

Maulana Azad National Institute of Technology, Bhopal - 462003

DEPARTMENT OF MECHANICAL ENGINEERING

SCHEME FOR B.TECH

(2024 admitted batch onwards)

First Year Credits (Cumulative) 41

THIRD SEMESTER:

Course Code	Course Name	Scheme of Studies Periods per week			Credits
		L	T	P	
MTH24231	Applied Numerical Methods	3	1	-	4
HUM24251	Fundamentals of Entrepreneurship	3	-	-	3
ME24211	Engineering Thermodynamics	2	1	-	3
ME24212	Mechanics of Materials	2	1	-	3
ME24213	Material Science and Engineering	3	-	-	3
ME24214	Mechanical Drawing and CAD	3	-	-	3
ME24215	Heat Engines Lab.	-	-	2	1
ME24216	Mechanics of Materials Lab.	-	-	2	1
ME24217	Material Characterization Lab.	-	-	2	1
ME24218	Professional Practices	-	2	-	2
ME24212	Minor-1 "Mechanics of Materials"	3	-	-	3*
Total Hours =27		18	3	6	24
Total Credits (Cumulative)					65
Additional Subject: - National Cadet Corps (NCC)					
NCC24251	National Cadet Corps III	1	5	1	7
Total Credits (Cumulative)					11

*(Minor-1 Extra for other dept. not for parent)

FOURTH SEMESTER:

Course Code	Course Name	Scheme of Studies Periods per week			Credits
		L	T	P	
ME24252	Fundamental of Design Methods	2	1	-	3
ME24221	Machine Design-1	3	1	-	4
ME24222	Mechanism of Machines	3	-	-	3
ME24223	Manufacturing Processes	3	-	-	3
ME24224	Industrial Engineering and Operations Research	3	-	-	3
ME 24225	Mechanical Measurements	2	1	-	3
ME24226	Mechanism of Machines Lab.	-	-	2	1
ME24227	Manufacturing Processes Lab.	-	-	2	1
ME24228	Project Based Lab-1	-	-	2	1
ME24224	Minor-2 "Industrial Engineering and Operations Research"	3	-	-	3*
Total Hours =25		16	3	6	22
Total Credits (Cumulative)					87
Additional Subject: - National Cadet Corps (NCC)					
NCC24252	National Cadet Corps IV	2	-	1	3
Total Credits (Cumulative)					14

*(Minor-2 Extra for other dept. not for parent)

FIFTH SEMESTER:

Course Code	Course Name	Scheme of Studies Periods per week			Credits
		L	T	P	
ME24351	Engineering Management	3	-	-	3
ME24311	Machine Design-2	3	-	-	3
ME24312	Machining Processes	3	-	-	3
ME24313	Fluid Mechanics	3	1	-	4
EE24332	Electrical Machines	3	-	-	3
	Departmental Elective-1(A)	3	-	-	3
ME24314	Fluid Mechanics Lab.	-	-	2	1
EE24333	Electrical Machinery Lab.	-	-	2	1
ME24315	Machining Processes Lab.	-	-	2	1
ME24316	Internship/ Industrial Training	-	-	2	1
ME24312	Minor-3 "Machining Processes"	3	-	-	3*
Total Hours =27		18	1	8	23
Total Credits (Cumulative)					110
Additional Subject: - National Cadet Corps (NCC)					
NCC24351	National Cadet Corps V	1	5	1	7
Total Credits (Cumulative)					21

*(Minor-3 Extra for other dept. not for parent)

SIXTH SEMESTER:

Course Code	Course Name	Scheme of Studies Periods per week			Credits
		L	T	P	
CS24352	Data Structures and Algorithm	3	1	-	4
ME24321	Heat and Mass Transfer	3	1	-	4
ME24322	Turbomachines	3	-	-	3
ME24323	Internal Combustion and Hybrid Engines	3	-	-	3
	Departmental Elective-2(A)	3	-	-	3
ME24324	Heat and Mass Transfer Lab.	-	-	2	1
ME24325	Turbomachines Lab.	-	-	2	1
ME24326	Internal Combustion and Hybrid Engines Lab	-	-	2	1
ME24327	Project Based Learning	-	-	2	1
ME24323	Minor-4 "Internal Combustion and Hybrid Engines"	3	-	-	3*
Total Hours =25		15	2	8	21
Total Credits (Cumulative)					131
Additional Subject: - National Cadet Corps (NCC)					
NCC24352	National Cadet Corps VI	2	-	1	3
Total Credits (Cumulative)					24

*(Minor-4 Extra for other dept. not for parent)

SEVENTH SEMESTER:

Course Code	Course Name	Scheme of Studies Periods per week			Credits
		L	T	P	
HUM24451	Engineering Economics and IPR	3	-	-	3
ME24411	Refrigeration and Air Conditioning	3	-	-	3
	Programme Elective-1(A)	3	-	-	3
	Programme Elective-2(A)	3	-	-	3
	Open Elective-1(C)	3	-	-	3
ME24412	Refrigeration and Air Conditioning Lab.	-	-	2	1
ME24413	Project Based Lab-2	-	-	4	2
ME24414	Industrial / Field Training	-	-	2	1
	Minor-5 "Any one Programme Elective from above"	3	-	-	3*
Total Hours =23		15	-	8	19
Total Credits (Cumulative)					150

*(Minor-5 Extra for other dept. not for parent)

EIGHTH SEMESTER:

Course Code	Course Name	Scheme of Studies Periods per week			Credits
		L	T	P	
	Programme Elective-3(A) (NPTEL/SWAYAM Courses Only)	3	-	-	3
	Programme Elective-4(A) (NPTEL/SWAYAM Courses Only)	3	-	-	3
ME24421	Internship/Project	-	-	16	8
ME24422	General Proficiency	-	-	-	1
Total Hours =22		6	-	16	15
Total Credits (Cumulative)					165

LIST OF ELECTIVES (GROUP A)

Group A Departmental Electives - Third Year		
S. No.	Course Code	Course Name
1.	ME24352	Gas Dynamics
2.	ME24353	Gas Turbines and Jet Propulsion
3.	ME24354	Automobile Engineering
4.	ME24355	An Introduction to Microfluidics
5.	ME24356	Robotics
6.	ME24357	Materials Handling
7.	ME24358	Service Operation Management
8.	ME24359	Statistical Quality Control
9.	ME24360	Mechatronics
10.	ME24361	Theory of Vibrations
11.	ME24362	Mechanics of Deformable Solids
12.	ME24363	Fracture Mechanics and Failure Analysis
13.	ME24364	Maintenance Engineering and Management
14.	ME24365	Product Design and Development
15.	ME24366	Theory of Elasticity and Plasticity
16.	ME24367	Material Management
17.	ME24368	Engineering Optimization
18.	ME24369	Mechanical Behaviour of Materials
19.	ME24370	Supply Chain Management

Group A Programme Electives - Fourth Year		
S. No.	Course Code	Course Name
1.	ME 24451	Energy Conversion Systems
2.	ME 24452	Design of Heat Exchangers
3.	ME 24453	Solar Energy
4.	ME 24454	Non-Conventional Energy Sources
5.	ME 24455	Energy Audit Carbon Sequestration
6.	ME 24456	Computational Fluid Dynamics and Heat Transfer
7.	ME 24457	Wind Energy Technology
8.	ME 24458	Additive Manufacturing Technologies
9.	ME 24459	Advanced Production Engineering
10.	ME 24460	Nano Manufacturing
11.	ME 24461	Lean Manufacturing
12.	ME 24462	Composite Materials
13.	ME 24463	Smart Materials
14.	ME 24464	Sustainable Supply Chain Management
15.	ME 24465	Accounts and Financial Planning
16.	ME 24466	Organizational Behaviour
17.	ME 24467	Total Quality Management
18.	ME 24468	Marketing Management
19.	ME 24469	CAD/CAM
20.	ME 24470	Advanced Operations Research
21.	ME 24471	Industrial Tribology
22.	ME 24472	Mechanics of Composite Materials
23.	ME 24473	Computational Methods
24.	ME 24474	Analysis and Design of Mechanical Control System
25.	ME 24475	Advanced Machine Design



SYLLABUS FOR B.TECH (Mechanical Engineering)

(2024 admitted batch onwards)

Name of Program		B.Tech (Mechanical Engg.)	Semester III	Year II
Name of Course		Applied Numerical Methods		
Course Code		MTH 24231		
Core / Elective / Other		Core		
Prerequisite:				
1.	Knowledge of Engineering Mathematics			
2.	Basics of statistical concepts such as central tendencies, dispersion etc.			
Course Outcomes:				
1.	Apply suitable numerical techniques for real world problem related to Electrical Engineering			
2.	Have ability of understanding statistical inferences			
Description of Contents in brief:				
1.	Numerical Methods: Solution of algebraic and transcendental equations, Solution of linear Simultaneous Equations.			
2.	Finite Differences, Interpolation and Extrapolation, Inverse Interpolation.			
3.	Numerical Differentiation and Integration.			
4.	Numerical solution of Ordinary & Partial Differential Equations.			
5.	Statistics: Curve fitting, Correlation and Regression Analysis			
6.	Probability Distribution.			
List of Text Books:				
1.	Advanced Engineering Mathematics by Erwin Kreyszig			
2.	Mathematical Statistics-Ray, Sharma and Chaudhary			
3.	Numerical Methods by Dr. B. S. Grewal			
List of Reference Books:				
1.	Numerical Analysis by Hildebrand, Mcgraw Hill.			
2.	Numerical Analysis by Scarborough, Oxford.			
3.	Mathematical Statistics – J E Freund & R E Walpole			
4.	Numerical Methods by E .Balaguruswamy, TMH			
URLs:				
1.	https://nptel.ac.in/courses/111/107/111107105/			
2.	https://nptel.ac.in/courses/111/105/111105041/			
3.	https://nptel.ac.in/courses/111/106/111106101/			
4.	https://nptel.ac.in/courses/110/107/110107114/			
Lecture Plan (about 36-40 Lectures):				
Lecture No.		Topic		
Solution of Algebraic and Transcendental Equations (08 L)				
1.	Basic Concept and Motivation			

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2.	Bisection method, Regula-Falsi method, Secant method
3.	Iterative method
4.	Newton-Raphson method, Chebyshev Method
5.	Newton's method for multiple roots
6.	Graffee's Root Squaring Method
7.	Descartes Rule of Signs, Lin Bairstow's Method for finding complex roots
8.	Rate of Convergence and order of convergence of different methods
Solution of Linear and Non-Linear Simultaneous Equations (5 L)	
9.	Introduction, Gauss Elimination, Partial and Complete pivoting
10	Gauss Jordan
11.	Iterative Method: Jacobi Iterative Method, Gauss-Seidel Method
12.	Factorization Method- LU Decomposition method
13	Newton Raphson method for Non-Linear Simultaneous Equations & its convergence
Finite Differences, Interpolation, Numerical Differentiation and Integration (11 L)	
14.	Introduction, Forward, Backward and Different operators
15.	Interpolation and Extrapolation: Newton Gregory's Forward interpolation Formula,
16.	Backward interpolation formula and problems.
17.	Central difference formulae: Gauss Forward, Gauss Backward, Stirling's Formula
18.	Central difference formulae (continued): Bessel's Formula, Laplace-Everette's Formula
19.	Divided Difference Table, Newton Interpolating formula for unequal interval
20.	Lagrange Interpolation formula, Inverse interpolation, Lagrange's inverse interpolation
21.	Numerical Differentiation, maxima and minima of tabulated functions
22.	Introduction, Numerical integration, Newton-Cotes quadrature formulae: Trapezoidal Rule, Simpson 1/3 Rule
23.	Simpson 3/8 Rule, Weddle Rule and problems
24.	Error analysis
Numerical Solution of ODE and PDE (06 L)	
25.	Introduction, Picard's method, Taylor's Series (ODE)
26.	Euler and Euler's Modified method (ODE)
27.	Runge- Kutta Method; III & IV order methods, (ODE)

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28.	Milne's Method and Error Analysis (ODE)
29.	Adams Bash-forth Method and Error Analysis (ODE)
30.	Error of above methods
Statistics (10 L)	
31.	Introduction, Curve Fitting by the Method of Least Square
32.	Examples of Curve Fitting.
33.	Correlation: , Type of Correlation, examples
34.	Coefficient of correlation, Rank correlation, examples
35.	Regression, Line of regression of X on Y, Line of regression of Y on X,
36.	Relation between correlation and regression, Standard Error of Estimate
37.	Random variable, Binomial Distribution, examples
38.	Poisson Distribution, examples
39.	Normal Distribution.
40.	Examples of Normal Distribution.

