, 2018. **T2.** J.-S. R. Jang, C.-T. Sun, and E. Mizutani, "Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence," Prentice-Hall, 1997. **T3.** S. Haykin, "Neural Networks and Learning Machines," 3rd Edition, Pearson, 2008. **Reference Books :** **R1.** D. E. Goldberg, "Genetic Algorithms in Search, Optimization and Machine Learning," Addison-Wesley, 1989. **R2.** M. Mitchell, "An Introduction to Genetic Algorithms," MIT Press, 1998 **Additional Resources: (Books, e-Resources)** Introduction to Fuzzy Logic Neural Networks and Deep Learning Genetic Algorithms Overview **MOOC Courses links :** ● Neural Networks and Deep Learning

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24-PEC-ME-5-03D: World Class Manufacturing		
Teaching Scheme: Theory: 4 Hours/Week	**Credit:** 04	**Examination Scheme:** **ISE :** 40 Marks **SEE** : 60 Marks
Prerequisites Courses: Manufacturing Process,Production Management,Quality Management,Industrial Engineering,,Operation Management		
Course Objectives: ● Discover best practices adopted by industry in the sphere of WCM ● Examine the Barriers to using IT strategically and Strategic Planning Methodology for World Class Manufacturing. ● Develop communication strategies and tools for effective implementation of WCM practices. ● Implement the World Class Manufacturing Plan across an organization.		
Course Outcomes: After completion of the course, learners should be able to CO1: Define challenges in world class manufacturing CO2: Study various world class manufacturing strategies. CO3:Understand total quality and employee involvement in manufacturing. CO4:Discuss different world class information systems for change management. CO5:Identify various methods and processes for WCM using brainstorming. CO6: Describe method to monitor performance in WCM.		
Course Contents		
Unit I	**Historical Perspective**	**6 Hours**
World class Excellent organizations – Models for manufacturing excellence – Business Excellence.		
Unit II	**Benchmark, Bottlenecks and Best Practices**	**6 Hours**
Concepts of benchmarking, bottleneck and best practices, Best performers – Gaining competitive edge through world class manufacturing – Value added manufacturing – eliminating waste – Toyota Production System – example		

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Unit III	**System & Tools for World Class Manufacturing**	**6 Hours**
Improving Product & Process Design – Lean Production – SQC , FMS, Rapid Prototyping , Poka Yoke , 5-S ,3 M, use of IT ,JIT, Product Mix , Optimizing , Procurement & stores practices , Total Productive maintenance , Visual Control		
Unit IV	**Human Resource Management in WCM**	**6 Hours**
Adding value to the organization – Organizational learning – techniques of removing Root cause of problems – People as problem solvers – New organizational structures . Associates – Facilitators –Teamsmanship – Motivation and reward in the age of continuous improvement.		
Unit V	**Typical Characteristics of WCM Companies**	**6 Hours**
Performance indicators – what is world class Performance – Six Sigma philosophy		
Unit VI	**Indian Scenario**	**6 Hours**
Leading Indian companies towards world class manufacturing – Task Ahead.		
Learning Resources		
Reference Books :		
R1. World Class Manufacturing - Strategic Perspective - B.S. Sahay ,KBC Saxena , Ashish Kumar (Mac Millan) **R2**. The Toyota Way - Jeffrey K.Liker – (Tata Macgraw Hill) **R3.** Operations Management for Competitive Advantage – Chase **R4.** Making Common Sense Common Practice – Moore **R5.** Managing Technology & Innovation for Competitive Advantage – Narayanan **R6.** Just In Time Manufacturing – M.G.Korgaonkar **R7.** Machine That Changed The World – Womack		

