Guru Nanak Dev Engineering College, Ludhiana
An Autonomous College under UGC Act 1956
B. Tech. (Mechanical Engineering)

Third Semester							
				L	T	P	Credit
1	PCC	CME101	Strength of Materials	3	1	2	5
2	PCC	CME102	Applied Thermodynamics-I	3	1	0	4
3	PCC	CME103	Machine Drawing and CAD	1	0	4	3
4	PCC	CME104	Manufacturing Processes	4	0	2	5
5	PCC	CME105	Engineering. Materials & Metallurgy	3	0	2	4
6	MNC	MCME101	Environment Sciences & Sustainability	2	0	0	0
7	PW&S	SMME101	Seminar and Technical Report Writing for Engineers	0	0	2	1
8	MPD	MPD102	MPD	0	0	1	0
9	PW&S	TRME101	Training 1 (after 1st Year)				1
Total (31 hrs)							23

Fourth Semester							
				L	T	P	Credit
1	PCC	CME106	Theory of Machines	3	1	2	5
2	PCC	CME107	Applied Thermodynamics-II	3	1	2	5
3	PCC	CME108	Fluid Mechanics	3	1	2	5
4	BSS	BSME101	Maths III	3	1	0	4
5	PEC	EME10X	Elective- I (NCER/M. Sc./CM)*	4	0	0	4
6	HSS	HSMC103	Business Essentials for Engineers	2	0	0	2
7	HSS	HSMC104	Universal Human Values: Understanding Harmony	2	0	0	2
8	MNC	MC101	Indian Constitution	2	0	0	0
9	MPD	MPD102	MPD	0	0	1	1
Total (33 hrs)							28

*NCER: Non-Conventional Energy Resources (EME101)
M Sc : Machining Science (EME102)
CM: Computational Methods (EME103)

Fifth Semester							
				L	T	P	Credit
1	PCC	CME109	Design of Machine Elements	3	0	2	4
2	PCC	CME110	Heat Transfer	3	1	2	5
3	PCC	CME111	Mechanical Measurement and Control	3	0	2	4
4	PCC	CME112	Industrial Automation and Robotics	3	0	2	4
5	PEC	EME10X	Elective- II	4	0	0	4
6	ESC	ESME102	Design Thinking	0	0	2	1
7	MNC	MC102	Essence of Indian Knowledge Tradition	2	0	0	0
8	MPD	MPD103	MPD	0	0	1	0
9	PW&S	TRME102	Training -II (after 2nd year)				1
Total (30 hrs)							23

Sixth Semester							
				L	T	P	Credit
1	PCC	CME113	Refrigeration and Air Conditioning	3	0	2	4
2	PCC	CME114	Operations Research	3	1	0	4
3	PCC	CME115	Industrial Engineering	3	0	2	4
4	PEC	EME10X	Elective- III (FMC/M.M P../CAD)*	4	0	0	4
5	ESC	ESME101	Program Specific Course (MV)	3	0	2	4
6	ESC	ESC106	Entrepreneurship and Startups	3	0	0	3
7	MNC	MC103	Disaster Management and Preparedness	2	0	0	0
8	PW&S	PRME101	Minor Project	0	0	2	1
9	PW&S	FSME101	Professional Skills for Engineers	2	0	0	2
10	MPD	MPD103	MPD	0	0	1	1
Total (33 hrs)							27

*****F MC: Fluid Machinery

***** MMP Modern Manufacturing Processes

*****CAD: Computer Aided Design

Seventh Semester							
				L	T	P	Credit
1	PEC	MOOCS	Elective –IV	4	0	0	3
2	OEC	MOOCS	OE –I	3	0	0	3
3	OEC	MOOCS	OE –II	3	0	0	3
4	OEC	MOOCS	OE –III	3	0	0	3
5	PW&S	PRME102	Major Project	0	0	6	3
6	MPD	MPD104	MPD	0	0	1	0
Total							15

Eighth Semester							
				L	T	P	Credit
1	PW&S	TRME103	Industrial Training (Trg-III)				12
2	MPD	MPD104	MPD	0	0	1	1
Total							13

Guru Nanak Dev Engineering College, Ludhiana
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B. Tech. (Mechanical Engineering)

Course Code: CME 101
Course Title: Strength of Materials

Programme: B.Tech.	**L:** 3 **T:** 1 **P:** 2	**Credits:** 5
Semester: 3	**Theory/Practical:** Theory	**Teaching Hours:** 45(L)+15(T)+30(P) = 90 hrs
Total Max. Marks: 150	**Continuous Assessment (CA) Marks:** 90	**End Semester Examination (ESE) Marks:** 60
Minimum Percentage of Numerical / Design / Programming Problems in ESE: 30%		
Duration of End Semester Examination (ESE): 3 hours		
Course Type: Core Course		

Prerequisites (if any): NIL
Additional Material Allowed in ESE: Scientific Calculator

On completion of the course, the student will have the ability to:

CO#	Course Outcomes
1	Formulate mechanics problems using calculus and differential equations.
2	Solve, analyze and design beams under bending stresses.
3	Understand the design considerations of structures subjected to different/wide range of loading conditions including thermal loads.
4	Relate the design problems with practical applications.
5	Solve problem involving simple and combined modes, including torsion.
6	Evaluate slope and deflection in different type of beams under different loading conditions

Contents

Part-A

Unit-1 Simple Stresses and Strains **08hrs**

Stress and Strain and their types, Hook's law, longitudinal and lateral strain, Poisson's ratio, stress-strain diagram for ductile and brittle materials, extension of a bar due to without and with self-weight, bar of uniform strength, stress in a bar, elastic constants and their significance, relation between elastic constants, Young's modulus of elasticity, modulus of rigidity and bulk modulus. Thermal stresses and strains: Temperature stress and strain calculation due to axial load and variation of temperature in single and compound bars.

Unit-2 Principal Stresses and Strains **08 hrs**

Two-dimensional stress system, stress at a point on a plane, principal stresses and principal planes, Mohr's circle for stresses and strains, principal stresses related to principal strains. Strain energy: Introduction to strain energy, strain energy in simple tension and compression. Stresses develop due to a different type of loads. Strain energy in pure shearing, torsion, and due to bending; Theories of failure: Maximum principal stress theory, maximum shear stress theory, maximum principal strain theory, total strain energy theory, shear strain energy theory. Graphical representation and derivation of the equation for these theories and their application to problems related to two-dimensional stress systems.

Unit-3 Bending Moment (B.M) and Shear Force (S.F) Diagrams **08 hrs**

Shear force and Bending Moment definitions; relation between load, shear force and bending moment; B.M and S.F diagrams for cantilevers, simply supported beams with or without overhangs, and calculation of

maximum bending moment, Shear force and Point of contra flexure under the following type of loads: a) Concentrated loads b) Uniformity distributed loads over the whole span or part of span c) Combination of concentrated and uniformly distributed load d) Uniformly varying loads e) Application of moments..

Part-B

Unit-4 Bending Stresses and Deflection in Beams **09 hrs**

Bending theory; assumptions, derivation of bending equation and its application to beams of rectangular, circular and channel, I and T- sections. Combined, direct and bending stresses in afore-mentioned sections, composite / flitched beams. Relationship between moment, slope and deflection, Double integration method, Macaulay's method, moment area method and use of these methods to calculate slope and deflection for the following: a. Cantilevers b. simply supported beams with or without overhang under concentrated loads, uniformly distributed loads or combination of concentrated & uniformly distributed loads.

Unit-5 Torsion **06 hrs**

Derivation of torsion equation, its assumptions and application on the hollow and solid circular shafts. Torsional rigidity, combined torsion and bending of circular shafts, principal stresses and maximum shear stresses under combined loading of bending and torsion.

Unit-6 Thin cylinders and spheres **06 hrs**

Calculation of Hoop stress, longitudinal stress in a cylinder, the efficiency of joints, changes in dimensions due to internal pressure. Principal stresses in a spherical shell, change in diameter and internal volume.

Tutorial hours will be used for practice sessions for design/numerical problems/programming/case-studies etc. (as the case may be).

Laboratory Work

Experiment No.	Experiment Title
1	To perform tensile test in ductile and brittle materials and to draw stress-strain curve and to determine various mechanical properties.
2	To perform compression test and impact tests on the given specimen
3	To perform hardness test. (Aluminium, Mild steel and Hardened steel)
4	To perform torsion test and to determine various mechanical properties of the given material
5	To perform bending test on beam and to determine the Young's modulus and modulus of rupture
6	To determine buckling load of long columns with different end conditions.
7	To draw load/ defection curve for helical spring
8	To perform Fatigue test on circular test piece.

Text Books

1. S.S. Rattan, "Strength of Materials", Tata McGraw Hill, 11th Edition, 2014 (E-Book).
2. R.S. Lehri, "Strength of Materials", Katson, 11th Edition, 2012.
3. Egor P. Popov, "Engineering Mechanics of Solids", Prentice Hall of India, 2nd Edition, 2001.
4. R. Subramanian, "Strength of Materials", Oxford University Press, 3rd Edition, 2 2007.
5. Timoshenko, "Mechanics of Materials", CBS Publication, 2nd Edition, 2006.

Reference Books

1. Kirpal Singh, "Mechanics of Materials", Standard Publishers, 7th Edition, 2013.
2. Ferdinand P. Been, Russel Johnson Jr and John J. Dewole, "Mechanics of Materials", Tata Mc-GrawHill Publishing Co. Ltd., 2005.
3. Sadhu Singh, "Strength of Materials", Khanna Publication, 11th Edition, 1978.
4. Russell C. Hibbeler, "Mechanics of Materials", Pearson Publications, 10th Edition, 2016.

Online Learning Materials

1. https://youtu.be/GkFgysZC4Vc Accessed on May 11, 2025
2. https://youtu.be/L04cOewVpEs Accessed on May 11, 2025
3. https://www.youtube.com/embed/rTkJydxVbFQ Accessed on May 11, 2025
4. https://www.youtube.com/embed/xSM2E98T5wk Accessed on May 11, 2025
5. https://www.youtube.com/embed/xyZ29zDdvCE Accessed on May 11, 2025
6. https://www.youtube.com/embed/aQM8d7kzdXU Accessed on May 11, 2025
7. https://www.youtube.com/embed/Zt3ENh1xwak Accessed on May 11, 2025

Supplementary SWAYAM Course

Sr. No.	Course Name	Instructor	Host Institute	URL
1	Strength of Materials	Prof. Sriman Kumar Bhattacharyya	IIT Kharagpur	https://onlinecourses.nptel.ac.in/noc19_ce18/preview
2	Strength of Materials	Prof. K Ramesh	IIT Madras	https://onlinecourses.nptel.ac.in/noc25_me73/preview
3	Structural Analysis-I	Prof. Amit Shaw	IIT Kharagpur	https://onlinecourses.nptel.ac.in/noc25_ce54/preview

Experiments to be performed through Virtual Labs

Sr. No.	Experiment Name	Experiment Link(s)
1	To measure strains on a beam in bending at fixed locations along the length of the beam, on tensile and compressive fibres.	https://vlab.amrita.edu/index.php?sub=77&brch=299&sim=1627&cnt=1
2	To determine experimentally, the ultimate shear strength in double shear of mild steel rod.	https://sm-nitk.vlabs.ac.in/exp/direct-shear-test-steel-rod/
3	To study the behaviour of mild steel rod subjected to gradual increasing equal loads at 1/3rd span and to determine its mechanical properties.	https://sm-nitk.vlabs.ac.in/exp/bending-test-mild-steel/
4	To find the Rockwell hardness number of mild steel, cast iron, brass, aluminium and spring steel etc.	https://sm-nitk.vlabs.ac.in/exp/rockwell-hardness-test/
5	To Study the beam under different loads acting on it.	https://bsa-iiith.vlabs.ac.in/exp/single-span-beams/objective.html
6	To determine the Column stability using boundary conditions.	https://bsa-iiith.vlabs.ac.in/exp/column-

		analysis/objective.html

Guru Nanak Dev Engineering College, Ludhiana
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B. Tech. (Mechanical Engineering)

Course Code: CME-102

Course Title: Applied Thermodynamics-I

Programme: B.Tech.	**L:** 3**T:**1**P:**0	**Credits:**4
Semester:3rd	**Theory/Practical:** Theory	**Teaching Hours:**45(L)+15(T) =60hrs
Total Max.Marks:100	**Continuous Assessment (CA) Marks:** 40	**End Semester Examination (ESE) : Marks:** 60
Minimum Percentage of Numerical/Design/Programming Problems in ESE:50%		
Duration of End Semester Examination (ESE):3hours		
Course Type: Core Course		

Prerequisites (if any): NIL
Additional Material Allowed in ESE: Scientific Calculator, Steam Table/Charts

On completion of the course, the student will have the ability to:

CO#	Course Outcomes
1	Understand the basic concepts of thermodynamics and Zeroth Law of Thermodynamics.
2	Apply the knowledge of First law of thermodynamics for various engineering applications.
3	Analyze the concept of Second law of Thermodynamics and related properties for the feasibility of engineering systems and solve engineering problems.
4	Evaluate and analyze the performance of Air Standard cycles for the particular applications in IC Engine.
5	Recognize the nature of substance from the understanding of its properties and use related Tables and Charts.
6	Evaluate and analyze the performance of Vapor power cycles.

Contents

Part-A

Unit-1. Basic concepts of Thermodynamics **09 Hrs**

Brief concept of continuum, Thermodynamic System, Boundary and Surroundings, Control (fixed) mass and Control Volume concept, Thermodynamic State, Thermodynamic Property, Condition for any quantity to be a property, Thermodynamic equilibrium, Thermodynamic path and process, Concept of reversible process, Quasi-static process, Irreversible process, Cyclic process, Energy and its forms; Physical insight to internal energy, Energy transfer across system boundary i.e. transient energies, Heat and work transfer-their comparison and sign conventions, Displacement work and other modes of work, Zeroth law of Thermodynamics.

Unit-2. First law of Thermodynamics **06 Hrs**

First law of Thermodynamics and its applications to closed and open system, Analysis of non- flow processes for a control mass undergoing constant volume, constant pressure, constant temperature, adiabatic and poly-tropic processes. Steady and unsteady flow processes and its applications in various engineering devices.

Unit-3.Second law of Thermodynamics **08 Hrs**

Limitations of first law of Thermodynamics, Heat reservoir, source and sink, Heat engine, Refrigerator, Heat pump, Kelvin-Plank and Clausius Statements of second law and their corollaries, Carnot and reversed Carnot cycle, Concept of entropy, T-S diagram, Principle of increase in entropy, Applications of second law, High grade and low grade energy, Available and non-available energy, Enthalpy and entropy as a function of independent variables, Third law of Thermodynamics.

Part-B

Unit-4.Gas power cycles and IC Engines **08 Hrs**

Air standard cycle and air standard efficiency. Otto cycle (constant volume heat addition cycle), Diesel cycle (constant pressure heat addition cycle), Dual cycle (mixed, composite and limited pressure heat addition cycle) and Brayton cycle; comparison of otto, diesel and dual cycle under some defined similar parametric conditions. Introduction to heat engines Classification and constructional features of I.C. engines.

Unit-5. Properties of pure substances and Gas Mixtures **06Hrs**

Formation of steam and its Thermodynamic properties, p-V, T-S and an h-s diagram for a pure substance, Use of the steam table and Mollier chart, Determination of dryness fraction, Equation of State of a Gas, Ideal Gas, Internal energy, Enthalpy and Entropy of Gas Mixtures.

Unit-6.Vapor power Cycles **08Hrs**

Steam power cycles, Rankine Cycles, Comparison of Rankine and Carnot Cycles, Reheat Cycle, Regenerative Cycles, Reheat – Regenerative Cycle, Binary Vapor Cycles, Thermodynamics of combined cycles.

Tutorial hours will be used for practice sessions for design/numerical problems/programming/case-studies etc. (as the case may be).

Text Books

1. P.K. Nag, “Engineering Thermodynamics”, McGraw Hill Education (India), Chennai, 6th Edition 2017.
2. V. Ganeshan, “Thermal Engineering”, McGraw Hill Education (India), Chennai
3. Y.A.Cengel, M.A.Boles, “Thermodynamics–An Engineering Approach”, McGraw Hill Education, 8th Edition 2017.
4. R. E. Sonntag, C. Borgnakke, &G. J. V. Wylen, “Fundamentals of Thermodynamics”, Wiley, 7th Edition 2009.
5. M.J. Moran, H.N. Shapiro, D.D. Boettner & M. Bailey,“Fundamentals of Engineering Thermodynamics”, John Wiley & Sons, 7th Edition, 2010.

Reference Books

1. J.B. Jones, & R.E. Dugan, “Engineering Thermodynamics”, Prentice Hall, 1st Edition 1995.
2. D.B. Spalding, E.H. Cole, “Engineering Thermodynamics”, Edwar Arnold, London, 1982.
3. V.G. Erokhim, M.G. Makhan, “Fundamentals of Thermodynamics and Heat Engines”, Mir Publishers, Moscow, 1986.
4. Shvets, V. Tolubinsky, “Heat Engineering”, Med Tech Science and Technology Series, 2nd Edition 1975.

Supplementary SWAYAM Course:

S. No.	Course Name	Instructor	Host Institute	URL

1	Concepts of thermodynamics	Prof. Suman Chakaraborty	IIT, Kharagpur	https://archive.nptel.ac.in/courses/112/105/112105266/
2	Basic thermodynamics	Prof. S.K. Som	IIT, Kharagpur	https://archive.nptel.ac.in/courses/112/105/112105123/
3	Engineering thermodynamics	Prof.V. Babu	IIT, Madras	https://archive.nptel.ac.in/courses/112/106/112106310/

Guru Nanak Dev Engineering College, Ludhiana
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B. Tech. (Mechanical Engineering)

Course Code: CME103

Course Title: Machine Drawing and Computer Aided Drafting

Programme: B. Tech.	**L:** 1 **T:** 0 **P:** 4	**Credits:** 4
Semester: 3rd	**Theory/Practical:** Theory	**Teaching Hours:** 15(L)+60(P) = 75 hrs
Total Max. Marks: 150	**Continuous Assessment (CA) Marks:** 90	**End Semester Examination (ESE) Marks:** 60
Minimum Percentage of Numerical / Design / Programming Problems in ESE: 00%		
Duration of End Semester Examination (ESE): 3 hours		
Course Type: Core Course		

Prerequisites (if any): NIL
Additional Material Allowed in ESE: NIL

On completion of the course, the student will have the ability to:

CO#	Course Outcomes
1	Acquire the knowledge, understand and remember the elements of a Computer Aided Drafting **(**CAD) through software and its features
2	To develop the capability of modeling important machine components using CAD software through 2D modeling.
3	Use standards used in machine drawing of machine components and assemblies.
4	Analysis of acquired knowledge/understanding for visualization of mechanical mechanisms.
5	Understand the mechanical CAD part to progress in Design and entrepreneurship development.
6	Generate the sectional and orthographic views of assembled components

Contents

Introduction to Computer Aided Drafting tools/software like Pro-desktop or Pro-E or AutoCAD or G-star etc. Requirements of machine drawing; Sectional Views and rules of sectioning, Machining and Surface Finish symbols indicating tolerances in dimensioning. Various types of screw threads, nuts and bolts, screwed fasteners, welding joints, riveted joints, coupling, knuckle joint, couplings, keys and cotter.

Generation of Part and Assembly Drawings including Sectioning and Bill of Materials. First Angle Projection assembly of Various Mechanical Components: Plummer Block, Foot Step Bearing, Steam Stop Valve, spring-loaded Safety Valve, Blow-off Cock, Tail Stock, Screw Jack, Expansion Joint.

Note: First angle projection to be used. BIS codes for various applications in Machine Drawing to certain thinking to design and Entrepreneurship development CAD product. Drawings should contain bill of materials and illustrate the use of its tolerances and surface finish requirements.

Laboratory Work

The following exercises are to be done in 3D modeling using AutoCAD/CATIA or other software

Experiment No.	Experiment Title
1	Popular forms of Screw threads, bolts, and nuts
2	Riveted joints for plates

3	Flange Coupling
4	Knuckle joint
5	Spigot and socket pipe joint
6	Modeling and assembly parts of Plummer Block
7	Modeling and assembly of parts in screw jack
8.	Modeling and assembly of parts in Foot Step Bearing.
9.	Modeling and assembly of parts in Steam Stop Valve.
10.	Modeling and assembly of parts in Blow-off Cock.
11.	Modeling and assembly of parts in Tail Stock.

Software Packages: Auto CAD, CATIA V5 etc.

Text Books

1. Ajeet Singh, "Machine Drawing (including Auto CAD)", McGraw Hill, 2nd edition, 2012
2. N.D. Bhatt, "Machine Drawing", Charotar publications,50th Edition, 2014
3. P.S. Gill, "Machine Drawing", S K Kataria and Sons, 18th edition, 2017 Reprint
4. Pohit, G., Machine Drawing with AutoCAD, Pearson Education Asia (2007).
5. Dhawan, R.K., Machine Drawing, S.Chand & Company Limited (2003).

Reference Books

1. Gene R. Cogorno,"Geometric Dimensioning and Tolerancing for Mechanical Design", McGraw-Hill Professional, 2 nd Edition,2011. (E-Book Available)
2. Paul Drake, Jr., "Dimensioning and TolerancingHandbook", McGraw-Hill Professional, 1 st Edition, 1999.(E-Book Available)
3. French, T. E. and Vierck, C. J., Graphic Science and Design, McGraw Hill (2000)
4. Narayana, K.L., Kannaiah P. and Reddy, K.V., Machine Drawing, New Age International Publishers (2002).
5. SP 46: 1988, "Engineering Drawing Practice for Schools and Colleges", Bureau of Indian standards.

Online Resources:

1. https ://www.autodesk.in/campaigns/autocad-tutorials
2. https://my.solidworks.com/training

Course Code: CME-104

Course Title: Manufacturing Practices

Programme: B. Tech.	**L**: 3 **T**: 0 **P**: 2	**Credits:** 4
Semester: 3rd	**Theory/Practical: Theory**	**Teaching Hours**: 45(L) +30(P) = 75 Hrs.
Total Max. Marks: 150	**Continuous Assessment (CA)** Marks: 90	**End Semester Examination(ESE)** Marks:60
Minimum Percentage of Numerical / Design / Programming Problems in ESE: Nil		
Duration of End Semester Examination (ESE): 3 hours		
Course Type: Core Course		

Prerequisites (if any): NIL
Additional Material Allowed in ESE: Nil

On completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Use the Knowledge of Fundamental principles of Castings, Welding, forming and cutting processes for their practical applications.
2	Identify and suggest equipment, tools and accessories required for performing the various manufacturing processes.
3	Know about cutting tools and their materials and related concepts like tool life, wear, and coolants/lubricants.
4	Identify various machine tools and knowledge of different parameters of the processes for analyzing their effect.
5	Suggest a suitable process for manufacturing of component.
6	Understand the latest technologies in Manufacturing Processes

Contents

Part-A

Unit No -I Introduction **03 Hrs**

Classification of manufacturing processes; Selection criteria for manufacturing processes; General trends in manufacturing.