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program	B.Tech (Mechanical Engg.)	Semester III	Year II
Name of the Course:	Fundamentals of Entrepreneurship		
Course Code:	HUM24251		
Core/Elective/Other:	Core		
Pre-requisites:	1. Fundamental Understanding of Personnel Administration is an integral part for Engineers before entry into organization and to setup any startup business. 2. Organizational theories and Motivation for Entrepreneurship, enthusiastic for systematic approach to handle the materialistic and non-materialistic motivation		
Course Outcomes:			
1	Course will inculcate administrative skills for Engineers to handle the all the matters related to personnel and their dimensions.		
2	Engineering students will be in position to take appropriate decision to understand the industrial Laws and application of administrative principles for smooth functioning of Industry and a fresh idea to setup new business.		
3	Boost up the engineers to develop Business ideas to become successful entrepreneurs to setup new operational business units to address the need of society.		
Description of Content in Brief:			
1	Introduction: Meaning, nature and scope of Personnel Administration in India, functions and significance of Personnel Administration, Recruitment, Training, Promotion and Disciplinary Action, Classification of Services, Generalists and Specialists, Development of Public Services in India, Bureaucracy and Modern Democratic System, Performance Appraisal.		
2	Organizational Theories:Organizational Development Theories, Fredric Winslow Taylor, Marry Parker Follett, Elton Mayo, Max Weber, Henry Fayol, Power, Accountability, Responsibility, Control, Transparency and Conflict Resolutions		
3	Entrepreneurship: Meaning and importance of Entrepreneurship, Evolution of Entrepreneurship, Factors influencing Entrepreneurship: Social factors, psychological factors, economical factors and environmental factors. Characteristics of an Entrepreneur, Types of Entrepreneur: type of business, use of technology, motivation. New Generation of entrepreneurship: social entrepreneurship, tourism entrepreneurship, women entrepreneurship. Barriers to Entrepreneurship.		
4	Entrepreneurial motivation:Relevance of Motivation, Maslow's Theory, Herzberg's Theory, Douglas McGregor, Ethics, Corruption and Anti-Corruption Machinery in country		
5	Industrial Laws:Factory Act 1948, Provident Fund Act 1952,Dispute Act, Labour Act, Compensation Act 1919,Inter State Migrant worker Act, LabourAct, Sexual Harassment Act, Special Economic Zone (SEZ), National Small Industries, Quality Standard with Special reference to (ISO), Small Industries Development Bank of India (SIDBI), New Pension Scheme 2004 Act.		
List of Text Books:			
1	D. Ravindra Prasad, V.S. Prasad, P. Satyanarayana, Y. Pardhasaradhi. Administrative Thinkers. Sterling Publishers Private Limited Second Revised Enlarged Edition, New Delhi. 2010.		
2	Haidi, Patricia & Brush, Teaching Entrepreneurship, Edward Elgar, United States of America, 2014.		

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3	Norma M. Riccucci, Public Personnel Management, Rutledge, United States of America, 2017.
4.	Padhi, Labour & Industrial Laws, PHI Learning Private Limited, Eastern Economy Edition. New Delhi,2017
List of Reference Books	
1	Monappa & Saiyadain, Personnel Management, McGraw Hills, January-2001.
2	Howard & Donald, Entrepreneurship: Theory, Process &Practice, engage Learning, Australia, 2010.
3	Jared, Donald & John, Public Personnel Management, Rutledge, United Kingdom,2018
4	Sinha & Sekhar, Industrial Relations, Trade Unions and Labor Legislations, Pearson Publication, New Delhi.2017
URLs:	
1	https://www.my-mooc.com/en/categorie/entrepreneurship
2	https://nptel.ac.in/courses/110/106/110106141/
3	https://nptel.ac.in/courses/122/105/122105020/
Lecture Plan	
1.	Historical Background of Organization and its Personnel with its nature and scope.
2.	Meaning definitions, relevance of personnel administration in organizations
3.	Why to understand personnel administration first than entrepreneurship development for Engineers
4.	Types of organizations and personnel administration
5.	Laws of recruitment, types, legal procedures in the organization to promote and demote the personnel, Performance Appraisal
6.	Development of personnel administration in India, bureaucracy and its types in India, Contribution of Max Weber
7.	Promotion, types of promotion, disciplinary action and classification of services, Administrative tribunals
8.	Generalists Vs. Specialists, their arguments and need of the hierarchy at the top of the organization.
9.	Modern Democratic system and organizations in the world
10.	Organizational Theories and its development; Contributions of classical thinkers in the professionalism.
11.	Contributions of Frederick Winslow Taylor in the development of Scientific management approach, functional foremanship and development of scientific tools and techniques for more efficiency.
12.	Top level management and contribution of French engineer in the development of basic professional principles for high rise in production.
13.	Hawthorne Experiment and emergence of new Human Relation approach by the Elton Mayo
14.	Marry Parker Follet and orders to follow in different situations and understand the behavior of employees.
15.	Accountability, Responsibility, Power, Control, Authority and its Impact on people.

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16.	Transparency and conflicts in the organizations
17.	Interdependence between the Entrepreneurship and Personnel administration
18.	Basic understanding of entrepreneurship ,its relevance and challenges
19.	Factors influencing the entrepreneurship
20.	Social factors, psychological factors, economical factors and environmental factors
21.	Characteristics of an Entrepreneur,
22.	Types of Entrepreneur: type of business, use of technology, motivation
23.	New Generation of entrepreneurship: social entrepreneurship, tourism entrepreneurship, women entrepreneurship.
24.	Barriers to Entrepreneurship
25.	Entrepreneurial motivation: Relevance of Motivation to start a new business
26.	Maslow's Need Hierarchy Theory, Herzberg's Theory X and Y.
27.	Douglas McGregor, Ethics,
28.	Corruption and Anti-Corruption Machinery in country
29.	Factory Act 1948, Provident Fund Act ,1952
30.	Compensation Act, 1919 and its implementation in the industries
31.	Provident Fund Act, 1952 its provisions and benefits.
32.	Rural Entrepreneurship in India
33.	Quality Standard with Special reference to (ISO)
34.	New Pension Scheme 2004,Act for all the central and states government employees
35.	Industrial Development Bank of India (IDBI)
36.	Case studies on Entrepreneurship in the world and India
37.	National Institute of Entrepreneurship in India
38.	Banking system in India and Entrepreneurship
39.	Central Government Initiatives to start a business
40.	Problems and Prospects of entrepreneurship in India
41.	Special Economic Zone (SEZ)
42.	Industrial Dispute Act,1947
43.	Trade Union Act, 1926
44.	Equal Remuneration Act, 1976
45.	Inter-state Migrant Workmen Act,1979
46.	Child Labor (Prohibition & Regulations) Act,1986
47.	Sexual Harassment at the Workplace (Prevention, Prohibition & Redresses) Act, 2013
48.	Contract Labor (Regulation & Abolition) Act,1970

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49.	Apprentices Act, 1961
50.	Case Studies

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester III	Year II
Name of Course		Engineering Thermodynamics		
Course Code		ME24211		
Core / Elective / Other		Core		
Prerequisite if any: Nil				
Course Outcomes:				
1.	Understand the concepts of continuum, system, control volume, thermodynamic properties, thermodynamic equilibrium, work and heat.			
2.	Apply the laws of thermodynamics to analyze boilers, heat pumps, refrigerators, heat engines, compressors and nozzles.			
3.	Evaluate the performance of steam power cycles.			
4.	Analyze and evaluate the available energy and irreversibility.			
5.	Understand and analyze properties of pure substances and gas mixtures.			
6.	Analyze air standard cycles applied in prime movers.			
Description of Contents in brief:				
Unit 1.	Fundamental Concepts and Definitions: Continuum and macroscopic approach; thermodynamic systems (closed and open); thermodynamic properties and equilibrium; state of a system, paths and processes on state diagrams; concepts of heat and work, different modes of work; zeroth law of thermodynamics; concept of temperature.			
Unit 2.	First Law of Thermodynamics: First law applied to elementary processes, closed systems and control volume, general energy equation, steady flow energy equation on unit mass and time basis, application of SFEE for devices such as boiler, turbine, heat exchangers, pumps, nozzles, etc. Illustrative problems.			
Unit 3.	Second Law of Thermodynamics: Limitations of the first law, definition of a heat engine, heat pump, refrigerator, thermal efficiency and the coefficient of performance. Kelvin-Planck and Clausius statements of the second law, their equivalence, reversible heat engine, Carnot theorems and corollaries. Reversible process, irreversible process, Carnot cycle, thermodynamic temperature scale. Entropy, Clausius theorem, Clausius inequality, Principle of increase of entropy, available and unavailable energy, irreversibility, illustrated problems.			
Unit 4.	Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapor phases with reference to T-v, P-T, P-V, P-h, H-s & T-s diagrams, triple and critical points, phase rule, ideal and real gases, equations of state, Thermodynamic Relations: Helmholtz and Gibbs Function, Coefficient of volume expansion and isothermal compressibility, Maxwell Relations, T-ds equations, difference in heat capacities, ratio of heat capacities, Internal energy relations, Clausius- Claperyon equation, Joule-Thomson coefficient.			
Unit 5.	Vapour& Gas Power cycles: Carnot cycle, Rankine cycle, comparison of Carnot and Rankine cycle, modified Rankine cycle, calculation of cycle efficiencies, variables affecting efficiency of Rankine cycle. Carnot, Otto, Diesel, Dual, Atkinson and Brayton cycle. Comparison of Otto, Diesel and Dual cycles, calculation of air standard			

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	efficiencies, mean effective pressure, brake thermal efficiencies, relative efficiencies of I.C. engine.
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List of Text Books:

1.	P.K.Nag, Basic and Applied Thermodynamics, Mc GrawHill Education, New Delhi, 2010
2.	G.J.Van Wylen and R.E.Sonntag, Fundamentals of Thermodynamics, Wiley Eastern, New Delhi, 2008
3.	Yonus A Cengel and Michale A Boles, Thermodynamics: An Engineering Approach, McGraw Hill, 2016