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24-VSEC-ME-5-02 : Drone Technology and Applications		
Teaching Scheme: Practical: 4 Hours/ Week	**Credit:** 02	**Examination Scheme:** **TW** : - 50 Marks **OR:** - 50 Marks
Prerequisites Courses: Basics of Electronics, physics, mathematics, Computer science, Communication system		
Course Objectives: ● Understand the basic principles and concepts of drone technology ● Learn the principles and practices of drones ● Explore the simulation tools, Drone Programming and firmware used in drone technology. ● Examine the diverse applications and use cases of drones in various sectors.		
Course Outcomes: After completion of the course, learners should be able to CO1: Identify and Explain Drone Components and Systems CO2: Design and Assemble a Functional Drone CO3: execute programs on Simulation Tools and utilize the firmware. CO4: Analyze and Apply Drones in Industry-Specific Use Cases		
Course Contents		
Unit I	**Fundamentals of Drone**	**7 Hours**
Types of Drone, Main Components and secondary components of Drone, Applications of Drone, Identification of motor movements and motor sizes, Selection of components as per sizes, Propeller Direction, UAS and its Types, Drone Rules, Drone Zone-Permission Protocol. **Assignment 1:** To understand the fundamentals of drone flight dynamics		
#Exemplar/Case Studies- Study of Assembly of drones using components.		
Unit II	**Drone Design and Operations**	**7 Hours**
Drone Design - pixhawk 2.4.8 Connection, **Assembling Drone Components**,Yaw, Roll, Pitch, Throttle, **Flight Operation-**Pre-Flight Planning (Weather, Airspace, Mission Objectives), Flight Path and Waypoint Planning,Flight Logs and Team Management,, Ground Testing and Calibration, Flight Testing Procedures **Assignment 2:**Take a flight of drones to navigate through a set course autonomously.		

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#Exemplar/Case Studies: Study of Aero GCS Green		
Unit III	**Communication and firmware Development**	**8 Hours**
Communication Protocols-Need and Importance**, Drone Simulators**-ArduPilot, Mission Planner, Implementing sensors in simulation, **Drone Programming with Python-**Dronekit Python installation**,,** Integrate **Arduino** with drone components, Android development, Firmware development **Assignment 3**: a. Program a drone that can drop a small payload. b. Program a drone-based light show c. Synchronize drone movements with music.		
#Exemplar/Case Studies : Flying a Drone using Mission planner		
Unit IV	**Use Cases of Drones**	**8 Hours**
Drones in Agriculture, Surveying and Mapping, Data Collection and Image Analysis,Machine Learning and AI in Drone Data Analysis,Swarm Drones and Cooperative Behavior, **Assignment 4**: a. Capture stunning aerial photos and videos. b. To design a drone-based system for monitoring crop health and environmental conditions. c. To Simulate drones for mapping and surveying applications.		
#Exemplar/Case Studies	**Study of Aerogcs orange,Pickstork for image analysis**	
Learning Resources		
Text Books		
T1. Tony Phan,Drone Builder's Guide: From Amateur to Professional,ISBN: 9781541016360 **T2. Michael J. Singer, Drone Operations: A Comprehensive Guide for Commercial Drone Pilots ,ISBN*: 9781733282100** **T3. David McGriffy, Make: Drones: Teach an Arduino to Fly,ISBN: 9781680451715** **T4. Joseph Howse, Programming Drones with Python: Build and Code Drones from Scratch, ISBN: 9781789346466** **T5. K. R. Krishna, Drones in Agriculture, ISBN: 9781771886846** **T6. Fergus Kennedy, Drone Photography & Video Masterclass, ISBN*: 9781781575383**		
Reference Books :		
R1. John Baichtal, Building Your Own Drones: A Beginner's Guide to Drones, UAVs, and ROV, ISBN:		

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9780134000121
R2. Reg Austin, Unmanned Aircraft Systems: UAVS Design, Development and Deployment, ISBN*: 9781119964261
R3. David McGriffy, Make: Drones: Teach an Arduino to Fly, ISBN: 9781680451715
R4. Adam Juniper, Drones: The Complete Guide, ISBN*: 9781781575383
R5. P. Karthikeyan, Sathish Kumar, and V. Anbarasu, Drone Data Analytics in Aerial Computing, ISBN: 9780367332517

Additional Resources: (Books, e-Resources)

- Drone Communities and Forums https://diydrones.com/
- https://projecthub.arduino.cc/suhaspn007/autopilot-drone-d3fa9f
- https://www.youtube.com/playlist?list=PLgiealSjeVyx3t4N9GroE29SbVwhYrOtL

MOOC Courses links :

- Robotics: Aerial Robotics (https://www.coursera.org/learn/robotics-flight)
- Drone Programming and AI (https://www.udacity.com/course/flying-car-nanodegree--nd787)

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24-CCC-ME-5-01 : The Scientific Study of Mind, Matter, and Consciousness		
Teaching Scheme: Theory: 3 Hours/Week	**Credit:** 02	**Examination Scheme:** **TW** : 50 Marks
Prerequisites Courses: Indian Knowledge System		
Companion Course: -NA		

Course Objectives:

- To introduce the core concepts of mind, matter, and consciousness from a scientific perspective.
- To explore the neuroscience of the mind and its relation to consciousness.
- To develop techniques for managing emotions and promoting mental well-being.
- To practice mindfulness and conscious decision-making.