Unit -II Casting Processes: **10 Hrs**

Introduction to metal casting; Patterns: types, materials and allowances; Moulding materials: moulding sand compositions and properties, sand testing, types of moulds, moulding machines. Cores: functions, types, core making process, core-prints, chaplets. Gating system design, Riser design. Melting furnaces, and metallurgical considerations in casting, Solidification of metals and alloys, Directional solidification, Segregation, Nucleation and Grain growth.

Unit -III Welding Processes **10 Hrs**

Introduction and classification of welding processes; Principle, Equipment and constructional details for Gas welding, Electric Arc welding, relative merits of AC & DC arc welding; Electrodes: types, selection, electrode coating ingredients and their function; Thermal effects on weldment: heat affected zone, grain size and its control; Resistance welding: principle and their types. TIG and MIG welding processes: principle, equipment and constructional details.

Part B

Unit- IV Metal Forming **08 Hrs**

Introduction and classification; Rolling process: introduction, classification, rolling mills, products of rolling, rolling defects and remedies; Forging: open and closed die forging, forging operations, forging defects, their causes and remedies; Extrusion: classification, equipment, defects and remedies; Drawing: drawing of rods, wires and tubes, drawing defects and remedies; Introduction to sheet metal forming operations.

Unit- V Metal Cutting **07 Hrs**

Introduction to machining processes; Cutting tool geometry, Cutting tool materials: high carbon steels, alloy carbon steels, high-speed steel, cast alloys, cemented carbides, ceramics and diamonds, and CBN; Mechanics of chip formation process, concept of shear angle and cutting forces in metal cutting; Merchant theory, tool wear, tool life, machinability.

Unit -VI Machine Tools **07 Hrs**

Classification, description and operations of Lathe machine, Shaping and Planning Machine, Milling machine, Boring machine; Broaching machine.

Laboratory Work

Sr.No.	Name of Practical
1	To determine grain fineness number, clay content and moisture content of a given sample of moulding sand.
2	To Prepare a specimen of moulding sand on a standard Rammer and to carry out following tests: a) Tensile, compressive and transverse strength b) Mould Hardness c) Shatter index d)Permeability
3	To study the effect of process parameters of MIG Welding (Voltage, wire feed, gas flow) on welding of Mild steel sheet.
4	To study the effect of process parameters of TIG welding (Pulse, Gas flow, current) on welding of Stainless steel and Mild steel sheets.
5	To grind single point and multipoint cutting tools and to prepare introductory report on cutting inserts.
6	To determine cutting forces with dynamometer for turning operation.
7	To prepare a job of spur gears by the use of milling machines

Text Books

1. P. N. Rao, "Manufacturing Technology, Foundry, Forming & Welding", Tata McGraw Hill, 4th Edition, 2017
2. P. N. Rao, "Manufacturing Technology, Metal Cutting and Machine Tools", Tata McGraw Hill, 4th Edition, 2017
3. B. L. Juneja and G. S. Sekhon, "Fundamentals of Metal Cutting & Machine Tools", New Age International (P) Ltd, 2nd Edition, 2017.
4. P. C. Sharma, "A Text Book of Production Technology", S. Chand & Company Ltd., 8th Edition, 2014.
5. H. S. Shan, "Manufacturing Processes", Cambridge University Press, 2nd Edition, 2018.

Reference Books:

1. Serope Kalpakjian and Steven R. Schmid, "Manufacturing Engineering and Technology", Pearson Publishers, 4th Edition, 2002.
2. J.A. Schey, "Introduction to Manufacturing Processes" ,McGraw Hill Co., 3rd Edition 2000.

3. G. Boothroyd& W.A. Knight, "Fundamentals of Machining and Machine Tools", 2nd Edition, Marcel Dekker, Inc., 1989.
4. Uday S. Dixit, "Metal Forming: Technology and Process Modeling", McGraw-Hill Professional, 2013.
5. HwaiyuGeng, "Manufacturing Engineering Handbook," McGraw-Hill Professional. 2nd Edition
6. Jonathan Beddoes, M. J.Bibby, "Principles of Metal Manufacturing Processes", Butterworth Heinemann Elsevier Publications.

Online Material

1. Modern Manufacturing Processes | Wiley Online Books
2. SO_IDCbookextract_rev9.pdf (idc-online.com)
3. E-manufacturing—fundamental, tools, and transformation - ScienceDirect
4. Advances in Manufacturing Processes and Smart Manufacturing Systems: Smart Materials and Manufacturing Systems and Sustainable Management Operations, Volume 1 | SpringerLink
5. (PDF) Good manufacturing Practice (researchgate.net)

Guru Nanak Dev Engineering College, Ludhiana
An Autonomous College under UGC Act 1956
B. Tech. (Mechanical Engineering)

Course Code: CME105

Course Title: Engineering Materials and Metallurgy

Programme: B.Tech.	**L:** 3 **T:** 0 **P:** 2	**Credits:** 4
Semester: 3rd	**Theory/Practical:** Theory	**Teaching Hours:** 45(L)+30(P) = 75 hrs
Total Max. Marks: 150	**Continuous Assessment (CA) Marks:** 90	**End Semester Examination (ESE) Marks:** 60
Minimum Percentage of Numerical / Design / Programming Problems in ESE: 10%		
Duration of End Semester Examination (ESE): 3 hours		
Course Type: Core Course		

Prerequisites (if any): NIL
Additional Material Allowed in ESE: Scientific Calculator

On completion of the course, the student will have the ability to:

CO#	Course Outcomes
1	Analyze and differentiate between ferrous and non-ferrous metals based on their properties, composition, and applications.
2	Apply crystallographic rules to calculate coordination number, APF, and c/a ratios for various crystal structures
3	Describe and explain the fundamental theories of imperfections in solids, diffusion mechanisms, plastic deformation, and re-crystallization processes.
4	Analyze and differentiate between eutectic, eutectoid, peritectic, and peritectoid transformations in binary phase diagrams
5	Describe phase transformations in the iron-carbon equilibrium diagram and the significance of TTT curves.
6	Explain, apply, and analyze heat treatment processes, surface hardening, and steel hardenability with evaluation.

Contents

Part-A

Unit-1 Ferrous and Non Ferrous Metals **08 hrs.**
Introduction, classification and composition of alloy steels, effect of alloying elements (Si, Mn, Ni, Cr, Mo, W, Al) on the structures and properties of steel. Non-Ferrous Metals & Alloys: Aluminum, Magnesium and Copper alloys: Composition, Properties and Applications.

Unit-2 Crystallography **06 hrs**
Atomic bonding in solids, crystal systems, crystal lattice of body centered cubic, face centered cubic, closed packed hexagonal; coordination number, APF, c/a ratio of HCP. crystallographic notation of atomic planes.

Unit-3 Imperfection **08 hrs**
Imperfection in solids; point defects, line defects and dislocations, interfacial defects, bulk or volume defects. Diffusion: diffusion mechanisms, steady-state and non-steady-state diffusion, factors affecting diffusion. Theories of plastic deformation; slip and twinning, recovery, re-crystallization.

Part-B

Unit-4 Phase Transformation **07 hrs**

General principles of phase transformation in alloys, Types of equilibrium diagrams: Two metals completely soluble in the liquid state and completely soluble in the solid state, Eutectic (Two metals completely soluble in the liquid state but completely insoluble in the solid state & Two metals completely soluble in the liquid state but partly soluble in the solid state), Peritectic, Eutectoid and Peritectoid system.

Unit-5 Iron carbon and TTT diagram **07 hrs**

Polymorphism and allotropy; allotropy of iron. Iron carbon equilibrium diagram and various phase transformations. Time temperature transformation curves (TTT curves): fundamentals, construction and applications.

Unit-6 Heat Treatment **09 hrs**

Principles and applications. Processes viz. annealing, normalizing, hardening, tempering. Surface hardening of steels: Principles of induction and oxyacetylene flame hardening. Procedure for carburizing, nitriding and cyaniding. Harden-ability: determination of harden-ability. Jominy end-quench test. Defects due to heat treatment and their remedies.

Laboratory Work

Experiment No.	Experiment Title
1	Preparation of models/Charts related to Atomic /Crystal Structures of Metals.
2	To prepare specimen involving cutting, mounting, polishing and etching of Mild Steel and to study microstructure of prepared specimen
3	To study the microstructure of following materials from standard specimens. 1) Hypo eutectoid and hyper eutectoid steel. 2)White and Grey Cast Iron 3) Non Ferrous Metals: Brass, Copper) Heat Treated Specimens: Annealed, Normalized, Hardened
4	To conduct Normalizing on Steel specimen and to study the effect of Normalizing on Hardness and Microstructure
5	To conduct Hardening of Steel specimen and to study the effect of Hardening on Hardness and Microstructure.
6	To determine the effect of different quenching media (Water, Oil, Brine solution) on Hardness of Steel Specimen
7	To determine Hardenability of steel by Jominy End Quench test.

Text Books

1. Sidney H Avner, “Introduction to Physical Metallurgy”, Tata McGraw-Hill. 2nd Edition, 2017
2. O.P. Khanna, “A Text book of Materials Science & Metallurgy”, Dhanpat Rai & Sons. Re-print 1984
3. U. C. Jindal, “Material Science and Metallurgy”, Pearson. Re-print 2011(E book)
4. Parashivamurthy K.I, “ Material science and metallurgy”, Pearson Re-print 2012(E book)
5. Lakhtin,Yu.M, “Engineering physical metallurgy and Heat treatment”, Mir Publishers. Re-print 1986
6. Laboratory Manuals.

Reference Books

1. V. Raghavan, “Physical Metallurgy: Principles and Practice”, PHI Learning. 3rd Edition 2015
1. B. Zakharov, “Heat Treatment of Metal”, University Press.1984

2. George S. Brady, "Materials Handbook: An Encyclopedia for Managers, Technical Professionals, Purchasing and Production Managers, Technicians, and Supervisors", McGraw-Hill Publication, 15th Edition, 2002.
3. Smallman, R.E. Ngan, A.H.W.,"Modern Physical metallurgy" Butterworth-Heinemann,8th Edition 2013.

Online Learning Materials

1. MIT Open Course Ware – Introduction to Materials Science and Engineering
2. https://ocw.mit.edu/courses/3-091sc-introduction-to-solid-state-chemistry-fall-2010/

Supplementary SWAYAM Course

Sr. No.	Course Name	Instructor	Host Institute	URL
1	Phase Diagrams in Material Science& Engineering	Prof.Krishanu Biswas	(IIT Kanpur)	https://archive.nptel.ac.in/courses/113/104/113104068/
2	SWAYAM-NPTEL course titled "Materials Science and Engineering"	Prof. Vivek Pancholi	(IIT Roorkee)	https://onlinecourses.nptel.ac.in/noc21_mm04/preview
3	Introduction to Materials Science and Engineering	Prof. Rajesh Prasad	IIT Delhi	https://onlinecourses.nptel.ac.in/noc25_mm17/preview

Experiments to be performed through Virtual Labs

Sr. No.	Experiment Name	Experiment Link(s)
1	metallography experiment (engineering lab)	https://www.slideshare.net/slideshow/3metallography-expriment-engineering-lab/47424631
2	DoITPoMS Virtual Lab – University of Cambridge	https://www.doitpoms.ac.uk/tlplib/jominy/index.php
3	Rockwell Hardness Test – Virtual Lab (NITK Surathkal)	https://sm-nitk.vlabs.ac.in/exp/rockwell-hardness-test/?utm

Guru Nanak Dev Engineering College, Ludhiana
An Autonomous College under UGC Act 1956
B. Tech. (Mechanical Engineering)

Course Code: MCME101

Course Title: Environmental Science and Sustainability

Programme: B. Tech.	**L: 2T:** 0 **P:** 0	**Credits:** 0
Semester: 3rd	**Theory/Practical:** Theory	**Teaching Hours:** 30
Total Max. Marks: 50	**Continuous Assessment (CA) Marks:**50	**End Semester Examination (ESE) Marks:** NA
Minimum Percentage of Numerical / Design / Programming Problems in ESE: NA		
Duration of End Semester Examination (ESE): NA		
Course Type: Mandatory Non Credit Course		

Prerequisites (if any): NIL
Additional Material Allowed in ESE: NA

On completion of the course, the student will have the ability to:

CO#	Course Outcomes
1	Propose solutions to environmental problems related to resource use and management
2	Infer threats to global biodiversity, their implications and potential solutions.
3	Interpret local, regional and global environmental issues
4	Interpret the sustainability concepts; understand the role and responsibility of engineers in sustainable development
5	Quantify sustainability, resource availability and Rationalize the Sustainability based on scientific merits.
6	Apply sustainability concepts in construction practices, designs, product developments and processes across various engineering disciplines

Contents

Part-A

Unit-1 Natural Resources **05 hrs**

Renewable and non-renewable resources: natural resources and associated problems, use and over-utilization of surface and ground water, floods, drought, dam's benefits and problems, growing energy needs, use of alternate energy sources.

Unit-2 Ecosystem and Biodiversity **05 hrs**

Concept of an ecosystem, producers, consumers, decomposers, ecological succession, food chains, food webs and ecological pyramids, biodiversity at global, national and local level, India as a mega diversity nation, threats to biodiversity, conservation of biodiversity.

Unit-3 Environmental Pollution and Social Issues **05 hrs**

Air pollution, water pollution, soil pollution, noise pollution, water conservation, rain water harvesting, resettlement and rehabilitation of people; its problems and concerns, environmental ethics: issues and possible solutions, climate change, global warming, acid rain.

Part-B

Unit-4 Introduction to Sustainability 04 hrs

Need and concept of sustainability, social-environmental and economic sustainability concepts, sustainable development goals.

Unit-5 Technology and Sustainability **04 hrs**

Nexus between technology and sustainable development, challenges for sustainable development, multilateral environmental agreements and protocols - Clean Development Mechanism (CDM)

Unit-6 Sustainable Design 0**7 hrs**

Basic concepts of sustainable habitat, green buildings, green materials & waste material for construction, material selection for sustainable design, green building certification- GRIHA & IGBC certification for buildings, energy efficient building design- passive solar design technique, thermal storage, cooling strategies, high performance insulation. sustainable cities, sustainable transport.

Text Books

1. G. Tyler Miller, Scott E. Spoolman, "Environmental Science", 17th Edition, Brooks/Cole, 2024.
2. D D Mishra, "Fundamental concepts in Environmental Studies", 3rd edition, S Chand & Co Ltd, 2014.
3. a. Kaushik, C. P. Kaushik, "Perspectives in Environmental Studies", 6th edition, New Age International Publishers, 2018.
4. E. Bharucha, "Textbook of Environmental studies" Kindle edition, Universities Press (India) Private Limied, 2019.
5. D. Allen, D. R. Shonnard, "Sustainability Engineering: Concepts, Design and Case Studies", 1st edition, Pearson, 2011
6. B. A. Striebig, A. A. Ogundipe, M. Papadakis, "Engineering applications in sustainable design and development", International edition, CL Engineering, 2015.
7. M. S. Sodha, N. K. Bansal, "Solar Passive Building, Science and Design", 1st edition, Pergamon Press, 1986
8. C. J. Kibert, "Sustainable Construction: Green Building Design and Delivery", 5th edition, Wiley, 2022

Reference Books

1. W. P. Cunningham, M. A. Cunningham, "Principle of Environmental Science", 9th edition, McGraw Hill, 2019 .
2. P. Meenakshi, "Elements of Environment Science & Engineering", 2nd edition, Prentice Hall India Learning Private Limted, 2012.
3. K. N. Duggal, "Elements of Environment Engineering", 3rd edition, S. Chand & Co. Ltd, 1996.
4. K. M. Mackenthun, "Basic Concepts in Environmental Management", 1st edition, CRC Press, 1999.
5. Ni bin Chang , "Systems Analysis for Sustainable Engineering: Theory and Applications", Illustrated edition, MacGraw Hill, 2010.
6. J. Twidell, T. Weir, "Renewable Energy Resources", 3rd edition, Routledge, 2015.
7. ECBC Code 2007, Bureau of Energy Efficiency, New Delhi Bureau of Energy Efficiency Publications-Rating System, TERI Publications - GRIHA Rating System.

Online Learning Materials

1. https://www.youtube.com/watch?v=wNjIJaXaTkQ&t=1446s
2. https://www.youtube.com/watch?v=or-z0Q03pcY
3. https://www.youtube.com/watch?v=or-z0Q03pcY
4. https://www.youtube.com/watch?v=SHxAOoxhKTA
5. https://www.youtube.com/watch?v=B8lTtrjxn2s
6. https://www.youtube.com/watch?v=CA5gxp6rWfA
7. https://www.youtube.com/watch?v=nFBvLIfFFqI

8. https://www.youtube.com/watch?v=MWgyRNtp2Do
9. https://www.youtube.com/watch?v=80JP9SBKGv4
10. https://www.youtube.com/watch?v=kqHeD5yKtoM
11. https://www.youtube.com/watch?v=RoIpCJwX7-M
12. https://www.youtube.com/watch?v=yy3VK6OYBbU
13. https://www.youtube.com/watch?v=1b2VDJbvAtA

Supplementary SWAYAM Course

Sr. No.	Course Name	Instructor	Host Institute	URL
1	Environmental Science	Prof. Sudha Goel and Prof. Shamik Chowdhary	IIT Kharagpur	https://onlinecourses.nptel.ac.in/noc24_hs160/preview
2	Environment and Development	Prof. Ngamjho Kipgen	IIT Guwahati	https://onlinecourses.nptel.ac.in/noc23_hs133/preview
3	Introduction to Environmental Engineering and Science – Fundamental and Sustainability Concept	Prof. Brajesh Kr. Dubey	IIT Kharagpur	https://onlinecourses.nptel.ac.in/noc25_ge17/preview
4	Water, Society and Sustainability	Prof. Jenia Mukherje	IIT Kharagpur	https://elearn.nptel.ac.in/shop/nptel/water-society-and-sustainability/?v=c86ee0d9d7ed
5	Basic Environmental Engineering and Pollution Abatement	Prof. P. Mondal	IIT Roorkee	https://onlinecourses.nptel.ac.in/noc24_ch53/preview
6	Sustainable Materials and Green Buildings	Prof. B.Bhattacharjee	IIT Delhi	https://onlinecourses.nptel.ac.in/noc19_ce40/preview

Course Code: SMME101

Course Title: Seminar and Technical Report Writing for Engineers

Programme: B.Tech.	**L:** 0 **T:** 0 **P:** 1	**Credits:** 1
Semester: 3rd	**Theory/Practical:** Practical	**Teaching Hours:** 26(P) = 26hrs
Total Max. Marks: 50	**Continuous Assessment (CA) Marks:** 50	**End Semester Examination (ESE) Marks:** 00
Minimum Percentage of Numerical / Design / Programming Problems in ESE: Not Applicable		
Duration of End Semester Examination (ESE): NIL		
Course Type: Seminar		

Prerequisites (if any): NIL

Additional Material Allowed in ESE: *NIL*

On completion of the course, the student will have the ability to:

CO#	Course Outcomes
1	Define and agree the purpose of the report and needs of the readers/audience
2	Design a document structure to effectively get the message across
3	Identify the necessary content and have an appropriate layout
4	Use readily available tools to assist with report writing
5	Reference and quote correctly, and not infringe. Know about Intellectual Property Rights
6	Speak and defend technical reports publicly.

Contents

Every Student has to present a seminar on a topic of science and Technology which is relevant to the Branch of Study.

They have to conduct a Power Point Slide Presentation and a prescribed format Report should be submitted to the department.

The credit of the seminar will be distributed among the presentation report, topic content, power point slide preparation, the abstract, skill of presentation, response to the questions, answering methods and to the overall efforts of the student, that are put in towards the successful execution of the seminar.

A seminar presentation is an expert talk of a particular subject matter, which is not directly covered by the curriculum syllabus, but it is relevant to the branch of study, should emphasis to grasp the physics of the problem and underlying fundamentals along with the relevance of the topic and application of subsequent project work.

Hard core sophisticated mathematical models, theories and correlations can be avoided. It can be even a comparative study between existing or non-existing ideas, methods, technologies, or a new practice, new principles of applications, new trends, new observations, measures, or even detailed analysis of an existing practice pros and cons etc.

Suggested Text Books/References:

1. Van Emden J.,"Effective communication for Science and Technology", Palgrave 2001.
2. Van Emden J., "A Handbook of Writing for Engineers",2nd Edition, Macmillan 1998.
3. Van Emden J. and Easteal J.,"Technical Writing and Speaking, an Introduction", McGraw-Hill 1996.
4. Pfeiffer W.S., "Pocket Guide to Technical Writing", Prentice Hall 1998.
5. Eisenberg A., "Effective Technical Communication", McGraw-Hill 1992.

6. Presentation skills: Effective Presentation Delivery (Coursera).
7. Frank Mittelbach , Michel Goossens, Johannes Braams,David Carlisle, Chris Rowley, "The LaTeX Companion (Tools and Techniques for Computer Typesetting)", 2nd Edition,Addison Wesley,2005
8. Stefan Kottwitz, "LaTeX Beginner's Guide",1st Edition PACKT, 2011.
9. Davies J.W., "Communication for Engineering Students", Longman, 1996.

E-Books and online learning material:

1. http://www.sussex.ac.uk/ei/internal/forstudents/engineeringdesign/studyguides/techreport writing.
2. "Introduction to LaTex", http://home.iitk.ac.in/~kalpant/docs/intro_latex.pdf.
3. LaTeX, Wikibook , http://en.wikibooks.org/wiki/LaTeX ,en.wikibooks.org, 2016.

Online Courses and Video Lectures:

1. "Technical Report Writing for engineers", https://www.futurelearn.com/courses/technicalreport writing-for-engineers
2. "Academic and Research Report Writing", https://swayam.gov.in/courses/4635-academic and research-report-writing.

Guru Nanak Dev Engineering College, Ludhiana
An Autonomous College under UGC Act 1956
B. Tech. (Mechanical Engineering)

Course Code: BSME101

Course Title: Mathematics-III

Programme: B.Tech.	**L : 3 T : 1 P : 0**	**Credits:4**
Semester: 4th	**Theory/Practical:** Theory	**TeachingHours:**45(L)+15(T)=60hrs
Total Max.Marks:100	**Continuous Assessment (CA) Marks:** 40	**End Semester Examination(ESE) Marks:** 60
Minimum Percentage of Numerical/Design/Programming Problems inESE:90%		
Duration of End Semester Examination(ESE):3 hours		
Course Type: Core Course		

Prerequisites (if any): BSC102, BSC104.

Additional Material Allowed in ESE: Use of (non-programmable) scientific calculator is allowed

On completion of the course, the student will have the ability to:

CO#	Course Outcomes
1	Analyze the properties of Laplace Transform and apply Laplace transforms to solve ordinary differential equations with initial conditions.
2	Demonstrate the representation of periodic functions using the Fourier series.
3	Solve second-order linear differential equations using power series (Frobenius methods) and define special functions.
4	*Solve* first and second order PDE'S using different methods.
5	*Apply* the Cauchy-Riemann equations to *verify* the analyticity of complex functions and *analyze* their behaviour in the complex plane.
6	*Apply* Cauchy's Integral theorem, Cauchy's Integral formula and residue theorem to evaluate real and complex integrals.