List of Reference Books:

1.	Holman.J.P., Thermodynamics, 3rd Edition, McGraw-Hill, 1995
2.	Rao Y.V.C., An introduction to Thermodynamics, New Age publishers, New Delhi, 2004
3.	M.J. Moron and H.N. Shapiro, Fundamentals of Engineering Thermodynamics, John Wiley & Sons, Inc. ,U.K. 2006

URLs:

1.	http://www.nptel.ac.in
2.	https://swayam.gov.in/nc_details/NPTEL

Lecture Plan (about 40-50 Lectures):

*Lecture No.	Topic	Remarks
1.	Continuum and macroscopic approach; thermodynamic systems (closed and open); thermodynamic properties and equilibrium	
2.	Thermodynamic properties and equilibrium; state of a system, paths and processes on state diagrams	
3.	Concepts of heat and work, different modes of work	
4.	Zeroth law of thermodynamics; concept of temperature illustrative Problems	
5.	First law applied to elementary processes, closed systems and control volume, general energy equation	
6.	Concept of energy, nature of energy, pure substance, two property rule, numerical problems	
7.	First law applied to a control volume, general energy equation, steady flow energy equation on unit mass and time basis	
8.	Steady flow energy equation on unit mass and time basis, application of SFEE for devices such as boiler, turbine	
9.	Application of SFEE for devices such as pumps, nozzles illustrative problems	
10.	Second Law of Thermodynamics: Limitations of the first law, definition of a heat engine, heat pump, refrigerator	
11.	Thermal efficiency and the coefficient of performance. Kelvin-Planck and Clausius statements of the second law	
12.	Equivalence of Kelvin-Planck and Clausius statements, reversible heat engine	
13.	Carnot theorems and corollaries	
14.	Reversible process, irreversible process, factors responsible for making a process irreversible	

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15.	Carnot cycle, thermodynamic temperature scale	
16-17.	Entropy, Clausius theorem, Clausius inequality	
18.	Principle of increase of entropy, available and unavailable energy, Irreversibility	
19.	Available and unavailable energy, irreversibility (continued)	
20.	Available and unavailable energy, irreversibility (continued)	
21.	Related numerical problems	
22.	Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapor phases	
23.	T-v, P-T, P-V, P-h, H-s & T-s diagrams, triple and critical points	
24.	Quality of steam, its determination	
25.	Steam processes; expressions for the change in internal energy, enthalpy, entropy in various processes	
26.	Phase rule, ideal and real gases, equations of state	
27.	Helmholtz and Gibbs Function, Coefficient of volume expansion and isothermal compressibility	
28.	Maxwell Relations, T-ds equations, difference in heat capacities, ratio of heat capacities, Internal energy relations	
29.	Clausius-Claperyon equation, Joule-Thomson coefficient	
30.	Related numerical problems	
31.	Related numerical problems	
32.	Simple Rankine cycle	
33.	Actual Rankine cycle; losses	
34.	Comparison of Carnot cycle	
35.	Mean Temperature of Heat Addition: Effect of pressure on Rankine cycle	
36.	Modified Rankine cycle: Reheat cycle.	
37.	Related numerical problems	
38.	Related numerical problems	
39.	Related numerical problems	
40.	Air Standard Cycles: Assumptions for air standard cycles, Otto Cycle	
41.	Analysis of Otto cycle, efficiency, work output and mean effective Pressure	
42.	Diesel cycle and its analysis	
43.	Diesel cycle and its analysis (continued)	
44.	Dual cycle, comparison of dual cycle with Otto and Diesel cycle	
45.	Atkinson and Brayton cycles	
46.	Related numerical problems	
47.	Related numerical problems	
48.	Related numerical problems	

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Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester III	Year II
Name of Course		Mechanics of Materials		
Course Code		ME 24212		
Core / Elective / Other		Core		
Prerequisites:				
1.	Physics / Mathematics			
2.	Engineering Mechanics			
Course Outcomes:				
1.	Understand the mechanical behavior of bodies, components, machines and structures when they are subjected to external loads / loading systems.			
2.	Design a component / machine / structure that can operate safely within specified constraints.			
3.	Utilize appropriate materials in design considering the relevant engineering properties, sustainability, cost and weight.			
Description of Contents:				
Unit 1. (8L)	Analysis of Stress & Strain - Uniaxial Stresses and Strains, Hooke's Law, Normal and Shear Stresses, Stress-Strain Curves, Material Properties, Elastic Moduli and their Relationships, Strain Energy, Impact Loading, Statically Indeterminate Problems, Thermal Effects.			
Unit 2. (8L)	Biaxial Stresses and Strains - Stress Transformation, Analytical Method, Mohr's Circle, Strain Transformation, Strain Measurements, Principal Planes, Principal Stresses and Principal Strains, Strain Energy in terms of Principal Stresses.			
Unit 3. (8L)	Torsion - Introduction, Torsion of Circular Shafts, Power Transmission by Shafts, Solid Shafts v/s Hollow Shafts, Compound Shafts, Tapered Shafts, Strain Energy in Torsion, Combined Bending and Twisting.			
Unit 4. (6L)	Bending & Shear Stresses in Beams - Introduction, Pure Bending, Normal Stresses in Beams, Combined Bending and Axial Stress, Shear Stress, Shear Centre, Strain Energy in Bending.			
Unit 5. (7L)	Deflection of Beams - Introduction, Concept and Equation of Elastic Curve, Beam Deflection Determination : Double Integration Method, Macaulay's Method, Castigliano's Theorem, Strain Energy Method, Moment-Area Method and Conjugate-Beam Method.			
Unit 6. (8L)	Pressure Vessels and Mechanical Springs - Introduction, Thin and Thick Pressure Vessels, Open and Close-coiled Helical Springs, Leaf Springs and Spiral Springs.			

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List of Text Books:	
1.	Elements of Strength of Materials, Timoshenko and Young, East-West Press.
2.	Mechanics of Materials, 9E, Goodno & Gere, Cengage Learning
3.	Mechanics of Materials, 10E/2016, R. C. Hibbeler, Pearson.
4.	Mechanics of Materials, Pytel and Kiusalaas, Cengage Learning.
5.	Mechanics of Materials, E. P. Popov, Prentice Hall.
6.	Mechanics of Materials, 8E/2019, Ferdinand Beer, et al, McGraw – Hill.
7.	Strength of Materials, K. K. Shukla, Anuj Jain, et al, Narosa Publication.
8.	Strength of Materials, S. Ramamrutham, Dhanpat Rai.
List of Reference Books:	
1.	Strength of Materials, Part I & II, 3E, Timoshenko, Krieger Pub Co.
2.	Strength of Materials, Crandal, Dahl and Lardner, Tata McGraw Hill.
3.	Strength of Materials, G. H. Ryder, Palgrave Macmillan
4.	History of Strength of Materials, 1983, Timoshenko, Dover Publications
URLs:	
1.	https://nptel.ac.in/courses/105/105/105105108/
2.	https://nptel.ac.in/courses/112/107/112107147/
3.	https://gradeup.co/theories-of-failures-i-2bcb95d0-83cf-11e6-890c-51e8ac482cfb

Lecture Plan

Lecture No	Topic
1	Introduction to Stresses & Strains
2	Basic Elasticity Principles
3	Stress-Strain Curves & Mechanical Properties of Materials
4	Strain Energy
5	Impact Loading
6	Composite Structures
7	Thermal Stresses
8	Combination of Thermal Stresses and Composite Structures
9	Biaxial Stresses and Strains
10	Analytical Method for Stress Transformation
11	Principal Planes, Principal Stresses, and Maximum Shear Stresses
12	Mohr's Circle – I
13	Mohr's Circle – II
14	Strain Transformation and Principal Strains
15	Strain Measurements
16	Strain Energy in terms of Principal Stresses.
MINI TEST	

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17	Introduction to Torsion
18	Torsion of Circular Shafts
19	Power Transmission by Shafts
20	Solid Shafts v/s Hollow Shafts
21	Compound Shafts.
22	Tapered Shafts
23	Strain Energy in Torsion
24	Combined Bending and Twisting
25	Shear Forces and Bending Moments in Beams
26	Theory of Pure Bending, Bending Stresses, Neutral Axis and Neutral Plane
27	Combined Bending and Axial Stresses
28	Shear Stresses in Beams
29	Shear Center
30	Strain Energy in Bending
MID TERM EXAM	
31	Deflection of Beams – Introduction and Concept of Elastic Curve
32	Double Integration Method
33	Macaulay's Method
34	Strain Energy Method
35	Castigliano's Theorem
36	Moment-Area Method
37	Conjugate-Beam Method
38	Introduction to Pressure Vessels, Thin & Thick Pressure Vessels
39	Analysis of Pressure Vessels - 1
40	Analysis of Pressure Vessels - 2
41	Analysis of Pressure Vessels - 3
42	Introduction to Mechanical Springs
43	Close - coiled Helical Springs
44	Open - coiled Helical Springs
45	Leaf Springs and Spiral Springs

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester III	Year II
Name of Course		Material Science and Engineering		
Course Code		ME24213		
Core / Elective / Other		Core		
Prerequisite if any:				
1.	Engineering Chemistry			
2.	Engineering Physics			
Course Outcomes:				
1.	Identify various crystal structure of materials and defects present			
2.	Identify various methods of determining mechanical properties of materials and various strengthening mechanisms in metals			
3.	Interpret various phase diagrams and analyze the solidification of metals			
4.	Select suitable heat treatment process to achieve desired set of mechanical properties in various alloys			
5.	Select various metallic alloys and non-metallic materials like polymers, ceramics and their intended applications			
Description of Contents in brief:				
Unit 1.	Concepts of crystal structure, Bravais lattice, unit cell, planes and directions, linear and planar density, 0,1, 2 and 3 dimensional defects in materials			
Unit 2.	Importance of defects in determining mechanical properties, Hall-Petch equation and critically resolved shear stress, methods of determining various mechanical properties-Tensile test, Impact test, hardness test, fatigue test and creep test, types of fracture.			
Unit 3.	Definition of phase, phase rule, Concept of solid solution, Unary and binary phase diagrams, concept of tie line, Lever rule derivation and application, Various invariant reactions, applications of various commercially used phase diagrams like Fe-Fe ₃ C diagram			
Unit 4.	Theory of nucleation and growth, TTT diagram and various heat treatment processes, various surface hardening processes, precipitation hardening, low alloy steels, stainless steels, aluminum, copper and titanium alloys			
Unit 5.	Crystal structure, mechanical properties and application of ceramics, Structure and mechanical properties of polymers, concept of crystallinity and glass transition temperature, application of polymers			
Unit 6	Introduction to composites, types and fabrication methods of composites, factors determining the mechanical properties of composites. Smart materials and their Applications			
List of Text Books:				
1.	William D Callister, Materials Science and Engineering: An Introduction, John Wiley and Sons, 7 th Edition, United States			

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2.	D.R. Askeland and P.P. Fulay, Essentials of Materials Science and Engineering, Cengage Learning, 2 nd Edition, Canada
3.	V.Raghvan, Materials Science and Engineering, PHI publications, 2 nd Edition, New Delhi
4.	Foundations of Materials Science and Engineering, Smith, 4th Edition McGraw Hill, 2009