Course Outcomes:
After completion of the course, learners should be able to
CO1: Understand core concepts of mind, matter, and consciousness.
CO2: Identify the relation to neuroscience of mind and consciousness.
CO3: Use strategies for emotional regulation and mental health.
CO4: Assimilate mindfulness and philosophical insights to improve decision-making.

Course Contents

Unit I	**Introduction to Neuroscience**	**07 Hours**

Foundation of Neuroscience, Basic Concepts: Mind, matter, and consciousness definitions; **Brain Anatomy:** Major structures and their functions; **Brain Waves:** Types (Alpha, Beta, Delta, Theta, Gamma), Correlation with consciousness states (awake, sleep, meditation)

#Exemplar/Case Studies: Meditation, Biofeedback : optimizing brain wave patterns.

Unit II	**Emotions and Thinking**	**07 Hours**

Emotions and the Brain: Framework for Emotional Intelligence, Biological mechanisms (amygdala, prefrontal cortex), Emotional regulation; **Emotion Management Techniques**: Mindfulness, Meditation, Cognitive Behavioral Therapy (CBT); **Critical Thinking:** Cognitive biases and logical fallacies, **Decision Making:** Rational vs. intuitive models.

#Exemplar/Case Studies: Real-life scenarios and its influence on mind

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Unit III	**Mindfulness Practices**	**09 Hours**
Inner Circle Management : Prime and Non-prime Activity, Self Awareness and Self Care through Meditation, **Five Core Concepts of Mindfulness:** (a) present-focused awareness, (b) an accepting or open attitude, (c) a non-judging approach, (d) compassion for self and others, and (e) the energy of mindfulness**, Benefits of Mindfulness, Mindfulness Techniques:** Mindful Yoga, **Scientific Evidence** : Research findings on Neuroplasticity and Mindfulness		
#Exemplar/Case Studies: Success Routine Framework (21 Days : write a report), Practice any type of breathing exercise (Presentation : share the experience)		
Unit IV	**Saptajyotirvikas and Wisdom of "SEE"**	**07 Hours**
Saptajyotirvikas Philosophy: Rise of this philosophy in 21st Century, Core principles of Saptajyotirvikas, **Wisdom of "SEE" (Scientific/Social Perspective, Experience, Expertise):** Definition, framework and components, **Integration of Saptajyotirvikas and SEE:** Practical applications in decision-making.		
#Exemplar/Case Studies	**Techniques for Advancing Consciousness:** Mindfulness and meditation practices. Strategies for mental stability and conscious decision-making.	
***Mapping of Course Outcomes**	CO3, CO4	
Learning Resources		
Text Books		
T1. Eran Asoulin, et al., "Introduction to Philosophy: Philosophy of Mind," Rebus Community, 2019, ISBN 13: 9781989014073 (https://open.umn.edu/opentextbooks/textbooks/776**)** **T2. Yashraj Patil, "Harmony 360 - Advancing Humanity through the Wisdom of "SEE" and Saptajyotirvikas," Writer's Pocket, 2024, ISBN-13 : 978-93-6083-226-1** (https://amzn.in/d/0iuJ88O4) **T3. Ann Swanson, "Science of Yoga," Dorling Kindersley Publication, 2019, ISBN-13: 9780241341230 (**https://www.amazon.in/Science-Yoga-Understand-Physiology-Practice/dp/146547935X**)** **T4. Casey Henley, "Foundations of Neuroscience", Michigan State University, 2021, ISBN 13: 9781626101098 (**https://open.umn.edu/opentextbooks/textbooks/1005**)**		
Reference Books :		
R1. Simply the Brain (DK Simply Series), Dorling Kindersley Publication, 2022, ISBN-13:		

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978-0241515891
(https://amzn.in/d/060rexqx**)**

R2. Rita Carter, "The Human Brain Book: An Illustrated Guide to Its Structure, Function, and Disorders," Dorling Kindersley Publication, 2019, ISBN-13: 978-0241302255 (https://amzn.in/d/0cfZ04LV**)**