Contents

Part-A

Unit-1LaplaceTransforms **8 hrs**

Definition and existence of Laplace Transforms, Laplace transforms of various standard functions, properties of Laplace transforms, inverse Laplace transforms, transform of derivatives and integrals, Transform of multiplication and division by t, convolution theorem, Laplace transform of unit step function. Applications to solution of ordinary linear differential equations with constant coefficients.

Unit-2FourierSeries **8 hrs**

Introduction, even and odd functions, periodic functions, Dirichlet's conditions for Fourier series, Euler's formulae for Fourier series expansion, change of interval, half range series expansions ,Fourier series of different waveforms.

Unit-3 Special Functions **6 hrs**

Frobenius method for power series solution of differential equations. Bessel's equation; Bessel functions of the first and second kind, recurrence relations, Legendre's equation; Legendre polynomials, generating function.

Part-B

Unit-4 Partial Differential Equations **12 hrs**

Formation of partial differential equations; Equations solvable by direct integration; Linear partial differential equations;solution of Lagrange's Linear equations, homogeneous partial differential equations with constant coefficients. Solution by method of separation of variables. Applications: Wave equation and Heat conduction equation in one dimension.

Unit-5 Complex Variables **11 hrs**

Definition of Limit; continuity; derivative of complex functions and analytic function. Necessary and sufficient conditions for analytic function (without proof); Cauchy-Riemann equation (Cartesian and polar co-ordinates); harmonic functions; orthogonal system; determination of conjugate functions. Millne's Thomson method; Applications to fluid flow problems. complex integration: Line integrals in the complex plane; Cauchy's integral theorem (without proof); Cauchy's integral formula (without proof)for analytic function and its derivatives. Taylor's and Laurent's expansions; singular points; poles; residue; Cauchy's Residue theorem; evaluation of real integrals by contour integration involving a function of sine and cosine functions

Text Books:

1. B.S. Grewal, "Higher Engineering Mathematics" ,44th Edition Khanna Publishers
2. Erwin Kreyzig, " Advanced Engineering Mathematics", 9th Edition Wiley India Pvt Ltd
3. Bali N. P, "Textbook of Engg. Mathematics", Laxmi Publishers, 9th Edition, 2011.

References:

1. Iyengar, T.K.V., B.Krishna Gandhi and S. Ranganatham& M.V.S.S.N. Prasad, "LaplaceTransforms, Numerical Methods & Complex Variables", S. Chand Publishing, 2018.
2. Sreenadh, S, "Fourier Series and Integral Transforms",. New Delhi,India: S Chand. 2014.
3. Dennis G. Zill, Michael R. Cullen, "Advanced Engineering Mathematics", CBS Publishers
4. R.K. Jain and S.R.K.Iyenger, "Advanced Engineering Mathematics", Narosa Publications, New
5. Delhi, 2008.
6. B.V. Ramana, "Higher Engineering Mathematics", 11th Reprint, Tata McGraw-Hill, New Delhi, 2010.
7. Sharma J. N. and Gupta R.K., "Differential Equations", Krishna Prakashan Media, 47th Edition, 2009.

Course Code: CME106

Course Title: Theory of Machines

Programme: B.Tech.	**L: 3 T: 1 P: 2**	**Credits:** 5
Semester: 4th	**Theory/Practical:** Theory	**Teaching Hours:** 45(L)+15(T)+30(P) = 90 hrs
Total Max. Marks: 150	**Continuous Assessment (CA) Marks:** 90	**End Semester Examination (ESE) Marks:** 60
Minimum Percentage of Numerical / Design / Programming Problems in ESE: 70%		
Duration of End Semester Examination (ESE): 3 hours		
Course Type: Core Course		

Prerequisites (if any): NIL

Additional Material Allowed in ESE: Scientific Calculator

On completion of the course, the student will have the ability to:

CO#	Course Outcomes
1	Understanding the basic concept of kinematics and kinetics of machine elements.
2	Evaluate forces and couples applied to the machine elements.
3	Understand the function and application of gears and Evaluate the velocity ratio and torque in different gear trains.
4	Creating and designing of different types of cams.
5	Applying the concept of Static and dynamic balancing of rotating and reciprocating masses.
6	Understand the function of belt drives, brakes and clutches.

Contents

Part-A

Unit-1 Basic Concept of machines: **5 hrs**

Degree of Freedom, Link, Mechanism, Kinematic Pair and Kinematic Chain, Principles of Inversion, Inversion of a Four Bar Chain, Slider-Crank- Chain and Double Slider-Crank-Chain. Grashoff's criterion, Graphical and Analytical methods for finding: Displacement, Velocity, and Acceleration of mechanisms (including Corliolis Components).

Unit-2 Force analysis: **5 hrs**

Introduction, Concept of force and couple, free body diagram, condition of equilibrium, Static equilibrium of mechanisms, methods of static force analysis of simple mechanisms.

Unit-3 Gears and Gear Trains: **8 hrs**

Toothed gears and their applications, types of toothed gears and its terminology. Conditions for correct

gearing, forms of teeth, length of Path of contact, length of arc of contact, contact ratio, involutes and its variants, interference and methods of its removal. Calculation of minimum number of teeth required on pinion and wheel for helical, spiral, bevel, worm gears and involute rack. Center distance for spiral gears and efficiency of spiral gears. Gear Trains: Types of gear trains such as simple, compound and epicyclic.

Part-B

Unit-4 Friction Devices: 6 hrs

Concepts of friction and wear related to bearing and clutches. Types of brakes function of brakes. Belt and Rope Drives : Flat and V-belts, Rope , Idle Pulley, Intermediate or Counter Shaft Pulley, Velocity Ratio, Crowning of Pulley, Loose and fast pulley, stepped or cone pulleys, ratio of tension on tight and slack side of belts, Length of belt, Power transmitted by belts including consideration of Creep and Slip.

Unit-5 Cams: 6 hrs

Types of cams and follower, definitions of terms connected with cams. Displacement, velocity and acceleration diagrams for cam followers. Analytical and Graphical design of cam profiles with various motions (SHM, uniform velocity, uniform acceleration and retardation, cycloidal Motion).Analysis of follower motion for circular, convex and tangent cam profiles.

Unit-6 Balancing: 8 hrs

Necessity of balancing, static and dynamic balancing, balancing of single and multiple rotating masses, partial unbalanced primary force in an engine, balancing of reciprocating masses, partial balancing of locomotives, swaying couple, variation of tractive effort and hammer blow condition of balance in multi cylinder in line and V-engines, concept of direct and reverse crank, balancing of machines, rotors and reversible rotors, two plane balancing of rotor.

Tutorial hours will be used for practice sessions for design/numerical problems/programming/case-studies etc. (as the case may be).

Laboratory Work

Experiment No.	Experiment Title
1	To fabricate various inversions of the kinematic chains.
2	To Draw displacement, velocity & acceleration diagrams of single slider/double slider crank & four bar mechanism by using working models.
3	To determine coefficient of friction for a belt pulley material combination.
4	To Demonstrate various types of gears.
5	To Perform the balancing of rotating masses.
6	To Analyse the profile of a cam with various followers.
7	To Determine gear train value of compound gear trains & epicyclic gear trains.
8	To Draw circumferential & axial pressure profile of journal bearing.
9	To Conduct experiments on various types of governors & to co-relate equilibrium height & speed of the governor.
10	To Determine moment of inertia of a fly wheel.

Text Books:

1. S.S.Rattan, "Theory of Machines", McGraw Hill Publications, 4th Edition, 2014.
2. Sadhu Singh, "Theory of Machines", Pearson Education, 2nd Edition, 2009.
3. Thomas Bevan, "Theory of Machines", CBS Publishers & Distributors, 3rd Edition 2005.
4. Robert L. Norton, "Kinematics and Dynamics of Machinery", Tata McGraw-Hill, 1st Edition
5. 2009.
6. Ghosh A. and Mallick A.K., "Theory of Mechanisms and Machines", Affiliated East West Pvt. Ltd, New Delhi, 3rd Edition 1988.

Reference Books:

1. Joesph E. Shigley, "Theory of Machines", Tata McGraw Hill Publications, 2nd Edition, 2011
2. V.P. Singh, "Theory of Machines", Dhanpat Rai and Sons Publications, 2nd Edition, 2004.
3. W.LCleghorn. , "Mechanisms of Machines", Oxford University Press, CDR Edition, 2005.

Supplementary SWAYAM Course

Sr. No.	Course Name	Instructor	Host Institute	URL
1	Introduction to Theory of Machines	Prof. Anirvan Das Gupta	IIT Kharagpur	https://onlinecourses.nptel.ac.in/noc24_me44/preview
2	Force analysis:	Prof. C. Amarnath	IIT Bombay	https://nptel.ac.in/courses/112101096
3	Gear and Gear Trains	Prof. R.S. Rengasamy	IIT Delhi	https://nptel.ac.in/courses/116102012
4	Friction Devices ,Belt rope and clutches	Prof. R.S. Rengasamy	IIT Delhi	https://nptel.ac.in/courses/116102012
5	CAM	Prof. J. Ram Kumar	IIT Kanpur	https://www.youtube.com/watch?v=Ww7-f5MzSHU
6	Balancing	Prof. Amitabha Ghosh	IIT Kanpur	https://archive.nptel.ac.in/courses/112/104/112104114/

Guru Nanak Dev Engineering College, Ludhiana
An Autonomous College under UGC Act 1956
B. Tech. (Mechanical Engineering)

Course Code: CME107

Course Title: Applied Thermodynamics-II

Programme: B. Tech.	**L: 3 T: 1 P: 2**	**Credits: 5**
Semester:4th	**Theory/Practical:** Theory	**Teaching Hours: 45(L)+15(T)+30(P) = 90 hrs**
Total Max. Marks:150	**Continuous Assessment (CA) Marks:** 90	**End Semester Examination (ESE) Marks:** 60
Minimum Percentage of Numerical/Design/Programming Problems in ESE: 50%		
Duration of End Semester Examination (ESE): 3 hours		
Course Type: Core Course		

Prerequisites (if any): NIL

Additional Material Allowed in ESE: Scientific Calculator, Steam Table/Charts

On completion of the course, the student will have the ability to:

CO#	Course Outcomes
1	Understand various types of steam turbines and analyze various performance parameters.
2	Estimate the amount of cooling water required in a specific type of condenser.
3	Understand working principles and performance parameters of reciprocating and rotary compressors.
4	Understand working principles and performance parameters of centrifugal and axial flow compressors.
5	Conduct thermal analysis of various types of gas turbines and their performance investigation.
6	Understand various types of jet propulsion systems and common propellants.

Contents

Part-A

Unit-1 Steam Turbines **8 Hrs**

Classification of steam turbine, Impulse and Reaction turbines, Staging, Stage and Overall efficiency, Reheat factor, Bleeding, Velocity diagram of simple and compound multistage impulse and reaction turbines and related calculations, work done, efficiencies of reaction, Impulse reaction turbines, state point locus, Losses in steam turbines, Governing of turbines, Comparison with steam engine.

Unit-2 Steam Condensers **5 Hrs**

Function of steam condensers, Elements of condensing unit, Types of condensers, Dalton's law of partial pressures applied to the condenser problems, Condenser and vacuum efficiencies, Cooling water calculations, Effect of air leakage, Method to check and prevent air in filtration, Description of air pump and calculation of its capacity, cooling towers: function, types and their operation.

Unit-3 Reciprocating and rotary compressors **9Hrs**

Introduction, Classification of Air Compressors; Application of compressors and use of compressed air in industry and other places ,Single stage single acting reciprocating compressor (with and without clearance volume): construction, operation, work input and best value of index of compression, heat rejected to cooling medium, isothermal, overall thermal, isentropic, polytrophic, mechanical efficiency, Clearance Volumetric efficiency, Overall volumetric efficiency, effect of various parameters on volumetric efficiency, free air delivery; Multistage compressors: purpose and advantages, construction and operation, work input, heat rejected in intercoolers, minimum work input, optimum pressure ratio; isothermal, overall thermal, isentropic, polytropic and mechanical efficiencies Comparison of rotary positive displacement compressors with reciprocating compressors, like Roots blower and Vane type Blower.

Part-B

Unit-4 Centrifugal & Axial Flow Compressors **9 Hrs**

Complete thermodynamic analysis of centrifugal compressor stage; Polytrophic, isentropic and isothermal efficiencies, Pre-guide vanes and pre-whirl; Slip factor, Degree of Reaction and its derivation; Energy transfer in backward, forward and radial vanes; Pressure coefficient as a function of slip factor, Surging and choking in compressors, Different components of axial flow compressor and their arrangement; Velocity vector; Vector diagrams; Thermodynamic analysis; Work done on the compressor and power calculations, Comparison of axial flow compressor with centrifugal compressor and reaction turbine; Field of application of axial flow compressors.

Unit-5 Gas Turbines **7 Hrs**

Classification and comparison of the Open and Closed cycles; Classification on the basis of combustion (at constant volume or constant pressure); Comparison of gas turbine with a steam turbine and IC engine; Fields of application of gas turbines; Thermodynamics of constant pressure gas turbine cycle (Brayton cycle); Calculation of net output, work ratio and thermal efficiency of ideal and actual cycles; Cycle air rate, temperature ratio; Operating variables and their effects on thermal efficiency and work ratio; Thermal refinements like regeneration, inter- cooling and re- heating and their different combinations in the gas turbine cycle and their effects on gas turbine cycle, Multistage compression and expansion; Dual Turbine system; Series and parallel arrangements; Closed and Semi-closed gas turbine cycle; Requirements of a gas turbine combustion chamber; Blade materials. Gas turbine fuels.

Unit-6 Jet Propulsion **7 Hrs**

Principle of jet propulsion; Description of different types of jet propulsion systems like rockets and thermal jet engines, like (i) Athodyd (ramjet and pulsejet), (ii) Turbojet engine, and (iii) Turboprop engine. Thermodynamics of turbo jet engine components; Development of thrust and methods for its boosting/augmentation; Thrust work and thrust power; Propulsion energy, Propulsion and thermal (internal) efficiencies; Overall thermal efficiency; Specific fuel consumption; Rocket propulsion, its thrust and thrust power; Propulsion and overall thermal efficiency; Types of rocket motors (e.g. solid propellant and liquid propellant systems);Various common propellant combinations (i.e. fuels) used in rocket motors; Advantages and disadvantages of jet propulsion over other propulsion systems; Fields of application of various propulsion units.

Tutorial hours will be used for practice sessions for design/numerical problems/programming/case-studies etc. (as the case may be).

Laboratory Work

Experiment No.	Experiment Title

1	Study of construction and operation of 2 stroke and 4 stroke Petrol and Diesel Engines using actual engines or models.
2	To plot actual valve timing diagram of a 4 stroke petrol and diesel engines and Study its impact on the performance of engine.
3	Study working construction of various boilers (Cochran, Lancashire, Babcock and Wilcox, Benson, Lamont, once through boiler tower type).
4	Study of working and construction of mountings and accessories of various types of boilers.
5	To perform a boiler trial to estimate equivalent evaporation and efficiency of a Fire tube/water tube boiler.
6	Determination of dryness fraction of steam and estimation of brake power, Rankine efficiency, relative efficiency, generator efficiency, and overall efficiency of an impulse steam turbine and to plot a Willian's line.
7	Determine the brake power, indicated power, friction power and mechanical efficiency of a multi cylinder petrol engine running at constant speed (Morse Test).
8	Performance testing of a diesel engine from no load to full load (at constant speed) for a single cylinder/ multi-cylinder engine in terms of brake power, indicated power, mechanical efficiency and specific fuel consumption and to measure the smoke density. Draw/obtain power consumption and exhaust emission curves. Also, make the heat balance sheet.
9	Performance testing of a petrol engine from no load to full load (at constant speed) for a single cylinder/ multi-cylinder engine in terms of brake power, indicated power, mechanical efficiency and specific fuel consumption and to measure the exhaust emissions. Also, draw/obtain power consumption and exhaust emission curves.
10	Study of construction and operation of various types of steam condensers and cooling towers.

Text Books:

1. R.Yadav, "Thermodynamics & Heat Engines", Central Publication House-Allahabad, 2011.
2. Mahesh M Rathor, "Thermal Engineering", McGraw Hill Education-New Delhi, 2010.
3. D.S. Kumar andV.P.Vasandani, "Heat Engineering", S.K.Kataria & Sons; Reprint, 2013.
4. J. S. Rajadurai, "Thermodynamics and Thermal Engineering" New Age International (P) Ltd. Publishers, 1st Edition 2003, Reprint 2015.
5. S.M.Yahya, "Turbines, Compressors and Fans", McGraw Hill Education (India), Chennai,4th Edition,2017.
6. P.L.Ballaney,"Thermal Engineering", Khanna Publishers, New Delhi, 2005.

Reference Books:

1. Jack D.Mattingly, "Elements of Gas Turbine Propulsion", McGraw Hill Education (India), Chennai, 6th Edition, 2013.
2. H.Cohen,G.F.C.Rogers and M.Sarvan,"Gas Turbine Theory",Pearson Education Canada; 5th Edition, 2008.
3. Heinz P.Bloch,"Steam Turbines:Design,Applications,and Re-rating",McGraw-Hill Professional, 2nd Edition,2009. (E-Book available)

Supplementary SWAYAM Course

Sr. No.	**Course Name**	**Instructor**	**Host Institute**	**URL**

1	Steam and Gas Power System	Prof.Ravi Kumar	IIT, Roorkee	https://archive.nptel.ac.in/courses/112/107/112107216/
2	Steam Power Engineering	Prof.Vinayak N.Kulkarni	IIT, Guwahati	https://nptel.ac.in/courses/112103277
3	Aerodynamic Design of Axial Flow Compressors And Fans	Prof.Chetan Kumar Sureshbhai Mistry	IIT, Kharagpur	https://archive.nptel.ac.in/courses/101/105/101105089/
4	Introduction to Aerospace Propulsion	Prof.Bhaskar Roy Prof.A.M. Pardeep	IIT, Bombay	https://archive.nptel.ac.in/courses/101/101/101101001/#

Guru Nanak Dev Engineering College, Ludhiana
An Autonomous College under UGC Act 1956
B. Tech. (Mechanical Engineering)

Course Code: CME108

Course Title: Fluid Mechanics

Programme: B.Tech.	**L: 3 T: 1P: 2**	**Credits:** 5
Semester: 4th	**Theory/Practical:** Theory	**Teaching Hours: 45(L)+15(L) +30(P) =** 90 hrs**.**
Total Max. Marks: 150	**Continuous Assessment (CA) Marks:** 90	**End Semester Examination(ESE) Marks:**60
Minimum Percentage of Numerical / Design / Programming Problems in ESE: 70%		
Duration of End Semester Examination (ESE): 3 hours		
Course Type: Core Course		

Prerequisites (if any): NIL

Additional Material Allowed in ESE: Nil

On completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Acquaint with the properties of fluids, stresses in fluids, and the applications of fluid mechanics.
2	Understand the pressure, hydrostatic forces and buoyancy concept.
3	Analyze problems related to velocity field, acceleration and forces in fluid and body interactions.
4	Use and apply dimensional analysis techniques to various physical fluid phenomena.
5	Evaluate the head loss for different viscous flows in pipe network and determination of drag.
6	Analyze the compressible flow through nozzle/ducts.

Contents

PART-A

Unit-I Fluid and Fluid properties **6 Hrs**

History and importance of fluid mechanics in real life and mechanical engineering, the concept of a Fluid, the Fluid as a continuum, Newton's law of viscosity, thermodynamic properties of a fluid, surface tension and capillarity, vapour pressure and cavitations.

Unit-II Fluid Statics **8 Hrs**

Pressure and pressure gradient, Pascal's law, Equilibrium of fluid element, hydrostatic pressure distribution, Hydrostatic forces on plane and curved surfaces, Buoyancy and floatation stability, pressure distribution in rigid-body motion, Manometry; pressure measurement.

Unit-III Integral and Differential flow analysis **12 Hrs**

Lagrangian and Eulerian description of fluid flow, Acceleration and substantial derivative, Streamlines, Streaklines, Pathlines, compressible and incompressible flow. Reynolds transport theorem, conservation of mass, linear and angular momentum for inertial control volumes, conservation of energy, and Bernoulli's equation. Deformation of fluid element under stresses, differential equations of mass conservation (Cartesian and cylindrical coordinates), differential equations of linear momentum (Euler's and Navier-Stokes equation), the stream function and velocity potential function, vorticity and circulation, free and forced vortex flow, inviscid and irrotational flow; Potential flow.

PART B

Unit- IV Dimensional analysis and similitude **4 Hrs**

Principle of dimensional homogeneity, The Rayleigh and Buckingham-Pi theorem, Dimensionless groups, scaling laws, Model versus Prototype analysis.

Unit-V Viscous flows **10 Hrs**

Reynolds Number Regimes, Laminar and turbulent flow, Hagen-Poiseuille equation, Darcy equation, Effect of rough walls; Moody's chart, hydraulic diameter, Major and minor losses in pipe systems, estimation of head loss for flow through pipes and pipe networks, Orifice and venturi flow meters, notches, hydraulic coefficients. Qualitative description of boundary-layers, Flow separation, Streamlined and bluff bodies, Lift, and drag.

Unit-VI Compressible flow **5 Hrs**

Speed of sound, the Mach cone, stagnation properties, critical conditions, isentropic flows and converging-diverging nozzles, formation of shocks and its types.

Laboratory Work

Sr. No.	Name of Practical
1	To determine the meta-centric height of a floating vessel under loaded and unloaded conditions.
2	To study the flow through a variable area duct and verify Bernoulli's energy equation.
3	To determine the discharge coefficient for a venturi meter.
4	To determine the head loss in a pipe line due to sudden expansion/ sudden contraction/ bend.
5	To determine the discharge coefficient for a V- notch or rectangular notch.
6	To determine the friction coefficients for pipes of different diameters.
7	To determine velocity of flow using Pitot tube apparatus
8	To determine hydraulic coefficients for flow through Orifice.
9	To analyze free and forced vortex flow.