List of Reference Books:

1.	R. Abbaschian, L. Abbaschian, Robert E. Reed-Hill, Physical Metallurgy Principles, Cengage Learning, 4 th Edition, Canada
2.	M.A. Meyers, K.K. Chawla, Mechanical Behaviour of Materials, Cambridge University Press, 2 nd Edition, New York
3.	Elements of Materials Science and Engineering, H. VanVlack, Addison-Wesley
4.	Alan Cottrell, An Introduction to Metallurgy, Edward Arnold, 2 nd Edition, London

URLs:

1.	https://www.doitpoms.ac.uk/
2.	http://ocw.mit.edu/courses/materials-science-and-engineering/
3.	http://www.nptel.iitm.ac.in/courses/Webcourse-contents/IIScBANG/Material%20Science/New_index1.html
4.	http://www.nptel.iitm.ac.in/courses/113106032/

Lecture Plan (about 40-50 Lectures):

*Lecture No.	Topic	Remarks
1.	Introduction to the course, classification of materials	
2.	Definition and importance of materials science and engineering, materials tetrahedron, a review of chemical bonding and its role in defining nature and properties of materials, crystalline and amorphous materials	
3.	Concept of Crystal structure, lattice, motif and unit cell	
4.	Introduction to symmetry, 14 Bravais Lattices and 7 crystal systems, concept of symmetry	
5.	Details of SC, BCC, FCC and HCP structure, packing fraction, theoretical density	
6.	Concept of miller indices for drawing planes and directions in cubic and hcp unit cell	
7.	Linear and planar density, Slip planes and slip systems	
8.	Importance and Introduction to various defects in the material, Concept of Burger's Vector	
9.	Dislocations and their classification, Role of dislocations in plastic deformation,	
10.	Role of defects in determining the mechanical properties of materials, Various strengthening mechanisms in materials.	
11.	Hall Patch equation and concept of critically resolved shear Stress	
12.	Introduction to Tensile, hardness, impact and creep tests	
13.	Introduction to fatigue test and types of fracture	
14.	Definition of phase, Phase rule, classification of phase	

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15.	Concept of solid solution, Substitutional and interstitial solid solution, Hume Rothery's Rules,	
16.	Introduction and classification of phase diagrams, Methods to represent concentration in solid solutions	
17.	Unary and binary Phase diagrams, Examples, Tie line concept, Lever Rule derivation and application	
18.	Interpretation of binary phase diagram and microstructure development	
19.	Eutectic, eutectoid, peritectic, monotectic and peritectoid reactions and their importance	
20.	Fe-Fe ₃ C phase diagram, different phases in steels and their importance	
21.	Concept of undercooling, Theory of homogenous and heterogeneous nucleation	
22.	Growth, Nucleation rate and its variation with undercooling, Role of inoculants in solidification	
23.	Introduction to TTT diagram and various heat treatment processes	
24.	Microstructure development during isothermal holding and resulting mechanical properties	
25.	Other surface treatment processes like carburizing, nitriding, case hardening,	
26.	Carbonitriding, flame and induction hardening, vacuum and plasma hardening	
27.	Precipitation hardening treatment for ferrous and non-ferrous Alloys	
28.	Classification of alloy steels and their applications, Austenite and ferrite stabilizers, Classification of stainless steels and their applications. Corrosion resistance	
29.	Nomenclature of alloy steels and stainless steels, Tool steels and their applications, Aluminium alloys, copper alloys, titanium alloys and their applications	
30.	Nomenclature of Aluminium alloys, application of precipitation hardening in aluminium alloys	
31.	Introduction to Ceramics, Crystal structure, Imperfections in Ceramics	
32.	Mechanical properties of ceramics, Processing and application of ceramics, commercial ceramics being used in various applications, Structure of Polymers, Chemistry of polymer Molecules	
33.	Thermoplastic and thermosetting polymers, crystallinity in polymers	
34.	Mechanical Properties of polymers, Stress strain behavior, impact strength, Mechanism of deformation of semi crystalline polymers and elastomers	

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35.	Concept of glass transition temperature and factors influencing the glass transition temperature, vulcanization, commercial polymers being used in various applications.	
36.	Introduction to composites and their classification, Rule of mixtures.	
37.	Influence of fibre length, orientation and concentration on mechanical behaviour of composites	
38.	Metal matrix composites, ceramic matrix composites,	
39.	Polymer matrix composites, carbon-carbon composites and hybrid composites	
40.	Fabrication techniques of composites, commercial composites being used in various applications	
41.	Smart materials like piezoelectric materials, magnetostrictive Materials	
42.	Shape memory alloys and applications of smart materials	

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester III	Year II
Name of Course		Mechanical Drawing and CAD		
Course Code		ME24214		
Core / Elective / Other		Core		
Prerequisite if any:				
1.	Engineering Drawing/ Engineering Graphics/Engineering Arts			
Course Outcomes:				
CO1	An ability to develop part drawing of geometric objects and unique machine components through CAD software's and paper pencil techniques.			
CO2	An ability to develop assembly drawing using part drawing through CAD software's and paper pencil techniques.			
CO3	An ability to understand and prepare the detail drawing of machine assembly using British and BIS codes.			
CO4	An ability to identify, formulate and solve graphics and CAD drafting problems.			
Description of Contents in brief:				
Unit 1.	Introduction of Pictorial Projection, Type of Projection and Axonometric Projection. Isometric Projection. Problems on complex Isometric Projection. Curve of Interpenetration.			
Unit 2.	Introduction of CAD software's and their application. 2D sketching. 3D Modelling of simple part. 3D modelling of complex geometries and assemblies (Knuckle joint, Cams, Valve assemblies and Tool head of Shaper Machine).			
Unit 3.	Orthodox pencil and paper drawing of the assemblies of UNIT 2.			
Unit 4.	Advance 3D CAD Tools. Detailing of parts and assemblies. Bill of Material Generation, sectioning and dimensioning through CAD software and orthodox techniques.			
List of Text Books:				
S.No	Title of Book	Author, publication year and publisher		
1.	Mechanical Drawing	Anson Kent Cross		
2.	A Text-Book of Mechanical Drawing and Elementary Machine Design	Reid John S (John Simpson)		
3.	Machine Drawing	K. C. John, PHI Learning		
4.	Machine Drawing	K.L Narayana, New Age Publication		
5.	Machine Drawing	N D Bhatt, Charotar Publication.		
Lecture Plan (about 40-50 Lectures):				
*Lecture No.	Topic			Remarks
1-3	Introduction of Pictorial Type Projection. (Brief) Examples of Perspective projection and oblique projection. (Brush-up)			
4-6	Axonometric Projection - Isometric Drawing - Principle of Isometric Projection - Isometric Scale - Isometric Projection Vs Isometric View			

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6-9	▪ Isometric Projection and Isometric View of lamina ▪ Isometric Projection and Isometric View of circles ▪ Isometric Projection and Isometric View of solid models	
10-12	4 – 5 Applied Problems of Isometric Projection (Combined Geometries Type Problems)	
13-15	Curve of interpenetration	
16-18	Introduction of CAD Tools (sketching) on Drafting software	
19-21	3D Part modelling through Extrude and Revolve along with editing Tools	
22-24	Assembly Introduction and Concept, Assembly of Knuckle joint, Problem Discussion and assembled view.	
25-27	Development of components in CAD software of assembly problems No-1.	Parallel Session of two Batches
	Dimensioning- introduction, nature of dimension, type of dimension, system of dimension and rules of dimensions. Completion of Assembly of Tool Head Shaper Machine-1, Problem Discussion and assembled view in Paper pencil	
28-30	Dimensioning- introduction, nature of dimension, type of dimension, system of dimension and rules of dimensions. Completion of Assembly of Tool Head Shaper Machine-1, Problem Discussion and assembled view in Paper pencil	Parallel Session of two Batches
	Development of components in CAD software of assembly problems No-1.	
31-33	Assembly of Tool Head Shaper Machine-1, Problem Discussion and assembled view in Paper pencil	Parallel Session of two Batches
	Assembly of components in CAD software of assembly problems No-1.	
34-36	Assembly of components in CAD software of assembly problems No-1	Parallel Session of two Batches
	Assembly of Tool Head Shaper Machine-1, Problem Discussion and assembled view in Paper pencil	
37-39	Assembly of Tool Head of Shaper Machine-2, Problem Discussion and assembled view in Paper pencil	Parallel Session of two Batches
	Assembly of components in CAD software of assembly problems No-2.	
40-42	Assembly of components in CAD software of assembly problems No-2.	Parallel Session of two Batches
	Assembly of Tool Head of Shaper Machine-2, Problem Discussion and assembled view in Paper pencil	
43-45	Assembly of Plummer Block in Paper pencil	Parallel Session of two Batches
	Assembly of Plummer Block in CAD software	
46-48	Assembly of Plummer in CAD software	Parallel Session of two Batches
	Assembly of Plummer Block in Paper pencil	

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	

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3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester III	Year II
Name of Course		Heat Engines Lab		
Course Code		ME 24215		
Core / Elective / Other		Core		
Prerequisite if any:				
1.	Introduction to Properties of Steam			
2.	Introduction to Internal Combustion Engines			
Course Outcomes:				
1.	Practical knowledge about Steam generation			
2.	Boiler Mountings and Accessories			
3.	Introduction to I C Engines			
Description of Contents in brief:				
Exp. 1.	Study of Simple Vertical CochranBoiler			
Exp. 2.	Study of Nestler’s Boiler			
Exp. 3.	Study of Lancashire & Locomotive (Fire Tube) Boiler(s)			
Exp. 4.	Study of Babcock & Wilcox (Water Tube) Boiler			
Exp. 5.	Study of Boilers Mountings & Accessories			
Exp. 6.	Study of High Pressure Boilers (La Mont & Benson)			
Exp. 7.	Study of cut model of 4 Stroke Petrol engine			
Exp. 8.	Study of cut model of 4 Stroke Diesel engine			
Exp. 9.	Study of cut model of 2 Stroke Petrol engine			
Exp. 10.	Study of cut model of 2 Stroke Diesel engine			
List of Text Books:				
1.	Thermal Engg. by R K Rajput, Laxmi Publications, 2008			
2.	Thermal Engg. by Onkar Singh, New Age Publications, 2009			
3.	Thermal Engg. by Domkundwar, Dhanpat Rai,1984			
4.	Internal Combustion Engines by Sharma & Mathur, Dhanpat Rai Publications, 2014			
5.	BME by Pandya & Shah, Charotar publishing house, 2015.			
List of Reference Books:				
1.	Thermal Engg. by P L Ballaney, Khanna Publication 1972			
2.	J.B. Heywood, Internal Combustion Engine Fundamentals, McGraw Hill Co.1988			
URLs:				

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1.	http://www.nptel.ac.in	
2.	https://swayam.gov.in/nc_details/NPTEL	