R3. Gaur Gopal Das, "Energize Your Mind: A Monk's Guide to Mindful Living" Sourcebooks, 2023, ISBN-13: 978-1728265377 (https://www.amazon.in/Energize-Your-Mind-Gaur-Gopal/dp/1728265371**)**

Additional Resources: (Books, e-Resources)

Buddha's Brain: Neuroplasticity and Meditation
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2944261/

What is Cognitive Behavioral Therapy?
https://www.apa.org/ptsd-guideline/patients-and-families/cognitive-behavioral

Mindfulness by American Psychological Association
https://www.apa.org/topics/mindfulness

What Are The 7 Principles of Mindfulness?
https://psychcentral.com/blog/non-judging-non-striving-and-the-pillars-of-mindfulness-practice

MOOC Courses links :

- Swayam Course : **Psychiatry - An Overview and How the Brain Creates Mind**
  https://onlinecourses.nptel.ac.in/noc21_hs34/preview
- Swayam Course : **Introduction to Brain & Behaviour**
  https://onlinecourses.nptel.ac.in/noc20_hs33/preview

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24-ELC-ME-5-02 : Technical Communication		
Teaching Scheme: Theory: 4 Hours/Week	**Credit:** 02	**Examination Scheme:** **TW** : 50 Marks
Prerequisites Courses: Research Methodology		

Course Objectives:

- Identify research gaps and select an advanced topic that addresses these gaps.
- Analyze the latest technologies and methodologies in research to present creatively.
- Create high-quality technical documents and professional communication materials using enhanced writing skills.
- Evaluate complex engineering problems, formulate solutions, and apply critical thinking skills to develop and present comprehensive research plans.

Course Outcomes:

After completion of the course, learners should be able to
CO1: Critically analyze advanced topics of professional interest.
CO2: Write high-quality technical documents and research papers.
CO3: Deliver and present advanced research methodologies.
CO4: Deliver professional technical presentations with confidence and clarity.

Course Contents

Unit I	**Introduction and Topic Selection**	**8 Hours**

Overview of seminar objectives and structure, Guidelines for selecting advanced research topics for dissertation, Conducting a comprehensive literature review, Advanced use of academic databases and citation management tools.

#Exemplar/Case Studies: Select a research topic in consultation with the guide. Hands-on session on systematic literature search.

Unit II	**Writing Research Papers and Reports**	**8 Hours**

Components and structure of high-quality research papers. Using LaTeX for professional report preparation.

#Exemplar/Case Studies : Formatting and structuring research papers in LaTeX.

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Unit III	**Professional Presentation Skills**	**8 Hours**
Designing professional presentations, Techniques for engaging public speaking, Create and deliver a Detailed presentation on the selected research topic.		
#Exemplar/Case Studies Creating presentation using popular tools like Canva.		
Unit IV	**Seminar of Research Topic**	**6 Hours**
Deliver seminar presentations on any topic of interest (30-35 minutes each). Submit research reports in LaTeX format on any topic presented.		
#Exemplar/Case Studies	Presenting a Dissertation/Thesis	
Learning Resources		
Text Books		
T1. "Research Methodology- Methods and Techniques", Kothari C.K, New Age International, New Delhi,2004. **T2.** "Research Methodology- A Step-By-Step Guide for Beginners", Ranjit Kumar, Pearson Education, Delhi, ISBN: 81-317-0496-3, 2006. **T3.** "Research design: Qualitative, quantitative, and mixed methods approaches", Creswell, John W. , Sage publications, 2013.		
Reference Books :		
R1. "Research Methods", Trochim, William M.K., 2/e, Biztantra, Dreamtech Press, New Delhi, ISBN: 81-7722-372-0, 2003 **R2.** "Applied Statistics & Probability for Engineers", Montgomery, Douglas C. &Runger, George C., 3/e, Wiley India, 2007 **R3**. Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition		
Additional Resources: (Books, e-Resources) 1. International Journal of Social Research Methodology . 2. The Postgraduate Research Handbook by Gina Wisker. 3. Research Methodology: Motivation for Research; Dr. S.N. Sridhara		
MOOC Courses links : ● https://www.coursera.org/learn/research-methods ● https://onlinecourses.swayam2.ac.in/cec20_hs17/preview		

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