Text Books:

1. D.S.Kumar, "Fluid Mechanics and Fluid Power Engineering", S K Kataria and Sons, 2016.
2. R.K.Bansal, "Fluid Mechanics and Hydraulic Machines", Laxmi Publication, 9th Edition 2010
3. S.K.Som, and G. Biswas, "Introduction to Fluid Mechanics and Fluid Machines", McGraw-Hill, 3rd Edition, 2004
4. F.M.White,"Fluid Mechanics", McGraw-Hill, 9th Edition, New Delhi, 2022.
5. Y.A. Cengel and J.M. Cimbala, "Fluid Mechanics - Fundamentals and Applications", McGraw Hill Publications, 4th Edition, 2019
6. P. K. Kundu, I. M. Cohen, D. R. Dowling, "Fluid Mechanics" Academic Press, 7th Edition, 2024
7. V.L. Streeter, and E.B.Wylie, "Fluid Mechanics", McGraw-Hill, 1983.
8. R.W. Fox, A.T. McDonald, and P.J.Pritchard, "Introduction to Fluid Mechanics", Wiley, 8th Edition, 2011

Reference Books:

1. I.G. Curie, "Fundamentals of Fluid Mechanics", CRC Press; 4th Edition, 2016.
2. G.K.Batchelor, "An Introduction to Fluid Dynamics", Cambridge University Press, 1st Edition, 1973
3. James A.Fay, "Introduction to Fluid Mechanics", Prentice-Hall of India Pvt.Ltd,

Online Material

1. Series of 39 videos on Fluid Mechanics by National Committee for Fluid Mechanics Films (NCFMF). http://web.mit.edu/hml/ncfmf.html

Guru Nanak Dev Engineering College, Ludhiana
An Autonomous College under UGC Act 1956
B. Tech. (Mechanical Engineering)

Course Code: EME101

Course Title: Non-Conventional Energy Resources

Programme: B.Tech.	**L: 4 T:0 P: 0**	**Credits:**4
Semester: 4th	**Theory/Practical:** Theory	**Teaching Hours: (L)=** 60 hrs
Total Max. Marks: 100	**Continuous Assessment (CA) Marks:** 40	**End Semester Examination (ESE) Marks:** 60
Minimum Percentage of Numerical / Design / Programming Problems in ESE: 20%		
Duration of End Semester Examination (ESE): 3 hours		
Course Type: Professional Elective Course		

Prerequisites (if any): NIL

Additional Material Allowed in ESE: NIL

On completion of the course, the student will have the ability to:

CO#	Course Outcomes
1	Know various types of energy resources
2	Design various types of solar collectors and use solar energy applications for different Systems
3	Understand principles of wind energy generation and estimate the power output
4	Know various types of direct energy conversion systems
5	Know types of bio gas generators and their functioning
6	Understand applications of Geothermal, Tidal and wave energy

Contents

Part-A

Unit-1 Introduction: **06 Hrs**

Renewable and non-renewable energy sources; advantages and disadvantages, their availability and growth in India; energy consumption as a measure of Nation's development; strategy for meeting the future energy requirements.

Unit-2 Solar Energy: **12 Hrs**

Solar radiation - beam and diffuse radiation; earth sun angles; attenuation and measurement of solar radiation; Optical properties of materials and selective surfaces; Principles; general description and design procedures of flat Plate and concentrating collectors; Solar energy storage systems - their types; characteristics and capacity; solar ponds. Applications of solar energy in water; space and process heating; solar refrigeration and air conditioning; water desalination and water pumping; solar thermal power generation; solar photovoltaic system; economic analysis of solar systems.

Unit-3 Wind Energy: **12 Hrs**

Principle of wind energy conversion; Basic components of wind energy conversion systems; wind mill components; various types and their constructional features; design considerations of horizontal and vertical axis wind machines: analysis of aerodynamic forces acting on wind mill blades and estimation of power output; wind data and site selection considerations.

Part-B

Unit-4 Direct Energy Conversion Systems: 10 Hrs

Magnetic Hydrodynamic (MHD) Generator: gas conductivity and MHD equations; operating principle; types and working of different MHD systems – their relative merits; MHD materials and production of magnetic fields. Thermo-electric generators: Thermo-electric effects and materials; thermo-electric devices and types of thermo-electric generators; thermo-electric refrigeration. Thermionic generators: thermo- ionic emission and materials; working principle of thermionic convertors. Fuel Cells: thermodynamic aspects; types; components and working of fuel cells. Performance; applications and economic aspects of above mentioned direct energy conversions systems.

Unit-5 Bio-mass: 10 Hrs

Concept of bio-mass conversion; photo-synthesis and bio-gasification; Bio gas generators and plants - their types constructional features and functioning; digesters and their design; Fuel properties of bio gas and community bio gas plants.

Unit-6 Miscellaneous Non-Conventional Energy Systems: 10 Hrs

Geothermal: Sources of geothermal energy-types; constructional features and associated prime movers. Tidal and wave energy: Basic principles and components of tidal and wave energy plants; single basin and double basin tidal power plants; conversion devices. Advantages/disadvantages and applications of above mentioned energy systems.

Text Books

1. H.P.Garg and Jai Prakash, “Solar Energy: Fundamentals and Applications”, Tata McGraw - Hill, 2000.
2. S.P.Sukhatme, “Solar Energy: Principles of Thermal Collection and Storage”, Tata McGraw Hill, 3rd Edition 2008.
3. S. N. Singh, “Non Conventional Energy Sources”, Pearson Education India, 2015.
4. Chang and S.L. Sheldon, “Energy Conversion”, Prentice Hall, 1963, Reprinted in 2015.
5. J.OM. Bockris and S. Srinivasan, “Fuel Cells: Their Electrochemistry”, McGraw Hill, 1969.

Reference Books

1. John A. Duffie and W.A.Beckman, “Solar Engineering of Thermal Processes”, John Wiley, 4th Edition 2013.
2. N.K.Bansal, Manfred Kleeman & Mechael Meliss, “Renewable Energy Sources and Conversion Technology” Tata McGraw Hill. 2004.
3. Freris. L.L , “Wind Energy Conversion Systems” , Prentice Hall, UK, 1st Edition, 1990 .
4. David M Mousdale, “Introduction to Biofuels”, Prentice Hall, UK, 1st Edition, 1990.

Supplementary SWAYAM Course

Sr. No.	Course Name	Instructor	Host Institute	URL
1	Non-conventional energy Resources	Prof. Prathap Haridoss	IIT Madras	https://onlinecourses.nptel.ac.in/noc24_ge24/preview
2	Renewable Energy Engineering: Solar, Wind And Biomass Energy Systems	Prof. Vaibhav Vasant Goud Prof. R. Anandalakshmi	IIT Guwahati	https://www.google.com/url?q=https://onlinecourses.nptel.ac.in/noc24_ch26/preview&sa=D&source=editors&ust=1747130069972838&usg=AOvVaw2EMYDZDs3flqhBseJZ2gUK

3	Renewable Energy Engineering: Solar, Wind And Biomass Energy Systems	Prof. Vaibhav Vasant Goud Prof. R. Anandalakshmi	IIT Guwahati	https://www.google.com/url?q=https://onlinecourses.nptel.ac.in/noc25_ch40/preview&sa=D&source=editors&ust=1747130069972769&usg=AOvVaw3bq631FMxuqam--7rDuhDU

Guru Nanak Dev Engineering College, Ludhiana
An Autonomous College under UGC Act 1956
B. Tech. (Mechanical Engineering)

Course Code: EME102
Course Title: Machining Science

Programme: B. Tech.	**L: 4 T: 0 P: 0**	**Credits: 04**
Semester: 4th	**Theory/ Practical:** Theory	**Teaching Hours: 60(L) + 0 (T) + 0(P)** = 60 Hrs
Total Max. Marks: 100	**Continuous Assessment (CA) Marks :**40	**End Semester Examination (ESE) Marks:** 60
Minimum Percentage of Numerical/Design/Programming in ESE: 20%		
Duration of End Semester Examination (ESE) : 03 Hours		
Course Type: Professional Elective Course		

Pre-requisites: Nil
Additional Material Allowed in ESE: Scientific Calculator

On completion of the course, the student will have the ability to:

CO#	Course Outcome
1	Explain the fundamentals of conventional machining processes, including classifications, applications, and tool geometries
2	Analyze the mechanics of metal cutting, including chip formation, force analysis, and apply measurement techniques using various dynamometers.
3	Evaluate tool wear mechanisms, predict tool life using Taylor's equation, and assess the influence of machining parameters on tool performance.
4	Examine thermal aspects of machining processes, assess temperature generation and its effect on machining, and recommend cutting fluids considering economic and environmental aspects.
5	Assess machinability and estimate machining time for various cutting operations, recommend chip control methods for different processes.
6	Apply principles of machining economics, Optimize machining parameters to minimize cost and maximize production efficiency;

Contents

Part - A

Unit-I Introduction to Machining Processes **08hrs**

Concept of conventional material removal; Classification and applications of machining processes; Surface generation with machining; Tool geometry of single and multi-point cutting tools; Different process parameters in various machining operations.

Unit-2 Mechanics of Metal Cutting& Measurement of Cutting Forces **12hrs**

Formation of Chip in metal cutting and different types of chips; Concept of Orthogonal & Oblique cutting, Merchant Theory for force evaluation in machining, Shear angle relationships; Specific cutting pressure; Velocity relations, Lee and Shaffer theory; need, and basic methods of measuring cutting forces; introduction to dynamometers; working principles and construction of lathe dynamometer, drilling dynamometer and milling dynamometers

Unit-3 Tool Wear and Tool Life **08hrs**

Mechanism and modes of wear, Types of wear in reference to cutting tools; Criteria of tool wear; Measurement of tool wear; Tool life: definition & factors affecting tool life; Taylor's tool life equation; Applications of tool life equation; Role of different machining parameters on tool life.

Part -B

Unit-4 Thermal Aspects of Machining **12hrs**

Causes and location of heat generation in metal cutting operations; Effect of cutting temperature on cutting tool and workpiece; Kinetic coefficient of friction; Stagnant phenomena; Analytical methods of temperature measurement in metal cutting- Average shear plane temperature, Average chip-tool interface temperature; Experimental determination of cutting temperature. Effect of various process parameters on temperature in metal cutting operations; Cutting fluids-types, their selection and method of application; Harmful ecological and health effects of metal cutting fluids; Economical use of metal working fluids.

Unit-5 Machinability **10hrs**

Concept of machinability; Assessment of machinability; Role of various factor on machinability; Estimation of machining time in turning, drilling, boring, milling and shaping operations; Major factor affecting machining time; Process capabilities of different machining processes; Control of Chip and Chip Breakers.

Unit-6 Economics of Machining **10hrs**

Various types of Machining costs; Economy and optimization of machining; Choice of Feed and cutting speed for optimal machining economics; Determination of optimum cutting speed for minimum cost; Maximum production rate and profit rate; introduction to machinability data systems.

Text Books

1. Winston A. Knight, Geoffery Broothroyd, "Fundamentals of Metal Machining & Machine Tools", CRC Taylor & Francis, 2005
2. G.K. Lal, "Introduction to Machining Science", New Age International Ltd., 2007
3. A. B. Chattopadhyay, "Machining and Machine Tools", Wiley India Pvt. Ltd.,2011
4. B.L. Juneja, G.S.Sekhon, "Fundamentals of Metal Cutting and Machine Tools", New Age International Ltd., 2003.
5. A. Bhattacharya, "Metal Cutting Principles", CBS Publishers, 1989.

Reference Books

1. Serope Kalpankjian, Steven R. Sachimid, "Manufacturing Engineering and Technology", Pearson Education, 2001
2. Edward Trent & Paul Wright, "Metal Cutting", Butterworth Heinemann", 2000
3. Milton C. Shaw, "Metal Cutting Principles". Oxford University Press, 2005
4. David A. Stephenson, John S. Agapiou, " Metal Cutting Theory and Practice", CRC Press, 2016
5. P.C.Sharma, "A Textbook of Production Engineering", S Chand and Company, 2019

Guru Nanak Dev Engineering College, Ludhiana
An Autonomous College under UGC Act 1956
B. Tech. (Mechanical Engineering)

Course Code: EME103
Course Title: Computational Methods

Programme: B.Tech.	**L: 4 T: 0 P: 0**	**Credits:** 4
Semester : 4th	**Theory/Practical:** Theory	**Teaching Hours:** 60 Hrs
Total Max. Marks : 100	**Continuous Assessment (CA) Marks:** 40	**End Semester Examination (ESE) Marks:** 60
Minimum Percentage of Numerical/Design/Programming Problems in ESE:80%		
Duration of End Semester Examination (ESE) :3hours		
Course Type: Professional Elective Course		

On completion of the course, the student will have the ability to:

CO#	Course Outcomes
1	Understand and quantify errors in numerical calculations, including floating-point representation.
2	Apply numerical methods such as Bisection, Newton-Raphson, and Secant to solve algebraic and transcendental equations.
3	Utilize interpolation techniques like Newton's and Lagrange's formulas for both evenly and unevenly spaced data.
4	Implement numerical differentiation and integration methods, including Newton-Cote's formulas and Simpson's rules.
5	Solve systems of linear equations using methods like Gauss elimination, LU decomposition, and iterative techniques.
6	Apply numerical methods to solve ordinary and partial differential equations, including Runge-Kutta and finite difference methods.

Contents

Part-A

Unit-1 Errors in Numerical Calculations **06hrs**
Errors and their analysis, general error formula, errors in a series approximation, floating point representation of numbers

Unit-2 Solution of Algebraic and Transcendental Equations **10hrs**
Bisection method, Fixed point iteration method, Method of false position, Newton-Raphson method, Secent method.

Unit-3 Interpolation Method **12 hrs**
Finite difference, forward, backward and central difference, Difference of a polynomial, Newton's formulae for interpolation, central difference interpolation formulae, Interpolation with unevenly spaced points, Newton's general interpolation formula, interpolation by iteration.

Part-B

Unit-4 Numerical Differentiation and Integration **10 hrs**
Numerical differentiation: formulae for derivatives, maxima and minima of a tabulated function, errors in numerical differentiation. Numerical Integration: Newton-cote's integration formula, trapezoidal rule, Simpson's one-third rule, Simpson's three eighth rule.

Unit-5 Solution of Linear Systems of Equations **10 hrs**

Gauss elimination, Gauss Jordan, LU Decomposition, Gauss Seidal, iteration method, Jacobi's method, Eigen value problems (Power method only).

Unit-6 Numerical solution of ordinary and partial differential equations 12 hrs

Initial value and Boundary value problems, Picard's method, Euler's and modified Euler's method, Solution by Taylor's series, Predictor –corrector method, Runge-Kutta method of order two and order four, finite difference method to derivatives. PDE- classification of PDE, Elliptic equation, Parabolic equations, Hyperbolic Equations, Solutions of Parabolic and Elliptic equations using iterative methods.

Text Books

1. Steven C. Chapra, "Applied Numerical Methods with MATLAB for Engineers and Scientists", McGraw Hill.Dr.
2. S. Grewal, "Numerical Methods in engineering and science", Khanna Publishers.
3. M.K. Jain, S.R.K. Iyengar and R.K. Jain, "Numerical Methods for Scientific and Engineering Computation", New age International Publishers.
4. S. S. Sastry, "Introductory methods of numerical analysis", Prentice Hall of India.
5. Dukkipati, Rao V., "Numerical Methods", New Age International (P) Ltd., Publishers.

Reference Books

1. Joe D. Hoffman, "Numerical Methods for Engineers and Scientists" , CRC Pr I Llc
2. Rao, Singiresu S., "Applied Numerical Methods for Engineers and Scientists", Pearson College Div.
3. Kendall E. Atkinson , "An Introduction to Numerical Analysis", John Wiley & Sons.

Guru Nanak Dev Engineering College, Ludhiana
An Autonomous College under UGC Act 1956
B. Tech. (Mechanical Engineering)

Course Code: CME109
Course Title: Design of Machine Elements

Programme: B.Tech.	L: 3 T: 1 P: 0	Credits: 4
Semester: 5th	Theory/ Practical: Theory	Teaching Hours: 45(L)+15(T) =60 Hrs
Total Max. Marks: 100	Continuous Assessment (CA) Marks: 40	End Semester Examination (ESE) Marks: 60
Minimum Percentage of Numerical / Design / Programming Problems in ESE: 80%		
Duration of End Semester Examination (ESE): 3 hours		
Course Type: Core Course		

Prerequisites (if any): NIL
Additional Material Allowed in ESE: Scientific Calculator, Design data book.

On completion of the course, the student will have the ability to:

CO#	Course Outcomes
1	Understand various types of design and criteria for selection of materials for different applications.
2	Apply various design considerations like stress concentration factor and factor of safety.
3	Understand various basic machine components under different loading conditions.
4	Analyze the fastening processes like bolting, welding, riveting etc. for different applications.
5	Evaluate machine members like transmission drives, levers, shafts, axles, keys, coupling and cotters etc. as per different requirements in the industry.
6	Create the design and suggest/apply suitable modifications in the design

Contents

Part-A

Unit I- Introduction **05 Hrs**

Meaning of design with special reference to machine design; Definition and understanding of various types of design; Design process; Design and Creativity; General Design Considerations; Concept of - tearing, bearing, shearing, crushing, bending and fracture; Designation of materials according to Indian standards code number 1570 (Part II/Sec I)-1979 (Reaffirmed 1991); Basic criteria for selection of materials; Mechanical properties of materials.

Unit II- Design Considerations **09 Hrs**

Concept of concurrent engineering in design; Manufacturing and Ergonomic considerations in Machine Design; Stress concentration; Factor of Safety under different loading conditions; Design for static loading; Design for variable loading for both limited and unlimited life; Concept of Fatigue and Endurance Strength.

Unit III- Keys and Couplings **07 Hrs**

Design of keys; Design of splines; Design of sleeve and solid muff coupling, clamp or compression coupling, rigid and flexible flange coupling; Design of universal joint.

Part-B

Unit IV-Design of Fasteners **08 Hrs**

Design of rivets for boiler joints, lozenge joints; Design of - spigot and socket cotter joint, gib and cotter joint, knuckle joint; Design of welded joints for various loading conditions such as torsion, shear, direct loading.

Unit V-Design of Transmission drives **10 Hrs**

Design of - flat belt, wire rope, chain, spur gear drive and flywheel; Design of single plate clutch; Design of solid and hollow shafts for transmission of torque, bending moment & axial forces; Design of shaft for rigidity.

Unit VI- Design of Levers **06 Hrs**

Design of foot lever, hand lever, cranked lever and safety valve lever.

Text Books

1. Joseph E. Shigley, Mischke Charles Russell, Richard Gordon Budynas, "Mechanical Engineering Design", McGraw-Hill, 8th Edition, 2006.
2. R. S. Khurmi, J. K. Gupta, "Machine Design", S.Chand and Co.,1st Multicolor Edition , 2014
3. Robert C. Juvinall, "Fundamentals of machine component design", John Wiley & Sons, 3 rd Edition, 2003.
4. P.C. Sharma, D. K. Aggarwal, "Machine Design", S. K. Kataria and Sons, 9th Edition, 1999.
5. V. B. Bhandari, "Design of Machine elements", Tata McGraw Hill, 3rd Edition, 2010.

Reference Books

1. Jack A. Collins, Henry R. Busby, George H. Staab, "Mechanical Design of Machine Elements and Machines", John Wiley & Sons, 2009.
2. T. Krishna Rao, "Design of Machine Elements: Volume II", I. K. International Pvt Ltd, 2010.
3. Peter R.N. Childs, "Mechanical Design Engineering Handbook", Elsevier Ltd., 2nd Edition, 2019.

Supplementary SWAYAM Course:

S. No.	Course Name	Instructor	Host Institute	URL
1	Design Practice	Prof. Shantanu Bhattacharya	IIT Kanpur	https://onlinecourses.nptel.ac.in/noc26_me46/preview
2	Design Practices for Intelligent Product Design	Prof. Bishakh Bhattacharya	IIT Kanpur	https://onlinecourses.nptel.ac.in/noc26_de11/preview
3	Design of Mechanical Transmission Systems	Prof. Ramkumar P	IIT, Madras	https://onlinecourses.nptel.ac.in/noc26_me62/preview
4	Design, Technology and Innovation	Prof. B.K. Chakravarthy	IIT Bombay	https://onlinecourses.nptel.ac.in/noc26_de09/preview
5	Experimental Stress Analysis	Prof. K. Ramesh, Dr. Tarkes Dora Pallicity	IIT Madras, IIT Guwahati	https://onlinecourses.nptel.ac.in/noc26_me14/preview
6	Product Engineering and Design Thinking	Prof. Pranab K Dan, Prof. Prabir Sarkar	IIT Kharagpur, IIT Ropar	https://onlinecourses.nptel.ac.in/noc26_me57/preview
7	Innovation by Design	Prof. B.K. Chakravarthy	IIT Bombay	https://onlinecourses.nptel.ac.in/noc26_de08/preview

Topics for Self Learning (TSL)

1. Material treatments & Failure Theories
2. Design of springs and bearings
3. Limits, Fits and use of international standards like ASME, ISO etc.
4. Use of FEA, composites, design optimization

Course Code: CME110
Course Title: Heat Transfer

Programme: B.Tech.	**L: 3 T: 1 P: 2**	**Credits: 5**
Semester: 5TH	**Theory/Practical: Theory**	**Teaching Hours: 45(L)+15(T)+30(P) = 90 Hrs.**
Total Max. Marks: 150	**Continuous Assessment (CA) Marks: 90**	**End Semester Examination (ESE) Marks: 60**
Minimum Percentage of Numerical / Design / Programming Problems in ESE: 50%		
Duration of End Semester Examination (ESE): 3 hours		
Course Type: Core Course		

Prerequisites (if any): NIL
Additional Material Allowed in ESE: Scientific Calculator

On completion of the course, the student will have the ability to:

CO#	Course Outcomes
1	Recognize the predominant mode of heat transfer in various engineering applications.
2	Analyze the various heat transfer problems (mainly one dimensional under steady state condition) using basic laws of heat transfer and electrical analogy.
3	Develop mathematical relations to solve heat transfer problems.
4	Select and design the fins for various engineering applications.
5	Apply the basic laws of radiation and electrical network analysis to solve radiative heat exchange problems.
6	Design the heat exchangers by using the concept of conductive and convective (simple and phase change) heat transfer phenomenon.

Contents

Part-A

Unit-1 Introduction and Mechanism of Heat Flow **06 Hrs.**

Concept of heat transfer; Difference between the Course of "Heat Transfer" and its parent Course "Thermodynamics"; Different modes of heat transfer – Conduction; Convection and Radiation. Fourier's law of heat conduction; Coefficient of thermal conductivity; Effect of temperature and pressure on thermal conductivity of solids, liquids and gases

Unit-2 Conductive Heat Transfer **10 Hrs.**

Three dimensional general conduction equations in rectangular, cylindrical and spherical coordinates; Deduction of one dimensional steady state heat conduction equation in rectangular; cylindrical and spherical coordinates with and without internal heat generation for uniform thermal conductivity of material; Concept of variable thermal conductivity; Electrical network analysis for heat transfer through composite/multilayer material. Concept of equivalent area; Conduction shape factor; Conduction through edges and corners of walls; Critical thickness of insulation layers on electric wires and pipes carrying hot fluids; Introduction to unsteady heat transfer; Newtonian heating and cooling of solids; Physical significance of thermal diffusivity.

Unit-3 Heat Transfer from Extended Surfaces **08 Hrs.**

Concept of fin; Classification of fins and their applications; Straight fins of uniform cross-section; Straight fins with varying cross-sectional area (triangular profile only); Fin performance: fin effectiveness; fin efficiency; total fin effectiveness and total fin efficiency.