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester III	Year II
Name of Course		Mechanics of Materials Lab		
Course Code		ME 24216		
Core / Elective / Other		Core		
Prerequisites, if any: Nil				
1.	Physics			
2.	Engineering Mechanics (Statics in particular)			
3.	Mechanics of Materials (Co – requisite)			
Course Outcomes:				
1	Measure deformations, forces, and strains under a variety of loading conditions, including tension, compression, bending, or any combination of these loadings using Universal Testing Machine (UTM).			
2	Predict component behavior using experimental test results and engineering formulae.			
3	Analyze experimental data, theoretical models and their scalability to components.			
4	Formulate a solution path for analyzing an actual multi-component structure using experimental and theoretical methods.			
Description of Contents in brief:				
Unit 1.	Study of Universal Testing Machine (UTM)			
Unit 2.	Tension Test on UTM			
Unit 3.	Study of Strain Gauge			
Unit 4.	Study of Impact Testing and Concept of Impact Strength			
Unit 5.	Determination of Impact Strength through Charpy Impact Test			
Unit 6.	Determination of Impact Strength through Izod Impact Test			
Unit 7.	Study of Hardness Tests			
Unit 8.	Determination of Rockwell Hardness for different materials			
Unit 9.	Determination of Brinell Hardness for different materials			
Unit 10.	Determination of Vickers Hardness for different materials			
Unit 11.	Torsion Testing of Circular Shafts			
Unit 12.	Deflection through Curved Beam Apparatus			
List of Text Books:				
1.	Abdul Mubeen, Experimental Strength of Materials, Khanna Publishers, 1993E			
2.	William F. Hosford, Mechanical Behaviour of Materials, Cambridge University Press, 2E, 2009			
List of Reference Books:				
1.	Norman E. Dowling, Mechanical Behaviour of Materials, Pearson, 4E, 2012			
2.	Marc Andre Meyers and Krishan Kumar Chawla, Mechanical Behaviour of Materials, Cambridge university Press, 2E, 2008.			
URLs:				
1.	https://www.sciencedirect.com/topics/materials-science/impact-testing			

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2.	https://theconstructor.org/practical-guide/material-testing/tension-test-steel-rod/2482/
3.	https://www.gopracticals.com/mechanical/basic-mechanical/mechanical-conduct-tensile-utm/
4.	https://www.element.com/nucleus/2016/12/12/21/43/charpy-vs-izod-impact
5.	https://guidebytips.com/difference-between-izod-and-charpy-impact-test/

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program	B.Tech (Mechanical Engg.)	Semester III	Year II
Name of Course	Material Characterization Lab.		
Course Code	ME 24217		
Core / Elective / Other	Core		
Prerequisite if any:			
1.	Subject Knowledge of Material Science		
Course Outcomes:			
1.	Enable to do the quantitative and qualitative analysis of different structures.		
2.	Understanding the methodology of drawing phase diagrams.		
3.	Develop an understanding of the effects of heat treatment processes for Steel.		
4.	Enables to understand and correlate the structure and properties of materials.		
Description of Contents in brief:			
Exp 1.	To Study different Crystal Structures and prepare their Ball Models.		
Exp 2.	To Prepare the sample of a given material for micro-structural examination.		
Exp 3.	Micro-structural examination of given specimen through metallurgical microscope		
Exp 4.	To measure the Grain size of Polycrystalline Material through Image Analyzer.		
Exp 5.	To measure the Volume fraction of a Phase in a Dual Phase Material through Image Analyzer		
Exp 6.	To measure the Particle size of Particle Reinforcement a given Material through Image Analyzer		
Exp 7.	To Draw Phase diagram for Pb-Sn alloy System through thermal analysis.		
Exp 8.	To Perform the Annealing and Normalizing Processes for a given Mild steel specimen and to observe their effect.		
Exp 9.	To Perform the Hardening and Tempering Processes for a given Mild steel specimen and to observe their effect.		
Exp10.	To Determine the Hardenability of Steel through Jominy End quench Test.		
List of Text Books:			
1.	ASM Handbook Mechanical Testing and Evaluation.		
2.	Metallography: Principles and Practice, George F. Vander Voort, ASM Int.		
3.	Laboratory Manual of the Institute.		
List of Reference Books:			
1.	Materials Science and Engineering, William D. Callister, John Wiley		
2.	The Science and Engineering of Materials, Askeland and Phule, Thomson		
3.	Heat treatment Principles & Techniques, T.V. Rajan & Sharma, PHI		
URLs:			
1.	http://www.nptel.iitm.ac.in/courses/Webcourse-contents		
2.	http://www.researchgate.net		
3.	http://ocw.mit.edu/courses/materials-science-and-engineering		

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Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester III	Year II
Name of Course		Professional Practices		
Course Code		ME 24218		
Core/ Elective / Other		Core		
Prerequisite: Nil				
Course Outcomes:				
CO 1	To know the historical background and evolution of the Mechanical Engineering discipline.			
CO 2	To know the Present State of the Art of the Mechanical Engineering Discipline.			
CO 3	To acquire knowledge about the Government Policies and Schemes relevant to the Mechanical Engineering Discipline.			
CO 4	To acquire the knowledge of Outreach Activities in the Mechanical Engineering Discipline.			
Topics Covered as per Syllabus				
1.	Historical background of the Discipline.			
2.	Evolution of the Discipline.			
3.	Present State of Art of the Discipline.			
4.	Government Policies and Schemes relevant to the Discipline.			
5.	Avenues for Outreach activities in the Discipline.			
List of Text Books:				
1.	An Introduction to Mechanical Engineering: <u>Jonathan Wickert</u> , <u>Kemper Lewis</u> , Cengage Learning, 2016.			
2.	Professional Practice in Engineering and Computing Preparing for Future Careers: RiadhHabash, 1st Edition, Boca Raton, CRC Press, 2019			

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B. Tech	Semester IV	Year II
Name of Course		Fundamental of Design Methods		
Course Code		ME24252		
Core / Elective / Other		CORE		
Prerequisite if any:				
1.	NIL			
Course Outcomes:				
CO1	Develop a strong understanding of the design process and apply it in a variety of business Settings			
CO2	Analyse self, culture, teamwork to work in a multidisciplinary environment and exhibit empathetic behavior			
CO3	Formulate specific problem statements of real time issues and generate innovative ideas using design tools			
CO4	Apply critical thinking skills in order to arrive at the root cause from a set of likely causes			
CO5	Demonstrate an enhanced ability to apply design thinking skills for evaluation of claims and arguments			
Description of Contents in brief:				
Unit 1.	Introduction to design thinking, traditional problem solving versus design thinking, history of design thinking, wicked problems. Innovation and creativity, the role of innovation and creativity in organizations, creativity in teams and their environments, design mind-set. Introduction to elements and principles of design, 13 Musical Notes for Design Mind-set, Examples of Great Design, Design Approaches across the world			
Unit 2.	Understanding humans as a combination of I (self) and body, basic physical needs up to actualization, prosperity, the gap between desires and actualization. Understanding culture in family society, institution, startup, socialization process. Ethical behavior: effects on self, society, understanding core values and feelings, negative sentiments and how to overcome them, definite human conduct: universal human goal, developing human Consciousness in values, policy, and character. Understand stakeholders, techniques to empathize, identify key user problems. Empathy tools- Interviews, empathy maps, emotional mapping, immersion and observations, customer journey maps, and brainstorming, Classifying insights after Observations, Classifying Stakeholders, Do's & Don'ts for Brainstorming, Individual activity- 'Moccasin walk'			
Unit 3.	Defining the problem statement, creating personas, Point of View (POV) statements. Research- identifying drivers, information gathering, target groups, samples, and feedbacks. Idea Generation-basic design directions, Themes of Thinking, inspirations and references, brainstorming, inclusion, sketching and presenting ideas, idea evaluation, double diamond approach, analyze – four W's, 5 why's, "How Might We", Defining the problem using Ice-Cream Sticks, Metaphor & Random Association Technique, Mind-Map, ideation activity games - six thinking hats, million-dollar idea, introduction to visual collaboration and brainstorming tools - Mural, JamBoard			
Unit 4.	Fundamental concepts of critical thinking, the difference between critical and ordinary thinking, characteristics of critical thinkers, critical thinking skill slinking ideas, structuring arguments, recognizing incongruences, five pillars of critical thinking,argumentation versus rhetoric, cognitive bias, tribalism, and politics. Case study onapplying critical thinking on different scenarios. Lateral Thinking			

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Unit 5.	The argument, claim, and statement, identifying premises and conclusion, truth and logic conditions, valid/invalid arguments, strong/weak arguments, deductive argument, argument diagrams, logical reasoning, scientific reasoning, logical fallacies, propositional logic, probability, and judgment, obstacles to critical thinking. Group activity/role plays on evaluating arguments.
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List of Text Books:

1.	101 Design Methods A Structured Approach for Driving Innovation in Your Organization,	Vijay Kumar, John Wiley and Sons Inc, New Jersey
2.	Foundations of Ethics and Management	BP Banerjee, Excel Books
3.	Design Thinking	Gavin Ambrose and Paul Harris, AVA Publishing SA
4.	Design of Business:	Roger L. Martin, Harvard Business Press, Boston MA
5.	Engineering Design	G.E. Dieter
6.	Six Thinking Hats	Edward De Bono, Viking England, 1986
7.	The new age of innovation	C.K. Prahalad, M.S. Krishnan, Tata McGraw Hill

URLs:

1.	https://nptel.ac.in/courses/110/106/110106124/
2.	https://www.youtube.com/c/UniversalHumanValues

Lecture Plan (about 40-50 Lectures):

*Lecture No.	Topic	Remarks
1.	Introduction to design thinking	
2.	Traditional problem solving versus design thinking	
3.	History of design thinking,	
4.	Wicked problems.	
5.	Innovation and creativity	
6.	Role of innovation and creativity in organizations, creativity in teams and their environments, design mind-set	
7.	Introduction to elements and principles of design	
8.	Musical Notes for Design Mind-set,	
9.	Examples of Great Design, Design Approaches across the world	
10.	Understanding humans as a combination of I (self) and body, basic physical needs up to actualization, prosperity, the gap between desires and actualization.	
11.	Understanding culture in family society, institution, startup, socialization process.	
12.	Ethical behavior: effects on self, society, understanding core values and feelings, negative sentiments and how to overcome them,	
13.	Definite human conduct: universal human goal, developing human Consciousness in values, policy, and character	
14.	Understand stakeholders, techniques to empathize, identify key user problems.	
15.	Empathy tools- Interviews, empathy maps, emotional mapping, immersion and observations, customer journey maps, and brainstorming,	
16.	Classifying insights after Observations, Classifying Stakeholders,	
17.	Do's & Don'ts for Brainstorming	
18.	Individual activity- 'Moccasin walk'	

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19.	Defining the problem statement, creating personas, Point of View (POV) statements	
20.	Research- identifying drivers, information gathering, target groups, samples, and feedbacks.	
21.	Idea Generation-basic design directions,	
22.	Themes of Thinking, inspirations and references, brainstorming, inclusion,	
23.	Sketching and presenting ideas, idea evaluation, double diamond approach,	
24.	Analyze – four W's, 5 why's, "How Might We", Defining the problem using Ice-Cream Sticks,	
25.	Metaphor & Random Association Technique	
26.	Mind-Map, ideation activity games - six thinking hats, million-dollar	
27.	Fundamental concepts of critical thinking	
28.	The difference between critical and ordinary thinking	
29.	Characteristics of critical thinkers	
30.	Critical thinking skill slinking ideas	
31.	Structuring arguments	
32.	Recognizing incongruences	
33.	Five pillars of critical thinking	
34.	Argumentation versus rhetoric	
35.	Cognitive bias, tribalism, and politics	
36.	Case study on applying critical thinking on different scenarios.	
37.	The argument, claim, and statement,	
38.	Identifying premises and conclusion	
39.	Truth and logic conditions	
40.	Valid/invalid arguments, strong/weak arguments	
41.	Deductive argument, argument diagrams	
42.	Logical reasoning, scientific reasoning, logical fallacies, propositional logic,	
43.	Probability, and judgment, obstacles to critical thinking	
44.	Group activity/role plays on evaluating arguments.	