Part-B

Unit-4 Convective Heat Transfer **09 Hrs.**

Free and forced convection; Derivation of three-dimensional mass, momentum and energy conservation equations (Vector and Tensor form); Boundary layer formation: laminar and turbulent boundary layers (no derivation); Determination of heat transfer coefficient for free and forced convection by dimensional analysis method; Physical significance of dimensionless numbers related to convective heat transfer; Newton's law of cooling; Overall coefficient of heat transfer; Different design criterion for heat exchangers; Log mean temperature difference (LMTD) for parallel and counter flow heat exchangers; Calculation of length and number of tubes in a heat exchanger using LMTD and effectiveness-NTU method.

Unit-5 Boiling and Condensation **06 Hrs.**

Boiling: definition and types of boiling, different regimes and heat transfer during pool boiling of a liquid, nucleation and different theories accounting for increased h.t.c. during nucleate phase of boiling; Condensation: definition and types of condensation, film wise condensation on a vertical and inclined surface..

Unit-6 Radiative Heat Transfer **06 Hrs.**

Process of heat flow due to radiation; Definition of emissivity, absorptivity, reflectivity and transmissivity; Concept of black and grey bodies; Plank's law of non chromatic radiation; Wien's displacement law; Kirchoff's law; Stefan Boltzmann's law; Lambert's Cosine law; Definition of intensity of Radiation (only), irradiation, radiation density and radiosity; Geometric/ configuration factor and its use in heat exchange between two black bodies; Electrical network analysis for radiation exchange between two, three or four bodies (e.g. boiler or other furnaces); simplification of electrical network analysis for its application to simple bodies like two parallel surfaces, concentric cylinders/spheres and a body enveloped by another body etc.; Use of radiation shields.

Text Books

1. Incropera F.P. and De Witt D.P., "Fundamentals of Heat and Mass transfer", John Wiley, 7th Edition, 2011.
2. Cengel, A. Yunus, "Heat and Mass Transfer", Tata McGraw Hills Education Private Ltd, 4th Edition, 2013.
3. Kumar, D.S. "Fundamentals of Heat and Mass Transfer", S K Kataria & Sons, 7th Edition, 2013.
4. Chapman. A. J, "Heat Transfer", McGraw Hill, 7th Edition, 1990.
5. Holman, J.P. "Heat Transfer", Tata McGraw-Hill Publishing Company Ltd, 9th Edition, 2008

Reference Books

1. Warren M. Rohsenow, James P. Hartnett and Young I. Cho, "Handbook of Heat Transfer" Tata McGraw-Hill Publishing Company Ltd, 3rd Edition, 1998
2. R.C. Sachdeva, "Fundamentals of Engineering Heat & Mass transfer", New Age International Publishers, 2009
3. P.K. Nag, "Heat Transfer", Tata McGraw Hill, New Delhi, 2002.

Supplementary SWAYAM Course

Sr. No.	Course Name	Instructor	Host Institute	URL

1	Heat Transfer	Prof. Ganesh Viswanathan	IIT Bombay	https://onlinecourses.nptel.ac.in/noc26_ch10/preview
2	Conduction And Convection Heat Transfer	Prof. Suman Chakraborty, Prof. Sankar Kumar Som	IIT Kharagpur	https://onlinecourses.nptel.ac.in/noc26_me53/preview
3	Two Phase Flow and Heat Transfer	By Prof. Arup Kumar Das	IIT Roorkee	https://onlinecourses.nptel.ac.in/noc26_me85/preview

Laboratory Work

Sr. No.	Experiment Title
1	Determination of thermal conductivity of: - A solid insulating material by slab method. - Powder materials by concentric spheres method / or by some transient heat transfer technique. - a metal by comparison with another metal by employing two bars when kept in series and / or in parallel under different boundary conditions. - Liquids by employing thin layer
2	Determination of coefficient of heat transfer for free/forced convection from the surface of a cylinder / plate when kept: a) Along the direction of flow b) perpendicular to the direction of flow c) Inclined at an angle to the direction of flow
3	Plotting of the pool boiling curves for water and to determine its critical point.
4	Determination of heat transfer coefficient for film wise condensation drop-wise condensation
5	Determination of heat transfer coefficient by radiation and hence find the Stefan Boltzmann's constant using two plates/two cylinders of same size by making one of the plates/cylinders as a black body.
6	Plotting of the temperature profile and determination of fin effectiveness and fin efficiency for A rod fin when its tip surface is superimposed by different boundary condition like. a) Insulated tip b) Cooled tip c) Temperature controlled tip Straight triangular fins of various sizes and optimization of fin proportions Circumferential fins of rectangular/triangular section
7	To show that the illuminance of a surface is inversely proportional to the square of the distance of the surface from the light source.
8	Demonstrate the effect of flow rate variation on the performance characteristic of a concentric tube heat exchanger operating under parallel & counter flow conditions.

Guru Nanak Dev Engineering College, Ludhiana
An Autonomous College under UGC Act 1956
B. Tech. (Mechanical Engineering)

Course Code: CME111

Course Title: Mechanical Measurements and Control

Programme: B.Tech.	**L: 3 T: 0 P: 2**	**Credits: 4**
Semester: 5TH	**Theory/Practical: Theory**	**Teaching Hours: 45(L)+30(P) = 75 hrs**
Total Max. Marks: 150	**Continuous Assessment (CA) Marks: 90**	**End Semester Examination (ESE) Marks: 60**
Minimum Percentage of Numerical / Design / Programming Problems in ESE: 20%		
Duration of End Semester Examination (ESE): 3 hours		
Course Type: Core Course		

Prerequisites (if any): NIL
Additional Material Allowed in ESE: Scientific Calculator

On completion of the course, the student will have the ability to:

CO#	Course Outcomes
1	Understand the concept of measurements, their standards, and characteristics of measuri instrument and evaluate various errors in measuring systems by using statistical methods.
2	Students will comprehend metrology fundamentals, techniques and instruments for differ mechanical measurements.
3	Understand the function of sensors, transducers, amplifiers, filters, etc. in measurement instruments
4	Use the instruments for measurements of pressure, flow, temperature etc. in manufacturing or proc industry.
5	Students will be able to measure speed, force, power etc. in different fields of mechani engineering.
6	Analyze various control systems.

Contents

Part-A

Unit-1 Fundamentals of Measurement Systems **10 Hrs**

Requirement and classification of measurements and instruments Methods of measurement; Mechanical versus Electrical /Electronic instrument; Measuring Standards- primary, secondary and working standards, Generalized measurement system components, Static and Dynamic characteristics of Instruments - range and span, accuracy and precision, hysteresis, dead zone, dead time sensitivity and linearity, threshold and resolution, speed of response, lag, fidelity and dynamic error; Zero order system, First order systems. Types and sources of errors, error propagation, Calibration, Statistical analysis of test data in measurement including mean, median, standard deviation, probability distribution and use of probability tables.

Unit-2 Metrology and Instrumentation **08 Hrs**

Meaning and Objectives of metrology, Standards of measurements; Instruments and techniques for linear and angular measurements- their types, relative merits and limitations, ; concept and measurement of straightness and flatness by interferometry, Measurement of major diameter, minor diameter, effective diameter, pitch, angle and form of threads for internal and external threads; measurement of tooth thickness, pitch and checking of profile for spur gears, Surface roughness - specifications and measurement, comparators - their types, relative merits and limitations.

Unit-3 Basic and Auxiliary Functional Elements **06 Hrs**

Introduction to sensors and transducers, types of sensors and transducers, electro-mechanical sensors and transducers - variable resistance, inductance and capacitive pick-ups, photo cells and piezoelectric

transducers and application of these elements for measurement of position / displacement, speed / velocity / acceleration, force and liquid level. Resistance strain gauges, gauge factor, bonded and unbounded gauges, surface preparation and bonding technique, types of amplifiers with their relative advantages and disadvantages, Filters and their classification, and methods of signal transmission.

Part-B

Unit-4 Temperature, Pressure and Flow Measurement **10 Hrs**

Thermal expansion methods - bimetallic thermometers, liquid-in-glass thermometer and filled-in system thermometers; thermo-electric sensors - common thermo couples, reference junction considerations; metal resistance thermometers and thermistors; optical and total radiation pyrometers; Bourdon tube, diaphragm and bellows, vacuum measurement - McLeod gauge, thermal conductivity gauge and ionization gauge; Dead weight gauge tester. Electromagnetic flux meters, ultra-sonic flow meters and hot wire anemometer: flow visualization techniques

Unit-5 Force, Torque and Power Measurements **03 Hrs**

Mechanical tachometers, vibration reed tachometer and stroboscope; proving ring, hydraulic and pneumatic load cells, torque on rotating shafts; Absorption, transmission and driving dynamo meters.

Unit-6 Control systems **08 Hrs**

Introduction to control systems, Classification of control systems - open loop and closed loop control system, Automatic control systems; Properties of the transfer function, Representation of control components and systems; Regulator, Servo mechanism, Analogous systems; Block diagram; Signal flow graph; Time response of control system; Stability; Frequency response; Error detector; LVDT; Servo amplifier; Sample data systems; Industrial controllers; Pneumatic control systems, Hydraulic control system.

Text Books

1. Beckwith, Marangoni, Lienhard, “Mechanical Measurements”, PHI Learning Pvt. Ltd., 6th Edition, 2007.
2. D.S. Kumar, “Measurement Systems: Application and Design”, S.K. Kataria & Sons, 2nd Edition, 2012.
3. Sawhney, “A Course in Mechanical Measurements and Instrumentation”, Dhanpat Rai & Co., 10th Edition, 2015.
4. R.K. Jain, “Mechanical and Industrial Measurements”, Khanna Publishers, 11th Edition, 2010.
5. A.K. Tayal, “Instrumentation and Mechanical Measurements”, Galgotia Publications, 3rd Edition, 2011.

Reference Books

1. Holman, “Experimental Methods for Engineers”, McGraw-Hill Education, 8th Edition, 2011.
2. Doebelin, “Measurement Systems: Application and Design”, McGraw-Hill, 5th Edition, 2004.
3. Figliola and Beasley, “Theory and Design for Mechanical Measurements”, Wiley, 6th Edition, 2015.
4. Morris, “The Essence of Measurement”, Prentice Hall, 1st Edition, 1997.

Supplementary SWAYAM & NPTEL Courses

Sr. No.	Course Name	Instructor	Host Institute	URL
1	Mechanical Measurement Systems	By Prof. Ravi Kumar	IIT Roorkee	https://onlinecourses.nptel.ac.in/noc26_me80/preview
2	Advanced Measurement Techniques in Fluid Mechanics and Heat Transfer	By Prof. Saptarshi Basu	IISc Bangalore	https://onlinecourses.nptel.ac.in/noc26_me04/preview

Laboratory Work

Sr. No.	Experiment Name
1	Measurement of angle with the help of sine bar
2	To measure the displacement using a linear variable differential transformer (LVDT).
3	To calibrate a strain gauge.
4	Measurement of flatness of a surface using autocollimator.
5	Measurement of effective diameter of external threads using three wire method.
6	Calibration of a pressure gauge with the help of a dead weight gauge tester.

Guru Nanak Dev Engineering College, Ludhiana
An Autonomous College under UGC Act 1956
B. Tech. (Mechanical Engineering)

Course Code: CME112

Course Title: Industrial Automation & Robotics

Programme: B.Tech.	**L: 3 T: 0 P: 2**	**Credits: 4**
Semester: 5TH	**Theory/Practical: Theory**	**Teaching Hours: 45(L)+30(P) = 75 Hrs.**
Total Max. Marks: 150	**Continuous Assessment (CA) Marks: 90**	**End Semester Examination (ESE) Marks: 60**
Minimum Percentage of Numerical / Design / Programming Problems in ESE: 10%		
Duration of End Semester Examination (ESE): 3 hours		
Course Type: Core Course		

Prerequisites (if any): NIL
Additional Material Allowed in ESE: Scientific Calculator

On completion of the course, the student will have the ability to:

CO#	Course Outcomes
1	Understand the concept, need and application of hard automation, soft automation and their advantages.
2	Use the hydraulic and pneumatic valves and cylinders for their application in automation.
3	Design the pneumatic and hydraulic circuits for industrial automation applications.
4	Analyze the working of fluidic sensors for industrial applications.
5	Understand the working of various transfer devices and feeders in manufacturing industry.
6	Create a programme of robotic arm for industrial application.

Contents

Part-A

Unit-1 Introduction & Fluid Power **12 Hrs.**

Concept and scope of automation; Socio-economic impacts of automation; Types of automation; Low cost automation. Fluid power control elements; Standard graphical symbols; Hydraulic and pneumatic cylinders- Construction; Design and Mounting; Hydraulic and pneumatic Valves for pressure; Flow and direction control.

Unit-2 Basic hydraulic and pneumatic circuits **08 Hrs.**

Direct and indirect control of single and double acting cylinders; Designing of logic circuits for a given time displacement diagram & sequence of operations; Design of simple hydraulic and pneumatic circuits using - time delay valve, quick exhaust valve etc.; Speed control of a cylinder; Trouble shooting - causes & effects of malfunctions; Designation of specific elements in a circuit; Different types of sensors for hydraulic, pneumatic & electro-pneumatic systems.

Unit-3 Fluidics **06 Hrs.**

Boolean algebra, commutative law and distributive law; Truth tables and logic gates- AND gate, OR gate, XOR gate, NAND gate, NOR gate, NOT gate, XNOR gate; Fluidic devices; Coanda effect; Fluidic sensors and fluidic amplifiers - Construction; Working and Applications.

Part-B

Unit-4 Electrical and Electronic Controls **06 Hrs.**

Basics of programmable logic controllers (PLC) architecture and components of PLC; Ladder logic diagrams. Microprocessor – Introduction, structure of micro-controller.

Unit-5 Manufacturing system and material handling technologies **07 Hrs.**

Technologies enabling Industry 4.0: Introduction and overview of Internet of Things; Automated production lines and their applications; Group technology; Flexible manufacturing system; Automated assembly systems; Classification, constructional details and applications of Transfer devices; Vibratory bowl feeders; reciprocating tube; Centrifugal hopper feeders. Compelling Forces and Challenges for Industry 4.0.

Unit-6 Robotics **06 Hrs.**

Introduction, Classification based on geometry; control and path movement; End effectors – types and applications; Robot specifications, robot performance parameters, robot programming; Machine vision; teach pendants; industrial applications of robots for material transfer, machine loading and unloading, welding, assembly and spray painting operations.

Text Books

1. Mikell P. Groover, "Industrial Robotics", McGraw- Hill, 4th Edition, 2008.
2. S. R. Majumdar, "Pneumatic Control", Tata McGraw- Hill, 1stEdition, 2004.
3. Craig John, "Introduction to Robotics: Mechanics & Control", Prentice Hall of India, 3rd Ed 2007.
4. S. R. Deb, "Robotic Technology and Flexible Automation", McGraw Hill, 2nd Edition, 2010.
5. W. Bolton, "Mechatronics", Pearson Education, 4th Edition, 2011.

Reference Books

1. M. P. Groover, "Automation, Production Systems and Computer Integrated Manufacturing", Pearson Education, 5th Ed., 2009.
2. Mikell. P. Groover, "Industrial Robotics Technology, Programming and Applications", McGraw Hill Co, 1995.
3. J. J. Craig, "Introduction to Robotics, Mechanics and Control", Pearson Education, 3rd Edition, 2004.
4. K. S. Fu., R. C. Gonzalez and C. S. G. Lee, "Robotics Control, Sensing, Vision and Intelligence", McGraw Hill Book Co., 1987.

Supplementary SWAYAM Course

Sr. No.	Course Name	Instructor	Host Institute	URL
1	Automation in Manufacturing	Prof. Shrikrishna N. Joshi	IIT Guwahati	https://onlinecourses.nptel.ac.in/noc22_me123/preview
2	Oil Hydraulics and Pneumatics	Prof. Somashekhar S	IIT Madras	https://onlinecourses.nptel.ac.in/noc24_me55/preview
3	Robotics	Prof. Dilip Kumar Pratihar	IIT Kharagpur	https://onlinecourses.nptel.ac.in/noc21_me76/preview

Laboratory Work

Sr. No.	Experiment Title
1	Demonstration of different types of hydraulic valves, pneumatic valves and cylinders with their symbols.
2	Actuation of double acting cylinder by using hydraulic and pneumatic circuits.
3	Automating the cylinder sequence A+B+B-A- by using electro Pneumatic and PLC.
4	Demonstrate the working of power steering mechanism.
5	Use of direction control valve and pressure control valves in the design of clamping devices for jigs and fixture.
6	Demonstrate the working of robotic arm and its end effectors.

7	Analysis of basic hydraulic and pneumatic, electro pneumatic circuits using simulation software.
8	Automation system for pick & place, and Sorting of Objects on Conveyor Belt using PLC.

Guru Nanak Dev Engineering College, Ludhiana
An Autonomous College under UGC Act 1956
B. Tech. (Mechanical Engineering)

Course Code: EME104

Course Title: Power Plant Engineering

Programme: B.Tech.(ME)	**L: 4 T:0 P:0**	**Credits:4**
Semester:5th	**Theory/Practical: Theory**	**Teaching Hours: L(60) =60 Hrs.**
Total Max.Marks:100	**Continuous Assessment (CA) Marks: 40**	**End Semester Examination (ESE) Marks: 60**
Minimum Percentage of Numerical/Design/Programming Problems in ESE:10%		
Duration of End Semester Examination (ESE):3hours		
Course Type: Elective Course		

Prerequisites (if any): NIL
Additional Material Allowed in ESE: Scientific Calculator

On completion of the course, the student will have the ability to:

CO#	Course Outcomes
1	Understand energy sources for power generation and principles types of power plants.
2	Understand about essential features and types of hydro-electric and nuclear power plant.
3	Understand about essential features of steam power plant and also have knowledge about coal and ash handling systems.
4	Understand the working of I.C engines and able to compare its performance with other plants.
5	Conceptualize understanding of load factor, capacity factor, average load and peak load on power plant.
6	Understand different direct energy conversion systems.

Contents

Part-A

Unit-1. Introduction **05 hrs**
Energy sources for generation of electric power, Principles types of power plants-their special features and applications, Present status and future trends.

Unit-2. Hydro-Electric Power Plants **10 hrs**
Hydrograph, Flow duration curve, Essential features, layout of hydro Power Plant, Classifications, Hydroelectric survey, rainfall run-off, storage capacity, Site selection.

Unit-3. Steam Power Plant **10 hrs**
General Introduction, Essential features, Site Selection, Coal handling, feeding and burning, Fluidized bed combustion, Ash handling, dust collection, High pressure boilers, Economizers, Super heaters, Air pre heaters.

Part-B

Unit-4. Diesel and Gas Turbine Power Plants **10 hrs**
Classification of IC engines, four stroke and two stroke diesel engines, Combustion phenomenon, Electronic fuel injection, Supercharging and Turbocharging, Plant layout, Comparison with steam power plants.

Unit-5. Nuclear Power Plant **10 hrs**

Nuclear fuels, nuclear energy, nuclear reactions, Main components of nuclear power plant, nuclear reactors- PWR, CANDU, Breeder reactor, Gas cooled reactor, and applications, Site selection, radioactive waste disposal, Safety aspects, Reactor shutdown system, Future of Nuclear power.

Unit-6. Power Plant Economics **15 hrs**

Terms and conditions, Effect of load on power plant design, methods to meet variable load, prediction of load. Non-Conventional Power Generation, Biomass Energy, Geothermal power plants, Tidal power plants, Wind power plants, solar power plants, Electricity from city refuge. Direct Energy Conversion Systems: Thermoelectric conversion system, Photo voltaic power system, Fuel Cells, Magneto-hydrodynamic system.

Text Books

1. P.K. Nag, "*Power Plant Engineering",* Tata McGraw Hill, 2nd Edition, 2002.
2. G.R. Nagpal*, "Power Plant Engineering",* Khanna Publishers, 16th Edition, 2013.
3. S.C. Arora, S. Domkundwar*, "Power Plant Engineering",* Dhanpat Rai, 6th Edition, 2013.

Reference Books

1. R.K. Rajput, *"Power Plant Engineering",* Luxmi Publications, 4th Edition, 2008.
2. P.C Sharma, *"Power Plant Engineering",* Kataria & Sons, 1st Re-print 2016.

Supplementary SWAYAM Course

Sr. No.	Course Name	Instructor	Host Institute	URL
1	**Power Plant System Engineering**	**Prof. Niranjan Sahoo**	**IIT Guwahati**	**https://nptel.ac.in/courses/112103421**

Topics for Self-Learning (TSL)

Sr. No	Topics
1	Fertile Materials and Binding energy
2	Types of Solar Collectors
3	Comparison of Diesel with Nuclear Power Plant
4	Thermionic Conversion System

Guru Nanak Dev Engineering College, Ludhiana
An Autonomous College under UGC Act 1956
B. Tech. (Mechanical Engineering)

Course Code: EME105

Course Title: Automobile Engineering

Programme: B.Tech.	**L: 4 T: 0 P: 0**	**Credits: 4**
Semester: 5th	**Theory/Practical: Theory**	**Teaching Hours: L(60) = 60 Hrs.**
Total Max. Marks: 100	**Continuous Assessment (CA) Marks: 40**	**End Semester Examination (ESE) Marks: 60**
Minimum Percentage of Numerical / Design / Programming Problems in ESE: 10%		
Duration of End Semester Examination (ESE): 3 hours		
Course Type: Elective-II		

Prerequisites (if any): NIL
Additional Material Allowed in ESE: Scientific Calculator

On completion of the course, the student will have the ability to:

CO#	Course Outcomes
1	Identify the different parts of the automobile and understand the terminology related to automobiles.
2	Understanding the need and suitability of different power units for various power requirements, selecting appropriate fuels, and identifying key components of fuel supply and emission control systems in automobiles.
3	Students will understand lubricant and coolant characteristics, along with the construction and operation of various lubrication and cooling systems.
4	Understanding the working of automated and manual transmissions, steering systems including their geometry, and various suspension systems for vehicle stability and comfort.
5	Students will understand the constructional details and applications of wheels, tyres, and braking systems in automobiles.
6	Students will analyze automobile safety implications and their mitigations, along with maintenance practices and emerging future trends in automotive technology.

Contents

Part-A

Unit-1 Introduction **14 hrs**

Classification of automotive vehicles, components, basic structure, material and terminology, general layout; front engine rear drive and front engine front drive vehicles, four wheel drive vehicles, different power requirements of an automobile. Loads on the frame, considerations of strength and stiffness.

SI and CI Engines, use of alternate fuels such as CNG, LNG, LPG etc., blending of fuels. Air cleaner and fuel pumps; Air fuel requirements, Electronic fuel injection systems; MPFi (Petrol), Common Rail Fuel Injection (CRDI) system, construction of fuel injectors and nozzles. Emission control systems; Construction and working of Positive crank case ventilation system, Evaporative emission control, Exhaust Gas Recirculation (ECR) System, Catalytic converters, Silencers.

Unit-2 Cooling and Lubrication Systems **08 Hrs.**

Need of lubrication; desirable properties of lubricants; various types of lubricants, their grades and oil additives; different systems of lubrication, oil filters, oil pumps, Purpose of cooling, air and water cooling systems; radiator, thermostat, intercooler, pump and fan, use of antifreeze, vehicle cabin cooling and heating systems.

Unit-3 Transmission Systems **08 hrs.**

Basic requirements of transmission systems; manual and automatic transmission system, general arrangement of power transmission system, constructional features of different types of automobile clutches, different types of gear boxes; Sliding mesh, Constant mesh, Synchro- mesh gear boxes, construction and working of differential, front and rear axles; overdrives, propeller shaft, universal joint, fluid flywheel and torque tube drive. Continuously Variable Transmission (CVT). Full floating, Three quarter floating and Semi floating rear axles.

Part-B

Unit-4 Steering and Suspension **08 Hrs.**

Requirements of a general steering system, Steering geometry; castor action, camber and king pin angle, toe-in toe-out of wheels, steering linkages; Wheel alignment and balancing; power steering, Ball recirculating mechanism, Rack and Pinion Steering mechanism, Electronic Steering. Need of Suspension System, types of Suspension; independent suspension systems (Mac Pherson, Trailing Links, Wishbone), shock absorbers and stabilizers; constructional details and characteristics of leaf springs.

Unit-5 Wheels, Brakes and Tyres **10 Hrs.**

Basic requirements of wheels and tyres, types of road wheels, General braking requirements; classification of brakes; principle and constructional details of drum brakes, disc drakes; brake actuating systems; Mechanical, hydraulic and pneumatic brakes, Antilock Braking System (ABS). Tyre construction, material, types, tyre sizes and designation, tyre inflation pressure, safety precautions in tyres, tyre rotation. Types of tyre wear and their causes, selection of tyres under different applications, tyre retreading.

Unit-6 Safety and Maintenance **12 Hrs.**

Preventive maintenance, trouble shooting and rectification in different systems; engine tuning and servicing, major tools used for maintenance of automobiles. Safety standards; important safety features of latest vehicle. Latest provisions and amendments done in Motor Vehicles Act, 1988 related to vehicle, driving and safety. Future Trends in Automobiles Concept of hybrid vehicles and its need, Engine Management Control System (EMS), use of IoT in automobiles, Automotive sensors, ADAS system; Collision avoidance, Radar warning system, Global Positioning Systems (GPS). Introduction to electric mobility, its general layout and working, types of battery power packs with their advantages and disadvantages, types of electric motors and battery chargers.

Text Books

1. P.S. Gill, “A Textbook of Automobile Engineering”, S.K. Kataria & Sons, 2nd Edition, 2012.
2. Kirpal Singh, “Automobile Engineering Vol. 1 & 2”, Standard Publishers Distributors, 12th Edition, 2012.
3. R.K. Rajput, “A Textbook of Automobile Engineering”, Laxmi Publications (P) Limited, 1st Edition, 2007.
4. Er. S.K. Gupta, “A Textbook of Automobile Engineering”, S. Chand Publishing, 2nd Edition, 2019.
5. T.R. Banga and Nathu Singh, “A Text Book on Automobile Engineering”, Khanna Publishers, 1st Edition, 2005.

Reference Books

1. Heinz Heisler, “Vehicle and Engine Technology”, SAE International, 2nd Edition, 2012.
2. V. Ganesan, “Internal Combustion Engines”, McGraw Hill Education, 4th Edition, 2012.
3. William H. Crouse, “Automotive Mechanics”, McGraw-Hill, 10th Edition, 1993.
4. Iqbal Husain, “Electric and Hybrid Vehicles: Design Fundamentals”, CRC Press, 3rd Edition, 2021.

Supplementary SWAYAM & NPTEL Courses

Sr. No.	Course Name	Instructor	Host Institute	URL
1	Fundamentals of Automotive Systems	By Prof. C. S. Shankar Ram	IIT Madras	https://onlinecourses.nptel.ac.in/noc26_de12/preview

Guru Nanak Dev Engineering College, Ludhiana
An Autonomous College under UGC Act 1956
B. Tech. (Mechanical Engineering)

Course Code: EME106

Course Title: Characterization of Materials

Programme: B.Tech.	**L: 4 T: 0 P: 0**	**Credits: 4**
Semester: 5th	**Theory/Practical: Theory**	**Teaching Hours: 60(L)= 60 hrs**
Total Max. Marks: 100	**Continuous Assessment (CA) Marks: 40**	**End Semester Examination (ESE) Marks: 60**
Minimum Percentage of Numerical / Design / Programming Problems in ESE: 10%		
Duration of End Semester Examination (ESE): 3 hours		
Course Type: Core Course		

Prerequisites (if any): NIL
Additional Material Allowed in ESE: Scientific Calculator.

On completion of the course, the student will have the ability to:

CO#	Course Outcomes
1	Explain the fundamentals of material characterization and the factors affecting performance of materials.
2	Describe the working principles and applications of microscopic and diffraction techniques for micro-structural analysis.
3	Interpret spectroscopic techniques to determine chemical composition and molecular structure of materials.
4	Analyze thermal behavior and phase transformations of materials.
5	Evaluate friction, wear, and surface characteristics of materials.
6	Apply appropriate sample preparation methods for accurate materials characterization.

Contents

Part-A

Unit I- Introduction **10 Hrs**

Introduction to material characterization, its purpose and importance in materials science and engineering, Classification of materials and their industrial applications, Relationship between **structure, processing, properties, and performance,** Role of material selection and its characterization in product development and quality control, Structural, Chemical Mechanical, Thermal, Electrical and Surface characterization, Introduction to destructive and non-destructive characterization.

Unit II- Microscopic and Diffraction Techniques **12 Hrs**

Optical Microscopy (OM), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM), Scanning Tunneling Microscopy (STM), Confocal Laser Scanning Microscopy (CLSM), Focused Ion Beam Microscopy (**FIB**), Cryogenic Electron Microscopy (**Cryo-EM**), X-Ray Diffraction (XRD)

Unit III- Spectroscopic techniques **11 Hrs**

UV–Visible Spectroscopy (UV-Vis), Fourier Transform Infrared Spectroscopy (FTIR), Raman Spectroscopy, X-Ray Photoelectron Spectroscopy (XPS), Energy Dispersive X-Ray Spectroscopy (EDS / EDX), Nuclear Magnetic Resonance (NMR) Spectroscopy, Electron Spin Resonance (ESR / EPR)

Part-B

Unit IV-Thermal analysis techniques **09 Hrs**

Thermo-gravimetric Analysis (TGA), Differential Scanning Calorimetry (DSC), Differential Thermal

Analysis (DTA), Dynamic Mechanical Analysis (DMA), Thermo-mechanical Analysis (TMA)

Unit V- Tribological Characterization Techniques **08 Hrs**

Pin-on-Disc/Ball-on Disc Tribometer, Four-Ball Wear Tester, Reciprocating Wear Tester, Scratch Testing, Surface Profilometer

Unit VI- Sample Preparation Techniques **10 Hrs**

Importance of Sample Preparation, Objectives and General Steps of Sample Preparation viz. Sampling / Sectioning, Mounting, Grinding, Polishing and Etching, Sample Preparation for Different Characterization Techniques, Factors Affecting Sample Preparation, Common Errors in Sample Preparation, Applications of Sample Preparation and Safety Precautions.

Text Books

1. Zhang, Sam; Li, Lin; Kumar, Ashok. "Materials characterization techniques". CRC Press, 2008.
2. Leng, Yang. "Materials characterization: Introduction to microscopic and spectroscopic methods" Singapore: John Wiley & Sons, cop. 2008.
3. E. N. Kauffmann, "Characterization of Materials", 2 Volume Set, Wiley-Blackwell, 2003.
4. P. R. Khangaonkar, "An Introduction to Material Characterization", Penram Intl. Publishing (India) Pvt. Ltd.-Mumbai; First Edition, 2008.
5. Nicholas P. Cheremisinoff. "Polymer Characterization- Laboratory Techniques and Analysis", Elsevier, William Andrew 1996.

Reference Books

1. R. F. Egerton, "Physical Principles of Electron Microscopy", Springer US, 2005
2. D. Briggs, M.P. Seah, "Practical Surface Analysis by Auger and X-Ray Photoelectron Spectroscopy" (Wiley, Chichester, 1990)

Supplementary SWAYAM Course:

S. No.	Course Name	Instructor	Host Institute	URL
1	Acoustic Materials and Metamaterials	Prof. Sneha Singh	IIT Roorkee	https://onlinecourses.nptel.ac.in/noc26_me88/preview
2	Carbon Materials and Manufacturing	Prof. Swati Sharma	IIT Mandi	https://onlinecourses.nptel.ac.in/noc26_mm40/preview
3	Characterization of Polymers, Elastomers and Composites	Prof. Santanu Chattopadhyay	IIT Kharagpur	https://onlinecourses.nptel.ac.in/noc26_ch29/preview
4	Dealing with materials data : collection, analysis and interpretation	Prof. M P Gururajan, Prof. Hina Gokhale	IIT Bombay	https://onlinecourses.nptel.ac.in/noc26_mm18/preview
5	Introduction to materials science and engineering	Prof. Rajesh Prasad	IIT Delhi	https://onlinecourses.nptel.ac.in/noc26_mm19/preview
6	Material Characterization	Prof. Sankaran.S	IIT Madras	https://onlinecourses.nptel.ac.in/noc26_mm43/preview

7	Materials Science and Engineering	Prof. Vivek Pancholi	IIT Roorkee	https://onlinecourses.nptel.ac.in/noc26_mm47/preview

Topics for Self Learning (TSL)

S. No.	Topics
1	Piezoelectric and ferroelectric characterization
2	Characterization of Advanced Materials like nano, bio and smart.
3	Atomic Layer Deposition (ALD) and Auger Electron Spectroscopy (AES)
4	Industrial & Research Case Studies

Guru Nanak Dev Engineering College, Ludhiana
An Autonomous College under UGC Act 1956
B. Tech. (Mechanical Engineering)

Course Code: EME107

Course Title: Rapid Prototyping and Manufacturing

Programme: B.Tech.	L: 4 T: 0 P: 0	Credits: 4
Semester: 5th	Theory/Practical: Theory	Teaching Hours: 60(L)= 60 hrs
Total Max. Marks: 100	Continuous Assessment (CA) Marks: 40	End Semester Examination (ESE) Marks: 60
Minimum Percentage of Numerical / Design / Programming Problems in ESE: 10%		
Duration of End Semester Examination (ESE): 3 hours		
Course Type: Elective		

Prerequisites (if any): NIL
Additional Material Allowed in ESE: Scientific Calculator.

On completion of the course, the student will have the ability to:

CO#	Course Outcomes
1	Explain the fundamentals, evolution, and industrial significance of rapid prototyping and manufacturing systems.
2	Classify and compare rapid prototyping processes and manufacturing technologies based on principles, materials, accuracy, limitations, and applications.
3	Analyze errors, quality issues, and process limitations in rapid prototyping systems and apply basic control and improvement strategies.
4	Apply computer-integrated manufacturing tools such as CAPP, CIM, CAI, CMM, robotics, and automation for efficient product design, inspection, and production.
5	Develop and evaluate a flexible manufacturing system using group technology concepts and layout planning.
6	Evaluate industrial applications of rapid prototyping through case studies and emerging manufacturing technologies.

Contents

Part-A

Unit I- Introduction to Rapid Prototyping and Manufacturing Systems 08 Hrs

Introduction to prototyping and evolution of rapid prototyping (RP) systems, history and growth of the RP industry, traditional prototyping versus rapid prototyping, fundamentals of rapid prototyping, advantages and limitations of RP, classification of rapid manufacturing processes including additive, subtractive and formative processes, generic rapid prototyping process, evolution of manufacturing systems and system approach, role of computers and information technology in manufacturing, product life cycle and technology life cycle, challenges and opportunities for Indian manufacturing in achieving global competitiveness.

Unit II- CAD Modeling and Data Processing for Rapid Prototyping 10 Hrs

Rapid prototyping process chain and fundamental automated processes, 3D CAD modeling requirements for RP, data conversion and data transmission, file checking, slicing and build preparation, building and post-processing operations, supported file formats for RP including STL, IGES, STEP, HP/GL and CT, issues related to accuracy, data integrity and interoperability between CAD and RP systems.

Unit III- Rapid Prototyping Processes and Error Analysis 09 Hrs

Errors in rapid prototyping processes including pre-processing, processing and post-processing errors, part building errors in Stereolithography (SLA) and Selective Laser Sintering (SLS), dimensional accuracy,

surface finish and quality issues, process monitoring, control and improvement strategies in rapid prototyping.

Part-B

Unit IV-Rapid Prototyping Technologies and Case Studies 11 Hrs

Principles, processes, materials, advantages and limitations of rapid prototyping systems including Stereolithography (SLA), Fused Deposition Modelling (FDM), Laminated Object Manufacturing (LOM), Selective Laser Sintering (SLS), Laser Engineered Net Shaping (LENS), Direct Metal Deposition (DMD) and Three-Dimensional Printing (3DP), industrial case studies of rapid prototyping applications in manufacturing sectors.

Unit V- Manufacturing Systems, Group Technology, and Flexible Manufacturing Systems 10 Hrs

Manufacturing systems concepts and classifications, group technology including concept, need, benefits and scope, production layout types, features and applications, comparison of GT layout with conventional layout, cellular manufacturing systems including manual, automatic and assembly cells, flexible manufacturing system (FMS) concept, components and types, comparison of FMS with other manufacturing systems, basic FMS layout planning.

Unit VI- Automation, Advanced Manufacturing, and Applications 12 Hrs

Robotics in manufacturing systems including robot concepts, classifications and configurations, manipulators, grippers and selection criteria, sensors such as position, force, torque, proximity, vision, velocity and acceleration sensors, overview of robot programming methods, computer aided process planning (CAPP), computer integrated manufacturing (CIM) architecture and applications, computer aided inspection (CAI) and coordinate measuring machines (CMM), open-loop and closed-loop control systems, lean manufacturing, artificial intelligence applications in manufacturing and factory of the future.

Text Books

1. Chua C K, Leong K F, Chu S L, Rapid Prototyping: Principles and Applications in Manufacturing, World Scientific.
2. Gibson D W Rosen, Brent Stucker., Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer.
3. Connell, John, and Linda I. Shafer. Object-oriented rapid prototyping. Yourdon Press, 1995.
4. Hoque, Md Enamul, ed. Advanced applications of rapid prototyping technology in modern engineering. BoD–Books on Demand, 2011.
5. Hoque, Md Enamul, ed. Rapid prototyping technology: principles and functional requirements. BoD–Books on Demand, 2011.P. Radhakrishnan & S. Subranarayan, CAD/CAM/CIM, New Age Intentional
6. Bedworth, Wolfe and Anderson, Computer Integrated Design & Manufacturing by McGraw Hill International Publication.
7. Arthur J. Critchlow, Introduction to Robotics, McMillan publication
8. Yorom Koran, Robotics for engineers, McGraw Hill Publication
9. Rao, Tiwari & Kundra, Computer aided manufacturing, Tata McGraw Hill Publication

Reference Books

1. Noorani R, Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley & Sons
2. Kamrani A K, Nasr E A, Rapid Prototyping: Theory and practice, Springer
3. Dr Sadhu Singh, Computer Aided Design & Manufacturing. K. Publisher.
4. S.K.Vajpayee, Computer Integrated Manufacturing. PHI Publisher.

Supplementary SWAYAM Course:

S. No.	Course Name	Instructor	Host Institute	URL
1	Advanced Robotics Applications	Prof. Ashish Dutta	IIT Kanpur	https://onlinecourses.nptel.ac.in/noc26_me36/preview
2	Collaborative Robots (COBOTS): Theory and Practice	Prof. Arun Dayal Udai	IIT-ISM Dhanbad	https://onlinecourses.nptel.ac.in/noc26_me50/preview
3	Computer Integrated Manufacturing	By Prof. J. Ramkumar, Prof. Amandeep Singh Oberoi	IIT Kanpur	https://onlinecourses.nptel.ac.in/noc26_me48/preview
4	Design Practice	Prof. Shantanu Bhattacharya	IIT Kanpur	https://onlinecourses.nptel.ac.in/noc26_me46/preview
5	Manufacturing Automation	Prof. Sounak Kumar Choudhury	IIT Kanpur	https://onlinecourses.nptel.ac.in/noc26_me39/preview
6	Manufacturing Process Technology I & II	Prof. Shantanu Bhattacharya	IIT Kanpur	https://onlinecourses.nptel.ac.in/noc26_me47/preview
7	Mechatronics	Prof. Pushparaj Mani Pathak	IIT Roorkee	https://onlinecourses.nptel.ac.in/noc26_me83/preview
8	Product Design and Manufacturing	By Prof. J. Ramkumar, Prof. Amandeep Singh Oberoi	IIT Kanpur	https://onlinecourses.nptel.ac.in/noc26_me49/preview
9	Robotics: Basics and Selected Advanced Concepts	By Prof. Ashitava Ghosal	IISc Bangalore	https://onlinecourses.nptel.ac.in/noc26_me01/preview

Topics for Self Learning (TSL)

S. No.	Topics
1	Comparison Of Polymer, Metal, And Ceramic Additive Manufacturing Technologies
2	Sustainability And Environmental Impact Of Additive Manufacturing
3	Life Cycle Assessment (LCA) Of Additively Manufactured Products
4	Reverse Engineering Techniques Using 3D Scanning
5	Smart Manufacturing And Industry 4.0 Concepts
6	Future Trends In Manufacturing Including Artificial Intelligence And Machine
7	Learning In Process Optimization

Guru Nanak Dev Engineering College, Ludhiana
An Autonomous College under UGC Act 1956
B. Tech. (Mechanical Engineering)

Course Code EME109

Course Name: Plant Layout & Material Handling

Programme: B.Tech.	**L: 4 T: 0 P: 0**	**Credits: 4**
Semester: 5th	**Theory/Practical: Theory**	**Teaching Hours: 60(L) = 60 Hrs.**
Total Max. Marks: 100	**Continuous Assessment (CA) Marks: 40**	**End Semester Examination (ESE) Marks: 60**
Minimum Percentage of Numerical / Design / Programming Problems in ESE: 10%		
Duration of End Semester Examination (ESE): 3 hours		
Course Type: Elective		

Prerequisites (if any): NIL
Additional Material Allowed in ESE: Scientific Calculator.

On completion of the course, the student will have the ability to:

CO#	Course Outcomes
1	Able to Understand the procedures for systematic integration of organization.
2	Able to get the basics of process layout & product Layout.
3	Able to understand various techniques and tools of layout planning.
4	Able to know about the different type's material handling methods, paths equipment's and functions.
5	Able to understand various concepts of industrial building and utilities.
6	Able to analyze various methods of Material Handling.

Contents

Part A

Unit I: Plant Location and Facilities **10 Hrs.**
Factors to be considered – influence of location on plant layout, selection of plant site, Consideration in facilities planning and layout. Equipment's required for plant operation, Capacity, serviceability and flexibility and analysis in selection of equipment's, space requirements, and man power requirements.

Unit II: Plant Layout **10 Hrs.**
Classification of Layout, Advantages and Limitations of different layouts, Layout design procedures, Overview of the plant layout. Process layout & Product layout: Selection, specification, Implementation and follow up, comparison of product and process layout.

Unit III: Heuristics for Plant Layout **08 Hrs.**
ALDEP, CORELAP, CRAFT, Group Layout, Fixed position layout- Quadratic assignment model. Branch and bound method.

Part B

Unit IV: Material Handling **10 Hrs.**
Introduction, Material Handling systems, Material Handling principles, Classification of Material Handling Equipment, Relationship of material handling to plant layout. Basic Material Handling systems: Selection, Material Handling method- path, Equipment, function oriented systems.

Unit V: Industrial Building and Utilities **12 Hrs.**
Centralized electrical, pneumatic water line systems. Types of buildings, lighting, heating, air conditioning and ventilation utilities - planning and maintenance, waste handling, statutory requirements. Packing and storage materials: Importance of Packaging, layout for Packaging – Packaging machinery – wrapping and

Packing materials, cushion materials.

Unit VI: Analysis of Material Handling **10 Hrs.**

Methods to minimize cost of material handling- Maintenance of Material Handling Equipment's, Safety in handling Ergonomics of Material Handling equipment. Design, Miscellaneous equipment's.

TEXT BOOK:

1. Sharma S.C. "Plant Layout and Materials Handling", Khanna Publishers, (2000).
2. Agarwal G. K., "Plant Layout & Material Handling", Jain Brother, (2008).
3. Panneerselvam, R., "Production and Operations Management, Third Edition, PHI Learning Pvt. Ltd. (2012).
4. Mahapatra P.B., "Operations Management: A Quantitative Approach, Prentice Hall of India, (2010).

Reference Books

1 Arora K.C. (d), ARORA K.C., Shinde V. V., "Aspects of Materials Handling", Laxmi Publications, (2011).
2 Francis R. L., McGinnis L. F., White J. A., "Facility Layout and Location: An Analytical Approach", Prentice Hall of India (1995).

Supplementary SWAYAM Course:

S.No.	Course Name	Url
1.	Bulk Material Transport and Handling Systems	https://onlinecourses.nptel.ac.in/noc22_mm20/preview

Content beyond Syllabus:

1. Kan-Ban System
2. 5's System
3. Control Charts

Guru Nanak Dev Engineering College, Ludhiana
An Autonomous College under UGC Act 1956
B. Tech. (Mechanical Engineering)

Course Code: EME108

Course Title: Process Planning and Cost Estimation

Programme: B.Tech.	**L: 4 T: 0 P: 0**	**Credits: 4**
Semester: 5th	**Theory/Practical: Theory**	**Teaching Hours: 60(L)= 60 Hrs.**
Total Max. Marks: 100	**Continuous Assessment (CA) Marks: 40**	**End Semester Examination (ESE) Marks: 60**
Minimum Percentage of Numerical / Design / Programming Problems in ESE: 10%		
Duration of End Semester Examination (ESE): 3 hours		
Course Type: Elective		

Prerequisites (if any): NIL
Additional Material Allowed in ESE: Scientific Calculator.

On completion of the course, the student will have the ability to:

CO#	Course Outcomes
1	Select the process, equipment and tools for various industrial products.
2	Prepare process planning activity chart.
3	Explain the concept of cost estimation.
4	Compute the job order cost for different type of shop floor.
5	Calculate the machining time for various machining operations.
6	Select the various tools and equipment used in production process

Contents

Part A

Unit I Introduction To Process Planning **05 Hrs.**
Introduction – methods of process planning-Drawing interpretation-Material evaluation – steps in process selection – Production equipment and tooling selection.

Unit II Process Planning Activities **10 Hrs.**
Process parameters calculation for various production processes – Selection jigs and fixtures election of quality assurance methods – Set of documents for process planning – Economics of process planning – case studies.

Unit III Computer Aided Process Planning **15 Hrs.**
Basic part representation methods: CAD models-Feature based design-Design interface: syntactic pattern recognition-State transition diagram-Decomposition approach-Logic approach-Graph based approach. Process knowledge-Dimensions and tolerances- Surface properties-Process constraints-Process economics-Process capability. Computer aided Process Planning – Variant process planning – Generative process planning– Forward and Backward planning, input format – Totally Integrated process planning systems – Expert process planning-Commercial systems: CAM-I, CAPP, MIPLAN, APPAS, AUTOPLAN and PRO, CPPP

Part B

Unit IV Introduction To Cost Estimation **10 Hrs.**
Importance of costing and estimation – methods of costing-elements of cost estimation – Types of estimates – Estimating procedure – Estimation labor cost, material cost – allocation of overhead charges- Calculation of depreciation cost.