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester IV	Year II
Name of Course		Machine Design-1		
Course Code		ME 24221		
Core / Elective / Other		Core		
Prerequisite if any:				
1.	Strength of Material			
2.	Engineering Mechanics			
Course Outcomes:				
CO1	An ability to understand and formulate the component subjected to loads and identify the failure criteria.			
CO2	An ability to analyze the stresses and strains induced in a machine element.			
CO3	An ability to design a machine component using theories of failure.			
CO4	An ability to design pins joints, cotters, couplings and joints including riveted, bolted and welded joints.			
CO5	An ability to find the feasible solution (<i>with creative aptitude</i>) for a given problem with the help of design phases.			
CO6	An ability to use the standard data for designing the component.			
Description of Contents in brief:				
Unit 1.	Introduction- Engineering Design and classification. Basic design procedure, requirement of machine element, traditional design methods. Material selection on the basis of material index. Concept of methods- preliminary design, conceptual design, detailed design. Concurrent engineering, reverse engineering, and creative design. Factor of safety. Concept of Machine Design: Types of loads. Simple Stress and Strain.			
Unit 2.	Fasteners- Types of fasteners. Types of rivet joints, rivet heads, terminology, caulking and fullering, riveted joints (Lap and Butt). Design of welded joints: Types of welded joints Strength of parallel and fillet weld, strength of a welded joint. Threaded joint- Selection of standard threaded joint (Brackets) eccentric and offset loading.			
Unit 3.	Pin type joints- Standard pin type joints, Design Procedure on failure criteria and empirical relation based- Knuckle and cotter.			
Unit 4.	Shaft- Design of shaft, Design of shaft couplings rigid, flange and protective type flange. Design for power transmission and screws Effects of stress concentration in design. Design of power screws- designing for various types of screw jacks, lead screw of lathe machine and screw press. Computer aided design of at least one joint.			
Unit 5.	Springs- Design of springs: Helical springs, closed and open coiled tension, compression springs and their ends, design of leaf springs.			
List of Text Books:				
11.	Mechanical Engineering Design	J.E. Shigley and Charles R. Mischke, TMH		
12.	Engineering Design	G.E. Dieter		
13.	Machine Design	Kulkarni, TMH		
14.	Design of Machine Elements	V B Bhandari TMH		
15.	Machine Design	R. L. Norton Tata McGraw Hill, 2005.		

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List of Reference Books:		
1.	Mechanical Engineering Design: Principles and concepts,	Siraj Ahmed (2014): PHI Learning Pvt. Ltd, ISBN-978-81-203-4931-5, New Delhi
2.	The Mechanical Design Process.	David G. Ullman: ISBN 978-0-07-297574-1 McGraw- Hill, Inc. N.Y.
URLs:		
1.	https://nptel.ac.in/courses/112/105/112105124/	
Lecture Plan (about 40-50 Lectures):		
*Lecture No.	Topic	Remarks
1.	Introduction of subject, Simple stresses.	
2.	Concept of critical section of a part.	
3.	Brief discussion on combined stresses.	
4.	Material selection approaches and methods.	
5.	Material Selection method (Digital logic method).	
6.	Concept of preliminary design, conceptual design and detailed design.	
7.	Concept of concurrent engineering, reverse engineering, and creative design. Creative techniques.	
8.	Simple Stress and Strain.	
9.	Introduction of fasteners, Types of Fasteners.	
10.	Design Procedure of knuckle joint (failure criteria and empirical relation).	
11.	Knuckle joint applied problems (failure criteria).	
12.	Knuckle joint applied problems (empirical relation).	
13.	Design Procedure of cotter joint (failure criteria and empirical relation).	
14.	Cotter joint applied problems (failure criteria).	
15.	Cotter joint applied problems (empirical relation).	
16.	Design Procedure of riveted joint.	
17.	Applied problems on riveted joint.	
18.	Design Procedure of welded joints.	
19.	Applied problems on welded joints.	
20.	Design Procedure of threaded joint (In plane).	
21.	Applied problems on threaded joint (In plane).	
22.	Design Procedure of threaded joint (offset).	
23.	Applied problems on threaded joint (offset).	
24.	Design of shaft based on combined stresses.	
25.	Applied problems on shaft.	
26.	Design of rigid/flange couplings.	
27.	Applied problems on rigid/flange couplings (non-protective).	
28.	Applied problems on flange couplings (non-protective).	
29.	Power screw and their types. Design of power screw.	
30.	Applied problems on Power screws.	
31.	Design of power screw (stresses on power screw).	
32.	Applied problems on Power screws.	
33.	Design of springs (Stress and deflection equation based).	
34.	Materials and material selection for springs.	
35.	Applied problems on static and impact load.	

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36.	Applied problems on static and impact load.	
37.	Design of spring against fluctuating load.	
38.	Applied problems on fluctuating load	
39.	Design of leaf spring.	
40.	Applied problems on leaf spring.	

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester IV	Year II
Name of Course		Mechanism of Machines		
Course Code		ME 24222		
Core / Elective / Other		CORE		
Prerequisite if any:				
1.				
Course Outcomes:				
1.	Ability to synthesis and analysis of displacement, velocity and acceleration of the individual part involved in a mechanism.			
2.	One can understand the functioning and application of mechanism and its inversions involved in the machinery.			
3.	Able to understand the actual mechanism involved in the machinery along with different dynamic forces acting on various parts of the machinery.			
Description of Contents in brief:				
Unit 1.	Kinematics: Types of Plane Motion, Links, Pairs, Kinematics of Chains, Mechanism and Machines, Constraints and Degree of Freedom, Gruber's Equation, Transmission Angle, Inversion of Four Bar, Slider Crank and Double-Slider Crank Chain, Concept of Degree Of Freedom (DOF), Movability Criterion.			
Unit 2.	Motion Analysis: Absolute and Relative Motion, Kinematics Quantities and their Relationship: Vector Diagrams, D'Alembert's Principle, Instantaneous Centers and Kennedy's Theorem, Velocity and Acceleration Analysis, Velocity and Acceleration of Reciprocating Parts Specially Piston, Connecting Rod and Crankshaft. Dynamic Force Analysis of Engine Parts, Dynamic Force Analysis of Four Link Mechanism, Single Slider Mechanism, Computer Aided Analysis of Mechanisms.			
Unit 3.	Power Transmission Devices 1: Clutch Drives: Single Plate clutch, Multi plate clutch, Cone Clutch and Centrifugal clutch. Belt Drives: Types, Materials, Ratio of Friction Tensions, centrifugal effect on belt, maximum power transmission by a belt. Chain drives: Basics and Classification of Chain Drives. Brakes: Type of Brake Drives, Types of Dynamometers..			
Unit 4.	Power Transmission Devices 2: Gear drives: Fundamental Law of Gearing, Classification and Terminology, Geometry and Kinematics considerations of various Tooth Profiles, Advantages and Limitations of Cycloidal Profile over Involute Profile, AGMA Considerations, Length of Path of contact, Arc of contact and contact Ratio, Concept of Interference and Undercutting, Virtual Number of Teeth in a helical Gears, Force Analysis and Efficiency of Spiral Gears, Gear Trains			
Unit 5.	Concept of Exact Function Mechanism: Basics of Cam and Followers, Terminology and Classification of Cam and Follower, Types of Motion Curve and Layout of Cam Profiles, Profile for different Followers, Motions of Follower			
Unit 6	Gyroscope: Gyroscopic Couple in a Plane Disc, Effect of Gyroscopic couple in a Aero-plane, Effect of Gyroscopic couple in a Navel Ships, Effect of Gyroscopic couple in a Two Wheelers, Effect of Gyroscopic couple in a Four Wheeler.			
List of Text Books:				

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1.	Theory of Machines by SS Rattan (5 th edition)	
2.	Mechanism and machine theory by J S Rao V Dukkupati	
3.	Theory of machine by R S Khurmi and J K Gupta (Latest edition)	
List of Reference Books:		
1.	Theory of machines by Thomas Bevan	
2.	Theory Of Machines and Mechanisms by J E Singley etc	
3.	Theory Of Machine And Mechanisms by Gordon R. Pennock & Joseph E. Shigley John J. Uicker	
URLs:		
1.	https://wifigyan.com/ss-rattan-tom-theory-of-machines-book/	
2.	https://www.academia.edu/35666026/THEORY_OF_MACHINES_AND_MECHANISMS_Third_Edition	
3.	https://www.amazon.in/Theory-Machine-Mechanisms-Pennock-Shigley/dp/0199454167	
Lecture Plan (about 40-50 Lectures):		
*Lecture No.	Topic	Remarks
1.	Concept of Kinematics Kinetics Statics and Dynamics.	
2.	Kinematics Types of Plane Motion,	
3	Kinematic Links, Kinematic Pairs and its Classification	
4	Kinematics of Chains, Types of Chains	
5	Mechanism, Machines and Structure	
6	Constraints and Concept of Degree Of Freedom (DOF), Movability Criterion	
7	Kutzbach Criteria, Gruber’s Equation and Problems	
8	Transmission Angle and Problems	
9	Equivalent Mechanism, Four Bar Chain	
10	Inversion of Four Bar chain	
11	Inversion of Single Slider Crank Chain	
12	Inversion of Double-Slider Crank Chain	
13	Problems on Inversions	
14	Motion Analysis: Absolute and Relative Motion, Kinematics Quantities and their Relationship:Vector Diagrams	
15	Instantaneous Centers and Kennedy’s Theorem, Velocity andAcceleration Analysis, D’Alembert’s Principle	
17	Problems	
18	Velocity and Acceleration of Reciprocating Parts	
19	Velocity and Acceleration of Reciprocating Parts Piston Connecting Rod and Crankshaft.	
20	Problems	
21	Dynamic Force Analysis of Engine Parts	
22	Dynamic Force Analysis of Four Link Mechanism	
23	Dynamic Force Analysis of Single Slider Mechanism	
24	Computer Aided Analysis of Mechanisms	