Unit V Production Cost Estimation **10 Hrs.**

Estimation of Different Types of Jobs – Estimation of Forging Shop, Estimation of Welding Shop, Estimation of Foundry Shop.

Unit VI Machining Time Calculation **10 Hrs.**

Estimation of Machining Time – Importance of Machine Time Calculation – Calculation of Machining Time for Different Lathe Operations, Drilling and Boring – Machining Time Calculation for Milling, Shaping and Planning – Machining Time Calculation for Grinding.

Text Books:

1. Peter Scalon, "Process planning, Design/Manufacture Interface", Elsevier science technology Books.
2. Sinha B.P, "Mechanical Estimating and Costing", Tata-McGraw Hill publishing co, 1995.

References Books:

1. Chitale A.V. and Gupta R.C., "Product Design and Manufacturing", 2nd Edition, PHI, 2002.
2. Ostwalal P.F. and Munez J., "Manufacturing Processes and systems", 9th Edition, John Wiley, 1998.
3. Mikell P. Groover, "Automation, Production, Systems and Computer Integrated Manufacturing", Pearson Education 2001.
4. K.C. Jain & L.N. Aggarwal, "Production Planning Control and Industrial Management", Khanna Publishers 1990.

Supplementary SWAYAM Course:

Sr. No.	Title	Instructor	Institute	URL
1	Project Mamagement	Prof. A Ramesh	IIT Roorkee	https://nptel.ac.in/courses/110107430

Guru Nanak Dev Engineering College, Ludhiana
An Autonomous College under UGC Act 1956
B. Tech. (Mechanical Engineering)

Course Code: ESME101

Course Title: Design Thinking

Programme: B.Tech. (ME)	**L: 0 T: 0 P: 2**	**Credits:1**
Semester: 5th	**Theory/Practical: Practical**	**Teaching Hours: 30 Hours**
Total Max.Marks:50	**Continuous Assessment (CA) Marks: 50**	**End Semester Examination(ESE) Marks:00**
Minimum Percentage of Numerical/Design/Programming Problems in ESE: NIL		
Duration of End Semester Examination (ESE):NIL		
Course Type: Professional Course		

Prerequisites (if any): NIL
Additional Material Allowed in ESE: NIL

On completion of the course, the student will have the ability to:

CO#	Course Outcomes
1	Explain the Design Thinking process and identify real-life engineering problems for design solutions.
2	Conduct user research and define engineering problems using appropriate user-centered design techniques.
3	Generate, evaluate, and select suitable design concepts using creativity and decision-making tools.
4	Develop, test, and refine prototypes based on user feedback and iterative design principles.
5	Apply sustainable design principles and prepare a basic Business Model Canvas for an innovative solution.
6	Develop and present a Design Thinking-based mini project by applying the complete Design Thinking process.

Contents

Part A

Unit I: Introduction to Design Thinking **04 Hrs.**
Introduction to the Design Thinking process and its five stages (Empathize, Define, Ideate, Prototype, and Test). Identification of real-life engineering problems through observation and selection of a suitable problem for the semester project.

Unit II: User Research and Problem Definition **06 Hrs.**
Conduct user research through observation, interviews, and questionnaires to understand user needs. Prepare empathy maps, user personas, and customer journey maps. Identify the root cause of the problem using Fishbone Diagram and 5 Whys, and formulate a clear problem statement.

Unit III: Ideation and Concept Selection **05 Hrs.**
Generate innovative ideas using brainstorming, mind mapping, and SCAMPER techniques. Evaluate alternative solutions using a decision matrix based on feasibility, usability, cost, and sustainability, and select the most suitable concept.

Part B

Unit IV: Prototype Development and Testing **07 Hrs.**

Develop simple prototypes using sketches, paper models, cardboard models, or digital tools. Test the prototype with users, collect feedback, and improve the design through iterative modifications.

Unit V: Sustainable Design and Business Planning **04 Hrs.**

Study sustainable design concepts, eco-friendly material selection, waste reduction, and circular economy principles. Prepare a simple Business Model Canvas describing the value proposition, customer segments, key activities, and revenue streams.

Unit VI: Design Thinking Mini Project **04 Hrs.**

Develop, demonstrate, and present a Design Thinking-based mini project incorporating problem identification, user research, ideation, prototype development, testing, design improvement, and solution presentation.

Text Books:

1. Tim Brown, "Change by Design: How Design Thinking Creates New Alternatives for Business and Society", Revised Edition, Harper Business, 2019.
2. Idris Mootee, "Design Thinking for Strategic Innovation: What They Can't Teach You at Business or Design School", 1st Edition, John Wiley & Sons, 2013.
3. Michael Lewrick, Patrick Link, Larry Leifer, "The Design Thinking Playbook: Mindful Digital Transformation of Teams, Products, Services, Businesses and Ecosystems", 2nd Edition, John Wiley & Sons, 2020.
4. Andrew Pressman, "Design Thinking: A Guide to Creative Problem Solving for Everyone", 1st Edition, Routledge, 2019.
5. Don Norman, "The Design of Everyday Things", Revised and Expanded Edition, Basic Books, 2013.

Reference Books:

1. Hasso Plattner, Christoph Meinel, Larry Leifer (Eds.), "Design Thinking Research: Building Innovation Eco-Systems", 1st Edition, Springer, 2015.
2. Vijay Kumar, "101 Design Methods: A Structured Approach for Driving Innovation in Your Organization", 1st Edition, John Wiley & Sons, 2013.
3. Bruce Hanington, Bella Martin, "Universal Methods of Design: 125 Ways to Research Complex Problems, Develop Innovative Ideas, and Design Effective Solutions", 2nd Edition, Rockport Publishers, 2019.
4. Alexander Osterwalder, Yves Pigneur, Gregory Bernarda, Alan Smith, "Value Proposition Design: How to Create Products and Services Customers Want", 1st Edition, John Wiley & Sons, 2014.

Supplementary SWAYAM Course

Sr. No.	Course Name	Instructor	Host Institute	URL
1	Design Thinking – A Primer	Prof. Ashwin Mahalingam, Prof. Bala Ramadurai	IIT Madras	https://nptel.ac.in/courses/110106124
2	Product Engineering and Design Thinking	Prof. Pranab K Dan and Prof. Prabir Sarkar	IIT Kharagpur	https://nptel.ac.in/courses/112105316
3	Design, Technology and Innovation	Prof. B. K. Chakravarthy	IIT Bombay	https://nptel.ac.in/courses/107101088

4	Design Thinking and Human-Computer Interface	Prof. Sonal Atreya	IIT Roorkee	https://nptel.ac.in/courses/107107580

Guru Nanak Dev Engineering College, Ludhiana
An Autonomous College under UGC Act 1956
B. Tech. (Mechanical Engineering)

Course Code: CME113

Course Title: Refrigeration & Air Conditioning

Programme: B.Tech.(ME)	**L: 3 T:0 P:2**	**Credits:4**
Semester:6th	**Theory/Practical: Theory**	**Teaching Hours: 45(L)+ 30(P) = 75 Hrs.**
Total Max.Marks:150	**Continuous Assessment (CA) Marks: 90**	**End Semester Examination (ESE) Marks: 60**
Minimum Percentage of Numerical/Design/Programming Problems in ESE:50%		
Duration of End Semester Examination (ESE): 3hours		
Course Type: Core Course		

Prerequisites (if any): NIL
Additional Material Allowed in ESE: Scientific Calculator, RAC & Psychrometric Table/Charts.

On completion of the course, the student will have the ability to:

CO#	Course Outcomes
1	Understand and identify method/type of refrigeration and air conditioning systems and use of the different refrigerants from their nomenclature and their selection them from environmental aspects and field of application.
2	Analyze and evaluate vapor compression refrigeration cycle and system.
3	Analyze and evaluate multi-vapor compression refrigeration system.
4	Understand and determine psychometric properties.
5	Evaluate various psychometric processes and calculate cooling and heating loads for different domestic, commercial and industrial conditions.
6	Design air conditioning and refrigeration systems for various applications and select their components.

Contents

Part-A

Unit-1. Basic concepts **09 Hrs.**

Definition of refrigeration; Difference between refrigeration and cooling; Definition of air conditioning; Difference between refrigeration and air conditioning; Natural and mechanical refrigeration; Refrigerant: Classification and nomenclature of refrigerants; Desirable thermodynamic, chemical and physical properties of an ideal refrigerant; Azeotropes; Zeotropes; Effect of moisture and oil miscibility; Refrigerants dying agents and antifreeze solution; Ecofriendly refrigerants. Definitions of cooling/ refrigeration load, cooling/ refrigeration effect, cooling/ refrigeration capacity, heating load, heating effect, heating capacity; Units of refrigeration; Coefficient of performance and Energy efficient ratio; COP of a refrigerator; and COP/EPR of a heat pump; Single phase reversed Carnot cycle and its limitations; Two phase reversed Carnot cycle and its limitations; Bell Coleman/Reversed Brayton/Reversed Joule cycle and its analysis; Optimum COP and pressure ratio (No mathematical Analysis) Numerical.

Unit-2. Vapour Compression Refrigeration **08 Hrs.**

Vapour comession refrigeration system and its basic components; Representation of simple/ theoretical vapour compression refrigeration cycle on P-v, T-s and P-h diagrams; Dry versus wet compression; Expansion versus throttling of liquid refrigerant; Analysis of simple/theoretical vapour compression

refrigeration cycle; Introduction of P-h diagram/chart and refrigeration tables; Determination of properties of sub cooled, saturated and superheated refrigerant using saturated properties & specific heat tables, saturated & superheated properties tables, and P-h diagram; Compressor work and volumetric efficiency; Effect on performance and cooling capacity of simple/theoretical vapour compression refrigeration cycle due to change in evaporator pressure/temperature, condenser pressure/temperature, sub cooling of liquid refrigerant, super heating of suction vapours, use of liquid - vapour regenerative heat exchanger, heat exchange of vapours with compressor cylinder walls, pressure drop (wire drawing) in suction and discharge valves, pressure drop in evaporator and condenser; Representation of actual vapour compression refrigeration cycle on T-s and P-h diagrams (No mathematical analysis); use of inverter/variable refrigerant flow in vapour compression refrigeration system. Numerical.

Unit-3. Multi-pressure Vapour Compression Refrigeration **06 Hrs.**

Definition of flash gas, its advantages and disadvantages; Methods of flash gas removal: under cooler/ sub-cooler, flash tank/chamber/separator, liquid sub-cooler; Brief introduction to compound (multistage) compression, its advantages; Purpose of intercooling; Methods of intercooling: air intercooler, water inter intercooler, flash intercooler, flash chamber cum intercooler, liquid sub-cooler cum intercooler; Brief introduction to multiple evaporator systems; Use of individual and multiple expansion valves arrangements, with single and multiple (individual and compound) compressors; Cascade refrigeration system.

Part-B

Unit-4. Air Conditioning Concepts **08 Hrs.**

Psychrometry; Dry Air; Moist Air; Basic laws obeyed by Dry Air and Moist Air; Psychrometric properties of moist air: Dry bulb, wet bulb and dew point temperatures, specific humidity (humidity ratio), absolute humidity, relative humidity, degree of saturation, specific enthalpy, temperature of adiabatic saturation; Psychrometric chart and its use; Adiabatic mixing of moist air streams without condensation and with condensation; Human requirement of comfort; effective temperature and comfort charts; Industrial and comfort air conditioning applications; Numerical.

Unit-5. Psychrometric Processes **06Hrs.**

Basic psychrometric processes; Sensible heat process; Latent heat process; Total heat process; Sensible heat factor; Evaporative cooling; Cooling with dehumidification; Heating with dehumidification; Chemical dehumidification; Psychrometric processes in air conditioning equipment : By-pass factor; Contact factor; Cooling coils, heating coils, cooling and dehumidification coils, evaporative coolers, adiabatic dehumidifiers, water injection, steam injection, air washer; Numerical.

Unit-6. Calculations for Air conditioning Load, Rate and state of Supply Air **08 Hrs.**

Sources of heat load; sensible and latent heat load; Cooling and heating load estimation; Room sensible heat factor, grand sensible heat factor; Apparatus dew point temperature; Rate and state of supply air for air conditioning of different types of premises for summer and winter conditions, use of effective sensible heat factor; Numerical.

Text Books

1. C.P. Arora, “Refrigeration and Air Conditioning”, Tata McGraw Hill, 3rd Edition, 2009.
2. S.C. Arora, S. Domkundwar and V.A. Domkundwar, “A Course in Refrigeration and Air Conditioning”, Dhanpat Rai & Co (P) Ltd., Reprint, 2015.
3. M. Prasad, “Refrigeration and Air Conditioning”, New Age International (P) Ltd. Publishers, 3rd Edition, 2015.
4. R.C. Jordan and G.B. Priester,, “Refrigeration and Air Conditioning”, Prentice Hall of India, 2nd Edition, 1956.
5. W.F. Stoecker, “Refrigeration and Air Conditioning”, McGraw Hill, 2nd Edition, 1983

Reference Books

1. Ibrahim Dincer and Mehmet Kanoglu, "Refrigeration Systems and Applications", Wiley, 2010.
2. Roy J. Dossat, "Principles of Refrigeration", Pearson Education India, 2002.
3. ASHRAE Handbook
4. Carrier's Handbook J.B. Jones, & R.E. Dugan, "Engineering Thermodynamics", Prentice Hall, 1st Edition 1995.

Supplementary SWAYAM Course:

S. No.	Course Name	Instructor	Host Institute	URL
1	Refrigeration and Air-Conditioning	Ravi Kumar	IIT Roorkee	https://onlinecourses.nptel.ac.in/noc25_me114/preview
2	Advanced Refrigeration Systems	Prof. Jahar Sarkar	IIT, BHU Varanasi	https://onlinecourses.nptel.ac.in/noc26_me102/preview

Laboratory Work

Sr. No.	Experiment Title
1	Study of various elements of a vapour compression refrigeration system through cut sections models / actual apparatus.
2	Study and performance testing of domestic refrigerator.
3	Study the performance testing of Electrolux refrigerator.
4	Study and performance testing of an Ice plant.
5	Calculation/ Estimation of cooling load for a large building.
6	Study and performance testing of water cooler.
7	Visit to a cold storage for study of its working.
8	Study and performance testing of window type room air conditioner.

Guru Nanak Dev Engineering College, Ludhiana
An Autonomous College under UGC Act 1956
B. Tech. (Mechanical Engineering)

Course Code: CME114

Course Title: Operation Research

Programme: B.Tech.	**L: 3 T: 1 P: 0**	**Credits: 4**
Semester: 6th	**Theory/Practical: Theory**	**Teaching Hours: 45(L)+15(T) = 60 Hrs.**
Total Max. Marks: 100	**Continuous Assessment (CA) Marks: 40**	**End Semester Examination (ESE) Marks: 60**
Minimum Percentage of Numerical / Design / Programming Problems in ESE: 80%		
Duration of End Semester Examination (ESE): 3 hours		
Course Type: Core Course		

Prerequisites (if any): NIL
Additional Material Allowed in ESE: Scientific Calculator.

On completion of the course, the student will have the ability to:

CO#	Course Outcomes
1	Understand the characteristics of different types of operations research models in real-life environments.
2	Application of different types of deterministic and probabilistic models in finding real life environments.
3	Design new simple models, like CPM, to improve decision making.
4	Implement the various OR tools for better decision making.
5	Identify and apply the appropriate operation research model.
6	Use the policies to counter the policies played by the competitors

Contents

Part A

UNIT–I Linear Programming and Transportation Model **10 Hrs.**
Problem Formulation, Linear Programming Problem Formulation –Graphical solution – Simplex method – Artificial variables techniques - Big-M method, Duality, Sensitivity analysis Transportation Problems Optimal solution, unbalanced transportation problem –Degeneracy. Assignment problem –Formulation – Optimal solution - Variants of Assignment Problem-Traveling Salesman problem.

UNIT–II Theory of Games **05 Hrs.**
Introduction – Minimax (maximin) – Criterion and optimal strategy – Solution of games with saddle points – Rectangular games without saddle points – 2 X 2 games – dominance principle – m X 2 & 2 X n games - graphical method.

UNIT–III Replacement Analysis and Sequencing **10 Hrs.**
Introduction – Replacement of items that deteriorate with time – when money value is not counted and counted – Replacement of items that fail completely, group replacement. Inventory: Introduction – Single item – Deterministic models – Purchase inventory models with one price break and multiple price breaks – shortages are not allowed, Sequencing Introduction – Flow –Shop sequencing – n jobs through two machines – n jobs through three machines – Job shop sequencing – two jobs through 'm' machines.

Part B

UNIT – IV Waiting Lines **07 Hrs.**
Introduction – Terminology - Single Channel – Poisson arrivals and Exponential service times – with infinite population and finite population models – Multichannel – Poisson arrivals and exponential service times with

infinite population.

Unit V Dynamic Programming 06Hrs.

Introduction – Terminology-Bellman's Principle of Optimality – Applications of dynamic programming-shortest path problem – linear programming problem.

Unit VI Network models 07Hrs.

PERT & CPM Introduction; Analysis of time-bound project situations; Construction of networks; Identification of critical path; Slack and Float; Crashing of a network for cost reduction; Resource leveling and smoothening.

TEXT BOOKS

1. S.D.Sharma "Operations Research", Kedarnath, Ramnath 2015
2. Hiller &Libermann" Introduction to Operation. Research", Mc Graw Hill 2011
3. H. A.Taha " Introduction to Operation. Research",, PHI 2010

REFERENCE BOOKS

1. A.M.Natarajan, P.Balasubramani, & A. Tamilarasi "Operations Research" , Pearson . Education.
2. R.Pannerselvam "Operations Research" ,PHI Publications 2006
3. J.K.Sharma "Operation Research", MacMilan 2010

Supplementary SWAYAM Course:

Sr. No.	Course Name	Instructor	Host Institute	URL
1	Industrial engineering and operation Research	Prof. Uday Shanker Dixit	| IIT Guwahati	https://onlinecourses.nptel.ac.in/noc25_me181
2	Introduction to Operation Research	Prof. G Srinivasan	IIT Madras	https://nptel.ac.in/courses/110106062

Topics for Self Learning (TSL)

S. No.	Topics
1	Integer Programming
2	Queuing with variable population
3	Queuing with Variable Channels

Guru Nanak Dev Engineering College, Ludhiana
An Autonomous College under UGC Act 1956
B. Tech. (Mechanical Engineering)

Course Code: CME115

Course Name: Industrial Engineering

Programme: B.Tech.(ME)	**L: 3T:0 P:2**	**Credits:4**
Semester:6th	**Theory/Practical: Theory**	**Teaching Hours: 45(L)+ 30(P) = 75 Hrs.**
Total Max.Marks:150	**Continuous Assessment (CA) Marks: 90**	**End Semester Examination (ESE) Marks: 60**
Minimum Percentage of Numerical/Design/Programming Problems in ESE:10%		
Duration of End Semester Examination (ESE): 3hours		
Course Type: Core Course		

Prerequisites (if any): NIL
Additional Material Allowed in ESE: Scientific Calculator.

On completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Analysis and select a better site for a new, expended or modified industrial unit
2	Measure and analysis the work and methods used to carry out the work
3	Measure and design various ergonomical aspects
4	Understand the concepts of management
5	Understand the legislations and latest Amendments in Industrial Sector
6	Understand the latest and newer industrial engineering techniques

Contents

Part A

Unit I Plant Location & Layout **09 Hrs.**

Nature of Location Decision, Importance of Plant Location, Dynamic Nature of Plant Location, Choice of site for selection, Comparison of location, Principles of Plant layout and Types, factors affecting layout, methods, factors governing flow pattern, travel chart, analytical tools of plant layout, layout of manufacturing shop floor, repair shop, services sectors and process plant. Quantitative methods of Plant layout: CRAFT and CORELAP, Relationship diagrams.

Unit II Productivity and Work Study **11 Hrs.**

Definition o productivity, application and advantages of productivity improvement tools, reasons for increase and decreases in productivity. Areas of application of work study in industry. Work study. Method Study: Objectives and procedure for methods analysis, Recording techniques, Charts and Diagram, Micro motion and macro-motion study: Principles of motion economy, Normal work areas and work place design. Work Measurement: Objectives, techniques – time study, work sampling, pre-determined motion time standards (PMTS) Determination of time standards. Observed time, basic time, normal time, rating factors, allowances, and standard time. Job Evaluation and Wage Plan: Objective, Methods of job evaluation, job evaluation procedure, merit rating (Performance appraisal), method of merit rating, wage and wage incentive plans

Unit III Ergonomics **5Hrs.**

Need and relevance of ergonomics in industry, introduction to anthropometry, considerations in designing man machine systems, effect of environmental considerations like heat light, ventilation, humidity etc. on human performance, Occupational health and Safety Standard (OHSAS).

Part - B

Unit IV Concepts of Management and Production Planning and Control 08Hrs

Planning, Organizing, Staffing, Directing and Controlling, Centralization versus decentralization of authority and responsibility, Concept of benchmarking. Types of Production systems and their Characteristics, functions and objectives of Production Planning and Control, Sales forecasting: Techniques and Applications, Steps of Production Planning and Control: Process planning, Leading, Scheduling, Dispatching and Expediting with illustrative examples, Introduction to line of balance, assembly line balancing, and progress control.

Unit V Industrial Legislation 07Hrs.

Need for Industrial legislation, Factories act 1948, Industrial dispute act 1947, The Indian trade unions act 1926, Industrial employment act 1946, Payment of wage act 1936, Workmen compensation act 1923, Payment of bonus act 1965, Employees provident fund scheme 1952. Latest amendments and Legislations Concept ISO 9000, ISO 14000 and QS 9000

Unit VI Current Trends 05Hrs.