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25	Power Transmission Devices 1	
26	Belt Drives: Types, Materials	
27	Ratio of Friction Tensions, centrifugal effect on belt, maximum power transmission by a belt.	
28	Problems	
29	Clutch Drives: Single Plate clutch, Multi plate clutch	
30	Cone Clutch and Centrifugal clutch.	
31	Brakes: Type of Brake Drives	
32	Problems	
33	Types of Dynamometers	
34	Chain drives: Basics and Classification of Chain Drives.	
35	Power Transmission Devices 2: Gear drives, Fundamental Law of Gearing, Classification and Terminology	
36	Geometry and Kinematics considerations of various Tooth Profiles	
37	Advantages and Limitations of Cycloidal Profile over Involute Profile, AGMA Considerations	
38	Length of Path of contact, Arc of contact and contact Ratio,	
39	Concept of Interference and Undercutting	
40	Problems	
41	Problems	
42	Virtual Number of Teeth in a helical Gears in a Force Analysis and Efficiency of Spiral and Helical Gears.	
42	Virtual Number of Teeth in a helical Gears	
44	Force Analysis and Efficiency of Spiral Gears	
45	Problems	
46	Gear Trains	
47	Problems	
48	Concept of Exact Function Mechanism: Basics of Cam and Followers	
49	Terminology and Classification of Cam and Follower, Types of Motion Curve in and Layout of Cam Profiles	
50	Profile for different Followers, Motion Of Follower	
51	Problems	
51	Problems	
53	Gyroscope: Gyroscopic Couple in a Plane Disc	
54	Effect of Gyroscopic couple in a Aero-plane,	
55	Effect of Gyroscopic couple in a Navel Ships	
56	Effect of Gyroscopic couple in a Two Wheelers	
58	Effect of Gyroscopic couple in a Four Wheelers	
59	Problems	
60	Problems	

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Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester IV	Year II
Name of Course		Manufacturing Processes		
Course Code		ME 24223		
Core / Elective / Other		Core		
Prerequisite if any:				
1.	Basic Mechanical Engineering			
2.	Materials Engineering			
Course Outcomes:				
1.	Students shall be able to understand the foundry processes used to produce defect free ferrous/non ferrous castings in industries.			
2.	Students shall be able to understand the basics of machining, conventional machine tools, cutting tools, machining operations/parameters etc. to produce jobs at tool room/workshop.			
3.	Students shall be able to understand the basics of metals joining and forming processes.			
4.	Students shall be aware on principles/applications of latest/advance manufacturing processes viz; powder metallurgy and additivemanufacturing			
Description of Contents in brief:				
Unit 1.	Foundry: Introduction/objectives & flow diagram/layout of foundry shops/processes. Melting shop; furnaces operation & uses. Pattern shop; types, allowances, design, preparation. Core shop; types, design, preparation. Moulding shop; Materials, machines/equipments, molding methods, design consideration & calculations. Casting shop; types of processes, applications, casting defects & their causes with remedies.			
Unit 2.	Introduction to theory of machining, Conventional basic machine tools; Lathe, Drilling, Shaper & Planer machines – Purpose/application, types, specifications, construction/working, accessories/attachments, cutting tools with their materials/properties & geometry, machining operations, operating/cutting parameters/machining time with their calculations.			
Unit 3.	Introduction to Joining processes. Fusion & non fusion welding processes; Types, principles/metal transfer/heat source, applications, Numerical problems. Basic concept on high energy density welding processes. Weld ability, Welding defects and their causes withremedies.			
Unit 4.	Powder metallurgy – Introduction, powders production, powder characteristics, compaction and sintering.			
Unit 5.	Plastic deformation and yield criteria. Metal forming operations; hot-cold- warm working processes. Material behavior in metal forming processes. Classification of metal forming processes & their descriptions, applications.			
Unit 6.	Need for additive manufacturing (AM)/3D Printing (3DP)/Rapid Prototyping (RP), Background, Types of AM materials, Liquid, solid and powder based AM technologies, Steps of AM, Benefits of AM: manufacturing, medical and socio- cultural sectors.			
List of Text Books:				
1.	M. P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, Third edition. Wiley India Private Limited, 2009.			
2.	S. Kalpakjian, Manufacturing Processes for Engineering Materials, Fifth edition. Pearson Education, 2009			

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3.	Manufacturing Technology- foundry, forming & welding by P.N.Rao, McGraw HillPublication, 2018	
List of Reference Books:		
1.	Geoffrey Boothroyd and Winston A. Knight, Fundamentals of Metal Machining and Machine Tools, 3 edition, CRC Press, 2005	
2.	Amitabha Ghosh and Mallick A. K., Manufacturing Science. Affiliated East-West Press Pvt. Ltd. 2010.	
3.	John A. Schey, Introduction to Manufacturing Processes, 3 edition, McGraw Hill Education, 2012	
4.	G. K. Lal and S. K. Choudhury, Fundamentals of Manufacturing Process, 2009. Boca Raton, FL: CRC Press, 2011.	
5.	Chua, C.K. and Leong, K.F., Rapid prototyping: Principles and applications in manufacturing, John Wiley and Sons Inc., 1997	
URLs:		
https://nptel.ac.in/courses/112107144/		
https://nptel.ac.in/courses/112105127/1		
https://nptel.ac.in/courses/112/107/112107145/		
Lecture Plan (4 credit, 50 Lectures):		
*Lecture No.	Topics- Unit 1 to 3	
1	Foundry,.	
2	Melting Furnaces.	
3	Patterns, Cores.	
4	Solidification	
5	Moulding	
6	Riser and gating design	
7	Casting methods	
8	Defects & remedies	
9	Mechanics of machining	
10	Types of Lathe, its principle of working.	
11	Lathe construction/accessories, Specifications, Operations.	
12	Single point cutting tools.	
13	Materials, geometry.	
14	Drilling machine	
15	Twist drills	
16	Operations	
17	Shaping and Planers- Introduction	
18	Working principle and details of shaper and planers.	
19	Numerical problems based on operating parametersetc.	
20	Arc Welding	
21	Gas Welding	
22	TIG- MIG welding	
23	Introduction to Resistance Welding	
24	Details of resistance welding	

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25	Numerical problems associated with fusion weldings.	
26	Weldability of metals	
27	Welding defects and remedies.	
28	Powder metallurgy – Characteristics	
29	Production of powders.	
30	Compaction-Introduction	
31	Application in industries	
32	Sintering-Introduction and processing	
33	Plastic deformation and yield criteria.	
34	Cold and Hot working of metals.	
35	Forging, Rolling.	
36	Extrusion	
37	Drawing	
38	Bending	
39	Press; Working and Operations,	
40	Press Capacity.	
41	Need for Additive Manufacturing/3D Printing/Rapid Prototyping, Background.	
42	Types of AM materials.	
43	Types of AM materials.	
44	Liquid, solid and powder based AM technologies.	
45	Liquid, solid and powder based AM technologies.	
46	Steps of AM.	
47	Benefits of AM: manufacturing.	
48	Medical and socio-cultural sectors.	

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester IV	Year II
Name of Course		Industrial Engineering and Operations Research		
Course Code		ME 24224		
Core / Elective / Other		Core		
Prerequisite:				
1.	Nil			
Course Outcomes:				
1.	To enable students to understand various Industrial Engineering and Operations Research Techniques			
2.	To formulate and solve real world problems as mathematical models			
3.	To design methods to improve productivity and predict behavior of engineering systems.			
Description of Contents in brief:				
Unit 1.	Definition of Industrial Engineering, Relevance of Productivity in Industrial Engineering, Work content, Definition, productivity and work content, environmental conditions and work content, techniques to increase work content, Work study, method study, purpose, and work measurement, purpose, wage incentives, criteria etc.			
Unit 2.	Method study steps, recording techniques, analysis methods, principles of motion economy, etc., work measurement techniques, work sampling, sample size calculations, estimation of time, time study, definition of qualified worker, rating, standard time calculations etc.,			
Unit 3.	Definition and Scope of Operations Research, Problem Formulation and Model Construction. Linear Programming: Concept of optimality, graphical solution, Simplex Method, Duality, Sensitivity Analysis, Degeneracy.			
Unit 4.	Transportation and Assignment model: Transportation and Assignment Problems as special cases of Linear Programming, balanced and unbalanced Transportation Problem, Assignment Problems.			
Unit 5.	Inventory System: Definition, structure of inventory system, EOQ, Inventory Built up Model, Price Discounting Model, Shortage Model. Sequencing Model and Johnson's Rule. Waiting Line Model – Single Chanel System.			
Unit 6	Theory of Games – Two Persons Zero Sum Game, Games with Pure and Mixed Strategy, Simulation Model-Monte-Carlo Simulation. Introduction to Non Linear Programming and Genetic Algorithm.			
List of Text Books:				
1.	Introduction to Work Study by International Labour Organization, Geneva, 1003			
2.	Motion & Time Study, Design & Measurement of Work by Ralph M. Barnes; Wiley, 1980			
3.	Operations Research by Ravindran and Phillip; Wiley publication, 2007			
4.	Operations Management by Russel& Taylor; Wiley, 2008			
5.	Quantitative Techniques in Management by N D Vohra; McGraw Hill Education, 2006			
6.	Operations Research by Heera& Gupta, S Chand Publications, 2012			
List of Reference Books:				
1.	Operations Research: An Introduction, by Hamdy A. Taha, Prentice-Hall, New York, 1999			
2.	Operations Research: Applications and Algorithms, Winston, W. L.Duxbury Press, Belmont, 1995			
3.	Introduction to Operations Research, by Frederick S. Hillier and Gerald J. Lieberman, Tata McGraw Hill, New York, 2012			
URLs:				

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1.	https://nptel.ac.in/courses/112107249/	
2.	https://nptel.ac.in/courses/112106134/	
Lecture Plan (about 40-50 Lectures):		
Lecture No.	Topic	Remarks
1.	Introduction to Industrial Engineering /History and development of I.E.Productivity Concepts and Different Measures of Productivity	
2.	Work Content / Measure of Work Content / Ways to improve Productivity	
3.	Work Study: Approach and Methods / Human Factor in Work Study	
4.	Method study: objectives, generic procedure in various charts	
5.	Operations Process Chart, Flow process Charts	
6.	Diagrams – String Diagram, Flow Diagram, Travel Chart	
7.	Tutorial class for practice on charts/diagrams	
8.	Principles of Motion Economy, Two Handed Chart	
9.	Therbligs, Use of photographic techniques etc, Summary of Method Study	
10.	Work measurement, purpose, basic procedure, Work sampling	
11.	Various Techniques - PMTS, Time Study, Rating	
12.	Wage Incentives, Measured days work and wage incentives	
13.	Tutorial class for standard time calculations (W.S & T.S)	
14.	MINI TEST	
15.	Introduction of Operations Research and Applications of OR	
16.	Linear Programming: Formulation Linear Programming, Graphical Method,	
17.	Linear Programming: Graphical method Special Cases	
18.	Simplex Method – Algorithm	
19.	Simplex Method – Maximization Case & Minimization Cases	
20.	Tutorial class for Simplex method	
21.	Duality & Sensitivity Analysis	
22.	Transportation Problem – As a special case of LPP / Formulation	
23.	Transportation Problem – Methods for Initial basic feasible solution	
	Transportation Problem – Methods for Optimum Solution	
24.	Tutorial class	
25.	Assignment Problems – As a special case of Transportation Problem	
26.	Hungarian Assignment Model, Special Cases.	
27.	Tutorial class	
28.	Inventory System: Definition, Structure of Inventory System.	
29.	EOQ models, their variations, etc.	
30.	Production run model, Quantity discount model	
31.	Inventory Model with deliberate shortages allowed	
32.	Johnson's Rule and Introduction to Sequencing Model	
33.	Sequencing Model with One Machine - n job, Two Machines - n job	
34.	Sequencing Model with Three Machine - n jobs	
35.	Tutorial class for Inventory and sequencing	
36.	Introduction to probability theory, Queuing Theory: Introduction, Operating Characteristics	
37.	Poisson arrivals and exponential service time for single channel system	
38.	Queuing Theory: Single Server Model ,Multiple Server Models	
39.	Game Theory: Introduction and Terminology associated	
40.	Two Person Zero Sum Games : Pure Strategy Games and Saddle Point	
41.	Rule of Dominance, Mixed Strategy Games	

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42.	M x 2 and 2 x N Games using Graphical Method	
43.	Tutorial class for Game theory	
44.	Introduction to Simulation, Applications of simulation in industry	
45.	Monte Carlo Simulation Models	
46.	Tutorial class	
47.	Introduction to non-linear programming	
48.	Introduction to genetic algorithms and applications in engineering optimization	
49.	Case Study on Simulation	
50.	Summary of I.E and O.R.	