Definitions, Scope And Applications of Agile Manufacturing, Six Sigma, Value Engineering, Just-In-Time, Total Quality Management, Enterprise Resource Planning, Kaizen, Total Productive Maintenance. Failure Mode Effect Analysis, Statistical Quality Control: Quality circles, Quality assurance, Acceptance sampling, Quality Control Charts

Text Books

1. A.P. Verma, “Industrial Engineering & Management”, S. K. Kataria & Sons, 2014.
2. H.S. Shan, “Work Study and Ergonomics” Dhanpat Rai & Co. , 2004.
3. A. Shtub & Y. Cohen, “Introduction to Industrial Engineering”, CRC Press, Taylor & Francis Group.
4. O.P. Khanna, “Industrial Engineering and Management” , Dhanpat Rai & Co.
5. Philip E Hick, “Industrial Engineering & Management”, Tata McGraw Hill, 1994
6. R. Panneerselvam “Production and Operations Management”, PHI Private Ltd.,

Reference Books:

1. Telsang Martand, “Industrial Engineering & Production Management”, S Chand & Co, 2006.
2. Lee J. Krajewski, “Operations Management: Processes and Supply Chains”, Pearson Education, 2016
3. J.L. Riggs “Production System, Planning, Analysis and Control”, Wiley
4. Martand Telsang “Industrial Engineering and Production Management”, S Chand & company.
5. B. Kumar “Industrial Engineering and Management” Khanna Publishers
6. ILO, “Introduction to Work Study”, Oxford and IBH Publishing, 3rd Edition, 2008

Supplementary SWAYAM Course:

Sr. No.	Course Name	Instructor	Host Institute	URL
1	Industrial engineering & operation Research	Prof. Uday Shanker Dixit	IIT Guwahati	https://onlinecourses.nptel.ac.in/noc25_me181
2	Principles of Industrial Engineering	Prof. D. K. Dwivedi	IIT Roorkee	https://onlinecourses.nptel.ac.in/noc26_me78
3	Operation Management	Prof. Inderdeep Singh	IIT Roorkee	https://onlinecourses.nptel.ac.in/noc20_me30

Topics for Self Learning (TSL)

S. No.	Topics
1	Kanban
2	Poke Yoka
3	Design of Experiments

Lab Work

Exp. No	Experiment Title
1	Case study demonstration on location decision and site selection
2	Case study on plant layout problem
3	Case Study on forecasting problem using different forecasting techniques
4	To draw the Operation and flow process chart for Academic and Industrial Organization
5	Measure the standard time for a given task
6	Measure the impact of noise on human body
7	Measure the impact of lighting and ventilation on human body

Guru Nanak Dev Engineering College, Ludhiana
An Autonomous College under UGC Act 1956
B. Tech. (Mechanical Engineering)

Course Code: ESME102

Course Title: Mechanical Vibrations

Programme: B.Tech.	**L: 3 T: 0 P: 2**	**Credits: 4**
Semester: 6th	**Theory/Practical: Theory**	**Teaching Hours: 45(L)+30(P) = 75 hrs**
Total Max. Marks: 150	**Continuous Assessment (CA) Marks: 90**	**End Semester Examination (ESE) Marks: 60**
Minimum Percentage of Numerical / Design / Programming Problems in ESE: 70%		
Duration of End Semester Examination (ESE): 3 hours		
Course Type: Core Course		

Prerequisites (if any): NIL
Additional Material Allowed in ESE: Scientific Calculator, Design data book.

On completion of the course, the student will have the ability to:

CO#	Course Outcomes
1	Explain fundamental concepts of mechanical vibrations and their significance in mechanical and robotic systems.
2	Develop mathematical models of vibrating mechanical and structural systems.
3	Determine natural frequencies and responses of damped and undamped systems Courseed to free and forced vibrations.
4	Analyze multi-degree-of-freedom systems using analytical and matrix methods.
5	Evaluate vibration characteristics of rotating machinery and shafts including whirling phenomena.
6	Measure and interpret vibration signals using vibration measuring instruments and modern analysis tools.

Contents

Part A

Unit I Fundamentals of Mechanical Vibrations **06 Hrs**
Introduction to vibrations; vibration terminology and classification; harmonic motion and periodic motion; beats phenomenon; applications of vibration in engineering systems and robotics.

Unit II Single Degree of Freedom Systems – Free Vibrations **08 Hrs**
Free undamped vibrations; mathematical modeling using Newton's second law, D'Alembert's principle, energy method, and Rayleigh method; natural frequency of SDOF systems. Free damped vibrations; viscous damping; logarithmic decrement; underdamped, critically damped, and overdamped systems.

Unit III Forced Vibrations of Single Degree of Freedom Systems **08 Hrs**
Forced harmonic excitation; steady-state response; magnification factor; resonance; transmissibility; vibration isolation. Applications: rotor unbalance, equivalent viscous damping, excitation and stability considerations.

Part B

Unit IV Two Degree of Freedom Systems **06 Hrs**
Generalized coordinates; principal coordinates; coordinate coupling; derivation of equations of motion; Lagrange's equations; forced harmonic vibration of two-degree-of-freedom systems.

Unit V Multi Degree of Freedom Systems and Natural Frequency Determination **09 Hrs**

Multi-degree-of-freedom (MDOF) systems; derivation of equations of motion; flexibility and stiffness matrices; reciprocity theorem; modal analysis and mode shapes.Methods of natural frequency determination: Rayleigh method, Dunkerley method, Stodola method, matrix iteration method, and Holzer's method. Whirling of shafts: critical speed; whirling speed of shafts; applications in rotating machinery.

Unit VI Continuous Systems and Vibration Measurement **08 Hrs**

Continuous systems: introduction to continuous systems; lateral vibration of strings; transverse vibration of beams; orthogonality of eigenvectors. Vibration measurement and analysis: vibration measuring instruments; accelerometers and displacement sensors; frequency measuring instruments; FFT analyzer and basic signal processing; applications in machinery diagnostics and robotic systems.

Text Books

1. **Singiresu S. Rao**, "*Mechanical Vibrations"*, **6th Ed.**, Pearson Education, New York, 2017.
2. **G. K. Groover**, "*Mechanical Vibrations*", Nem Chand & Bros., Roorkee, India.
3. **W. T. Thomson and M. D. Dahleh**, "*Theory of Vibration with Applications"*, **5th Ed.**, Pearson Education, New Delhi, 1997.

Reference Books

1. **Graham Kelly**," *Theory and Problems of Mechanical Vibrations"*, **Schaum's Outline Series**, McGraw-Hill Education, New York.
2. **Graham Kelly**, "*Fundamentals of Mechanical Vibrations"*, McGraw-Hill Edu., New York.
3. **S. S. Rao,** "*Vibration of Continuous Systems"*, John Wiley & Sons.
4. **Leonard Meirovitch**, "*Elements of Vibration Analysis"*, McGraw-Hill Edu., New York.

Lab Work

Exp. No	Experiment Title
1	To determine the frequency of a simple pendulum.
2	To determine the frequency of a compound pendulum.
3	To determine the natural frequency of a spring–mass system.
4	To study lateral vibration of a beam.
5	To determine torsional vibration characteristics of a single rotor system.
6	To study free damped vibrations of a system.
7	To determine the whirling speed of a shaft.
8	To study forced vibrations of a damped system.
9	To study the frequency of rolling cylinders without slip inside another cylinder.

Guru Nanak Dev Engineering College, Ludhiana
An Autonomous College under UGC Act 1956
B. Tech. (Mechanical Engineering)

Course Code: EME110

Course Title: Fluid Machinery

Programme: B.Tech.	**L: 4 T: 0 P: 0**	**Credits: 4**
Semester: 6	**Theory/Practical: Theory**	**Teaching Hours: 60(L) = 60 Hrs.**
Total Max. Marks: 100	**Continuous Assessment (CA) Marks: 40**	**End Semester Examination (ESE) Marks: 60**
Minimum Percentage of Numerical / Design / Programming Problems in ESE: 30%		
Duration of End Semester Examination (ESE): 3 hours		
Course Type: Core Course		

Prerequisites (if any): NIL
Additional Material Allowed in ESE: Scientific Calculator

On completion of the course, the student will have the ability to:

CO#	Course Outcomes
1	Recognize basic components of turbo machines and understand related fundamental laws/ principles and apply these for calculation of various parameters like work done, force efficiency etc.
2	Know about constructional details, working and design aspects of runner/wheel and evaluate the performance of various turbines like Pelton, Kaplan and Francis.
3	Know scaled down models or on actual size hydraulic machines and evaluate results in terms of unit or specific quantities for comparison purpose.
4	Know about constructional details, working and evaluate the performance of centrifugal pump under different vane shape conditions.
5	Know about constructional details, working and evaluate the performance of reciprocating pump and evaluate the effect of various deviations from the ideal conditions on the work done.
6	Know about constructional details and working of hydraulic devices like fluid coupling, accumulator and intensifier.

Contents

Part-A

Unit-1 General Concepts **09 Hrs.**

Impulse momentum principle; jet impingement on stationary and moving flat plates; and on stationary or moving vanes with jet striking at the centre and tangentially at one end of the vane; calculations for force exerted; work done and efficiency of jet. Basic components of a turbo machine and its classification on the basis of purpose; fluid dynamic action; operating principle; geometrical features; path followed by the fluid. Euler's equation for energy transfer in a turbo machine and specifying the energy transfer in terms of fluid and rotor kinetic energy changes.

Unit-2 Pelton Turbine **08 Hrs.**

Component parts and operation; velocity triangles; work output; Effective head; available power and efficiency; design aspects such as mean diameter of wheel; jet ratio; number of jets; number of buckets with working proportions; governing of Pelton turbine.

Unit-3 Francis and Kaplan Turbine **08 Hrs.**

Component parts and operation velocity triangles and work output; working proportions and design parameters for the runner; Degree of reaction; Draft tubes - its function and types. Function and brief description of commonly used surge tanks; governing of reaction turbines.

Part-B

Unit-4 Centrifugal Pumps **09 Hrs.**

Layout and installation; Main elements and their functions; Various types and classification; Pressure changes in a pump; Heads of a pump - suction; delivery; static; manometric; total; net positive suction head and Euler's head; vane shape and its effect on head-capacity relationships; Departure from Euler's theory and losses; pump output and efficiency; Minimum starting speed and impeller diameters at the inner and outer periphery; model testing and Priming and priming devices; Multistage pumps - series and parallel arrangement; submersible pumps. Construction and operation; Axial and mixed flow pumps; Trouble shooting - field problems; causes and remedies.

Unit-5 Similarity Relation and Performance Characteristics **09 Hrs.**

Unit quantities; specific speed and model relationships; scale effect; Cavitation and Thomas's cavitation number; Concept of Net Positive Suction Head (NPSH) and its application.

Unit-6 Reciprocating Pumps & Hydraulic Devices and Systems **17 Hrs.**

Introduction to single acting and double acting reciprocating pumps; their components; and parts and working; pressure variations due to piston acceleration; acceleration effects in suction and delivery pipes; work done against friction; maximum permissible vacuum during suction stroke; Functions of Air vessels, Construction; operation and utility of simple and differential accumulator; intensifier; fluid coupling and torque converter; Air lift and jet pumps; gear; vane and piston pumps; Hydraulic Ram; Hydraulic lift; Hydraulic crane and Hydraulic press.

Text Books

1. Lal Jagdish, "Hydraulic Machines", Metropolitan Book Co., 2016.
2. Ojha C. S. P., Berndtsson R and Chandramouli P, "Fluid Mechanics and Machinery", Oxford University Press, 2010.
3. Subramania K., "Hydraulic Machines", Tata Mc-Graw Hill Education, 2013.
4. Purohit, R. K., "Hydraulic Machines", Scientific Publishers, 2007.
5. Kumar D.S., "Fluid Mechanics and Fluid Power Engineering", S K Kataria and Sons, 2016.

Reference Books

1. V.L. Streeter, and E.B.Wylie, "Fluid Mechanics", McGraw-Hill, 1983.
2. I.G. Curie, "Fundamentals of Fluid Mechanics", CRC Press; 4th Edition, 2016.
3. Mahmoud Galal El-Din Mohamed Rabi, "Fluid Power Engineering", McGraw-Hill Professional,2009.

Supplementary SWAYAM Course

Sr. No.	Course Name	Instructor	Host Institute	URL
1	Principle Of Hydraulic Machines & System Design	Prof. Pranab K. Mondal	IIT Guwahati	https://onlinecourses.nptel.ac.in/noc23_me98/preview
2	Fluid Machines	Prof. Sankar Kumar Som	IIT Kharagpur	https://onlinecourses.nptel.ac.in/noc19_me55/preview

Guru Nanak Dev Engineering College, Ludhiana
An Autonomous College under UGC Act 1956
B. Tech. (Mechanical Engineering)

Course Code: EME111

Course Title: Modern Machining Process

Programme: B.Tech.	**L: 4 T: 0 P: 0**	**Credits: 4**
Semester: 6	**Theory/Practical: Theory**	**Teaching Hours: 60(L) =60 Hrs.**
Total Max. Marks: 100	**Continuous Assessment (CA) Marks: 40**	**End Semester Examination (ESE) Marks: 60**
Minimum Percentage of Numerical / Design / Programming Problems in ESE: 30%		
Duration of End Semester Examination (ESE): 3 hours		
Course Type: Core Course		

Prerequisites (if any): NIL
Additional Material Allowed in ESE: Scientific Calculator

On completion of the course, the student will have the ability to:

CO#	Course Outcomes
1	Understand the concept of modern machining process and calculate the metal removal rate
2	Analysis the working of Electric Discharge Machining
3	Analysis the working of Electron Beam Machining
4	Analysis the working of Chemical Machining
5	Analysis the working of Ultrasonic Machining and Abrasive Jet Machining
6	Use the technology of rapid prototyping

Contents

Part-A

Unit I Mechanical Advanced Machining Process **08 Hrs.**

Introduction: Need for non-traditional machining methods – Classification of modern machining processes – Considerations in process selection materials and applications. Abrasive Jet, Water Jet and Abrasive Water Jet Machining: Basic principles, equipments, process variables and mechanics of metal removal, MRR, application and limitations. Ultrasonic machining: Elements, mechanics of metal removal, process parameters, economic considerations, applications, limitations and recent development.

Unit II Thermo Electric Advanced Machining Process **09 Hrs.**

Electric Discharge Machining: Principle of working – Power supply, dielectric system, electrodes and servo system – Circuit analysis – Material removal rate – Process variables and characteristics – Applications. Wire-Electric Discharge Machining: Principle of working, process variables and characteristics and applications – Principle and working of Electric Discharge grinding, electric discharge diamond grinding and micro electric discharge machining.

Unit III Electron Beam And Laser Beam Machining Process **11 Hrs.**

Electron Beam Machining:Generation and control of electron beam for machining, theory of electron beam machining, comparison of thermal and non-thermal processes. Plasma Arc Machining: Principle and working – Metal removal mechanism, process parameters, accuracy and surface finish and Applications. Laser Beam Machining: General principle and application of laser beam machining – Thermal features, cutting speed and accuracy of cut.

Part B

Unit IV Electro Chemical And Chemical Advanced Machining Process **11 Hrs.**

Electro Chemical Machining: Principle, ECM system, advantages, limitations and applications. Electro Chemical Grinding: Principle and working, process characteristics and applications. Chemical Machining: Fundamentals of chemical machining – Principle – Maskants – Etchants – Advantages and applications.

Unit V Ultrasonic Machining & Abrasive Jet Machining 12 Hrs.

Introduction, equipment, tool materials & tool size, abrasive slurry, cutting tool system design:- Effect of parameters on Material removal rate, tool wear, Accuracy, surface finish, applications, advantages & Disadvantages of USM. AJM Introduction, Equipment, Variables in AJM: Carrier Gas, Type of abrasive work material, stand off distance (SOD), nozzle design, shape of cut. Process characteristics-Material removal rate, Nozzle wear, Accuracy & surface finish. Applications, advantages & Disadvantages of AJM. Water Jet Machining: Principle, Equipment, Operation, Application, Advantages and limitations of Water Jet machining.

UNIT VI Other Advanced Machining Process 09 Hrs.

Electro Stream Drilling: Principle and working – Process performance. Magnetic Abrasive Finishing: Principle and working, material removal and surface finish and applications. Shaped Tube Electrolytic Machining: Principle and working, applications. Rapid Prototyping: Classification – Stereo lithography - Selective laser sintering and applications

Text Books

1. V. K. Jain "Advanced Machining Processes", Allied Publishers Pvt. Ltd., New Delhi.2002
2. P.C., Pandey. and H.S., Shan "Modern Machining Processes", Tata McGraw Hill, New Delhi.1980
3. Reference Books:
4. M Adithan "Unconventional Machining Process", , Atlantic Publications, New Delhi 2014
5. G.F., Marcel "Non-Traditional Manufacturing Processes", Dekker Inc., New York 1987.
6. Serope Kalpakjian and Steven R. Schmid "Manufacturing Engineering and Technology", Prentice
7. Hall.2013
8. V. K. Jain "Introduction to Micromachining", 2, Narosa publishing House, New Delhi.2014

Supplementary SWAYAM Course

Sr.No.	Course Title	Course Instructor	Institute	Url
1	Advanced Machining Processes	Prof. Shantanu Bhattacharya	IIT Kanpur	https://nptel.ac.in/courses/112104425

Guru Nanak Dev Engineering College, Ludhiana
An Autonomous College under UGC Act 1956
B. Tech. (Mechanical Engineering)

Course Code: EME112

Course Title: Computer Aided Design

Programme: B.Tech.	**L: 4 T: 0 P: 0**	**Credits: 4**
Semester: 6rd	**Theory/Practical: Theory**	**Teaching Hours: L(60) = 60**
Total Max. Marks: 100	**Continuous Assessment (CA) Marks: 40**	**End Semester Examination (ESE) Marks: 60**
Minimum Percentage of Numerical / Design / Programming Problems in ESE: 10%		
Duration of End Semester Examination (ESE): 3 hours		
Course Type: Elective Course		

Prerequisites (if any): NIL
Additional Material Allowed in ESE: Scientific Calculator

On completion of the course, the student will have the ability to:

CO#	Course Outcomes
1	Describe the role of computer systems in design and manufacturing
2	Understand geometric models and apply various techniques
3	Conceptualize the integration of Computer Aided Design and business aspects in an industry
4	Analyse various curves and surfaces and evaluate component for kinematic analysis
5	Use geometric modeling, assembly design, and visualization
6	Apply CAD techniques to **engineering design problems and product development.**

Contents

Part-A

Unit-1 Introduction to CAD **08 Hrs.**
Introduction to CAD and its role in Product design and development cycle; CAD system and its evaluation criteria ; advanced input and output devices, Display devices; Functions of a graphics package and Graphics standard GKS; IGES and STEP; Application areas of CAD

Unit-2 Geometric Modeling **10 Hrs.**
Need and types of Geometric Modeling: Wireframe; surface and solid modeling; Geometric Modeling Techniques: Boundary Representation (B-rep); Constructive Solid Geometry (CSG); Parametric Modeling Techniques

Unit-3 Kinematics analysis and simulation **10 Hrs.**
Mass; volumetric properties calculations; concepts of hidden-line removal and shading; Mechanical Assembly Kinematics analysis and simulation

Part-B

Unit-4 Geometric Transformations **09 Hrs.**
Overview of Mathematics preliminaries; matrix representation of 2 and 3 dimensional transformation for translation; scaling; rotation about principal axes; mirror imaging about a plane; principal axes and origin; Concatenation of transformation matrices. Applications of geometric transformations.

Unit-5 Representation of curves and surfaces **12 Hrs.**
Non-parametric and parametric representation of curves; parametric representation of Hermite Cubic; Bezier curves; Uniform and Non uniform B-spline curves; Surface and its analysis. Representation of Analytical and

synthetic surfaces (Bilinear Surface; Coons Surface Patch; Bi-cubic Surface Patch; Bezier Surface; B spline surface).

Unit-6 Advanced Industrial CAD Applications 11 Hrs.

CAD/CAM/CAE integration, Rapid Prototyping and 3D Printing, Future Trends in CAD Artificial intelligence in design, Cloud-based CAD systems, Virtual and augmented reality in design

Text Books

1. Mikell P. Groover, Emory W Zimmer's, "CAD/CAM: Computer-Aided Design and Manufacturing", PHI, 1984.
2. D. D. Bedworth, M. R Henderson & P.M. Wolfe, "Computer Integrated Design and Manufacturing", Tata McGraw Hill, 1991.
3. Z. Ibraham, "CAD/CAM - Theory and Practice", Tata McGraw Hill, 2009.
4. P. N Rao, "CAD/CAM Principles and Applications", Tata McGraw Hill, 2004.
5. Jayanta Sarkar, "Computer Aided Design: A Conceptual Approach" , CRC Press , 2014.

Reference Books

1. Srinivasa Prakash Regalla, "Computer Aided Analysis and Design", I K International Publishing House, 2010.
2. M.M.M. Sarcar, K. Mallikarjuna Rao, K. Lalit Narayan, "Computer Aided Design and Manufacturing", PHI Learning, 2008.
3. Zhuming Bi, Xiaoqin Wang, "Computer Aided Design and Manufacturing" , Wiley, 2020

Guru Nanak Dev Engineering College, Ludhiana
An Autonomous College under UGC Act 1956
B. Tech. (Mechanical Engineering)

Course Code: FSME101

Course Title: Professional Skills for Engineers

Programme: B.Tech. (ME)	**L: 2 T: 0 P: 0**	**Credits:2**
Semester: 6th	**Theory/Practical: Theory**	**Teaching Hours: 30 (L) = 30 Hours**
Total Max.Marks:100	**Continuous Assessment (CA) Marks: 40**	**End Semester Examination(ESE) Marks: 60**
Minimum Percentage of Numerical/Design/Programming Problems in ESE: NIL		
Duration of End Semester Examination (ESE):NIL		
Course Type: Professional Course		

Prerequisites (if any): NIL

On completion of the course, the student will have the ability to:

CO#	Course Outcomes
1	Develop effective communication and interpersonal skills.
2	Enhance analytical, aptitude, and problem-solving abilities.
3	Prepare for campus placements and professional careers.
4	Build leadership, teamwork, and ethical decision-making skills.
5	Develop career planning and lifelong learning competencies.

Contents

Part A

Unit I: Communication Skills and Professional Etiquette **08 Hrs.**
Importance of professional skills in engineering careers, Verbal and non-verbal communication, Active listening and presentation skills, Professional email writing and business correspondence, Group discussions and public speaking, Workplace etiquette and professional behavior .

Unit II: Critical Thinking and Aptitude Skills **08 Hrs.**
Quantitative aptitude fundamentals, Logical reasoning and analytical thinking, Data interpretation and problem-solving techniques, Verbal ability and reading comprehension, Decision-making and critical thinking exercises.

Part B

Unit III: Professional Development and Career Management **07 Hrs.**
Resume and curriculum vitae preparation, LinkedIn profile and professional networking, Personal branding, Career planning and goal setting, Interview skills (technical and HR interviews), Group discussion and mock interview practice.

Unit IV: Workplace Skills and Professional Ethics **07 Hrs.**
Teamwork and collaboration , Leadership and emotional intelligence, Time management and stress management, Engineering ethics and professional responsibility, Corporate culture and workplace expectations, Lifelong learning and career growth strategies.

Assignment:

1. Prepare a professional resume.
2. Deliver an individual presentation.
3. Participate in group discussions.

4. Solve aptitude practice exercises.
5. Conduct mock interviews.
6. Create and optimize a professional networking profile.
7. Analyze workplace ethics case studies.

Recommended Reference Books

1. Alex K. “Soft Skills: Know Yourself and Know the World”, S. Chand & Company Limited, 2025
2. Mitra B.K. “Personality Development and Soft Skills” Oxford Higher Education, 2nd Edition,2016
3. Aggarwal R.S. “Quantitative Aptitude for Competitive Examinations”, S. Chand & Company Ltd,2026.
4. Gayle M.L. “Cracking the Coding Interview” CareerCup Publisher 6th Edition, 2015.