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester IV	Year II
Name of Course		Mechanical Measurements		
Course Code		ME24225		
Core / Elective / Other		Core		
Prerequisite if any:				
1.	Engineering Physics			
2.	Basic Electrical and Electronic			
Course Outcomes:				
CO1	Students will be able to understand the general measurement system			
CO2	Students will be able to select suitable transducers for measurement			
CO3	Students will be able to design measurement system for force and torque			
CO4	Students will be able to measure pressure and temperature of system			
Description of Contents in brief:				
Unit 1.	Introduction to measurement system: definition, types, terminologies, methods and error in measurements. Standard of measurement, Calibration. Methods of measurement, classification of measuring instruments and generalized measurement system.			
Unit 2.	Linear and Angular measurement, measurement of geometric forms, straightness, flatness, roundness. Limit, Tolerance and Fit: Concept of limit tolerance and fit, Standardization, Interchange ability, selective assemblies, I S system, Design of limit gauges. Measurement of surface roughness.			
Unit 3.	Transducers: Introduction, Classifications, Quality attributes, Primary and Secondary transducer, Electro-mechanical, Data acquisition system, Intermediate modifying system, Terminal devices.			
Unit 4.	Pressure and Temperature measurement: zero reference for pressure measurement, mechanical analogue pressure gauges, digital pressure gauges; Temperature scales, temperature measuring devices, thermometer, thermocouple, pyrometers			
Unit 5.	Measurement of Force and Torque: SI unit of force and torque, force measurement system, force and load sensors, torque measurement Stress and Strain measurement: Strain Measurement, electrical resistance strain gauge, metallic resistance strain gauge, strain gauge ballast and bridge circuit			
List of Text Books:				
S.No	Title of Book		Author, publication year and publisher	
1.	Metrology & Measurement		Anand K Bewoor & Kulkarni, 2009, McGrawHill,	

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2.	Mechanical Measurement	Thomas G Backwith, 2011, Pearson Learning Solutions
3.	Engineering Metrology	Thomas A. Hughes, 2002, ISA Press

List of Reference Books:

S.No	Title of Book	Author, publication year and publisher
1.	Textbook of Metrology	M. Mahajan, 2001, Dhanpat Rai & Co (p) Ltd
2.	Engineering Metrology and Measurements	Raghavendra & Krishnamurthy, 2013, Oxford

URLs:

1.	https://www.youtube.com/watch?v=tN7iAzVEqa0&list=PLwdnzlV3ogoXJLQ8lSGb1hsztt24l9kZZ
2.	https://www.youtube.com/watch?v=Z6evuxYjYMs&list=PLSGws_74K019wiWyVU3CnVMMqAcF3_sxz
3.	https://www.youtube.com/watch?v=lc4dsNvm2Ks&list=PLC4053D34F565AEB6

Lecture Plan (about 40-50 Lectures):

*Lecture No.	Topic	Remarks
1.	Introduction to metrology, types	
2.	Need of Inspection, principal aspect of measurement	
3.	Errors in measurement	
4.	Accuracy and Precision	
5.	General Mechanical System	
6.	Definitions of Terminology in measurement system	
7.	Linear Metrology	
8.	Linear Metrology	
9.	Angular Metrology	
10.	Concept of Limit	
11.	Concept of tolerance, Fits	
12.	Selective assembly and Interchange ability	
13.	Transducers Introduction	
14.	Classification of Transducer	
15.	Primary Transducer Operations	
16.	Quality attributes of transducers	
17.	Electro-Mechanical Transducer	
18.	Intermediate Modifying Devices	
19.	DAQ	
20.	Signal Conditioning System	
21.	Input circuitry	
22.		
23.		
24.		
25.	Amplifiers circuit	
26.	Terminal devices	

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27.	Unit of force and torque	
28.	Force measurement system	
29.	Force and load sensor	
30.	Torque measurement	
31.	Torque measurement	
32.	Strain gauges	
33.	Pressure measurement	
34.	Pressure gauges	
35.	Digital pressure gauges	
36.	Measure pressure at high temperature	
37.	Temperature scales, measuring devices	
38.	Thermometer	
39.	Thermocouples	
40.	Pyrometers	
41.	Stress and Strain introduction	
42.	Strain Measurement	
43.	Strain-gage ballast circuit	
44.	Strain-gage bridge circuit	
45.	Stress-strain relationships	

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester IV	Year II
Name of Course		Mechanism of Machines Lab		
Course Code		ME24226		
Core / Elective / Other		Core		
Prerequisite if any:				
1.	Nil			
Course Outcomes:				
1.	Ability to synthesis and analysis of displacement, velocity and acceleration of the individual part involved in a mechanism.			
2.	One can understand the functioning and application of mechanism and its inversions involved in the machinery.			
3.	Able to understand the actual mechanism involved in the machinery along with different dynamic forces acting on various parts of the machinery.			
<u>List of Experiments</u>				
SNO	Name of Experiments			
1	To find the speed at which jump phenomenon occurs in the Cam Follower System			
2	Verification of Gyroscopic couple formula			
3	To obtain the Static and Dynamic Balancing on the experimental apparatus			
4	To determine the whiling speed of shaft			
5	Measure the logarithmic decrement of a one degree of freedom mass spring damper system for various damping medium, air, water and oil			
6	Investigate the forced harmonic response of a single degree of freedom under damped system to changing mass spring stiffness and damping.			
7	Measure the logarithmic decrement of a one degree of freedom mass spring damper system for various damping medium, air, water and oil			
8	Study of Four bar mechanism with different Inversions.			
9	To study the governors and to obtain controlling force curve of Watt, Porter, Proell and spring controlled governors			
10	Study of different Clutches			
11	Study of Brakes and Dynamometers			

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program	B.Tech (Mechanical Engg.)	Semester IV	Year II
Name of Course	Manufacturing Processes Lab		
Course Code	ME 24227		
Core / Elective / Other	Core		
Prerequisite if any:			
1.	Basics of manufacturing processes		
2.	Subject Knowledge of Manufacturing processes		
Course Outcomes:			
1.	To impart hands-on practical exposure on manufacturing processes and equipment.		
2.	To make student familiar with the different welding processes.		
3.	At the end of the lab learn preparation of various jobs using various manufacturing process like drilling, grinding and lathe.		
4.	The student will be trained to implement similar features in preparation of jobs can be extended to implement in the preparation of complicated jobs		
Description of Contents in brief:			
Exp 1.	Principal parts of tool, tool geometry, Demonstration on lathe machine: Various parts and its functions, job & tool holding procedure, operational aspects etc.,		
Exp 2.	Simple jobs on center lathe involving plain turning, step turning, taper turning and facing.		
Exp 3.	Practice in shaping machine, drilling machine and grinding machine.		
Exp 4.	Different types of lathe operations. Calculations of cutting speed, material removal rate and machining time for lathe, drill and shaping machines.		
Exp 5.	Preparation of job by Spot welding.		
List of Text Books:			
1.	ASM Handbook Machining, 2002		
2.	Introduction to Manufacturing processes. Mikell Groover, Wiley, 2011		
3.	DeGarmo's Materials and Processes in Manufacturing J.T. Black, Wiley, 2011		
List of Reference Books:			
1.	Manufacturing Engineering &Technology Srope Kalpakijan Prentice Hall, 2009		
2.	Manufacturing Science Amitabha Ghosh, Pearson, 1985		
3.	A Textbook of Manufacturing Technology: Manufacturing Processes R.K. Rajput, 2007		
4.	Introduction to Manufacturing processes. John A Schey, McGraw Hill, 2007		
URLs:			
1.	http://www.nptel.iitm.ac.in/courses/Webcourse-contents		
2.	https://swayam.gov.in		

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Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program	B.Tech (Mechanical Engg.)	Semester IV	Year II
Name of Course	Project Based Lab-1		
Course Code	ME24228		
Core/ Elective / Other	Core		
Prerequisite: Nil			
Course Outcomes:			
CO 1	Develop understanding of experimental and industrial projects		
CO 2	Develop understanding of solutions to problems of society		
Topics Covered as per Syllabus			
1.	Problem oriented small industrial projects		
2.	Solutions to societal problems		
3.	Visit to projects/industrial installations with latest technology		
4.	Innovative projects		
5.	Ideation and modelling		

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester V	Year III
Name of Course		Engineering Management		
Course Code		ME24351		
Core / Elective / Other		Core		
Prerequisite if any:				
1.	None			
Course Outcomes:Students shall develop				
1.	Understanding the relevance and importance of Management Practices for Engineers.			
2.	Knowledge and Practices on the interdisciplinary course content that combines an engineering focus with core business and management knowledge.			
3.	Ability to understand various methods of analysis and decision making related to operations, human resources, finances and marketing management.			
Description of Contents in brief:				
Unit 1.	Principles/Functions of Management, Measure of Productivity and ways to enhance Productivity. Management challenges for Engineers.			
Unit 2.	Operations Management and its scope, Production Systems, Facility Location, Facility Planning & Plant Layouts.			
Unit 3.	Industrial Design, Product Design, Product / Project Life Cycle, Quality Control and Quality Management, Forecasting Methods, Introduction to Supply Chain Management.			
Unit 4.	Material Management – Purchasing, Inventory & JIT Systems, Material Resource Planning, Scheduling, Project Management, PERT and CPM, Project Crashing.			
Unit 5.	Introduction to Financial Management, Financial Statements and Analysis, Operations Decision making - Break Even Analysis & Decision Trees			
Unit 6	Fundamentals of Marketing Management, Organizational Behavior and Leadership, Strategic Management, Statutory and Legal Issues.			
List of Text Books:				
1.	Modern production/operations management by Buffa: Wiley India, 2007			
2.	Marketing Management by Kotler; PHI, 2015			
3.	Operations Management and Supply Chain Management by Russel& Taylor; Wiley,2016			
List of Reference Books:				
1.	Handbook of Industrial Engineering: Technology and Operations Management by GavrielSalvendy; Wiley publication, 2001			
2.	Operations management by Krajewski; pearson, 2016			
3.	Industrial Engineering by Shankar Ravi; Galgotia Publication, 2000			
4.	Financial Management by I M Pandey; Vikas, 2015			
5.	Strategic Management by Pearce, Robinson and Mital; McGraw Hill Education, 2018			
URLs:				
1.	https://nptel.ac.in/courses/112/107/112107238/			
2.	https://nptel.ac.in/courses/110/107/110107144/			
Lecture Plan (about 40-50 Lectures):				
*Lecture No.	Topic			Remarks
1.	Introduction to the course and its scope			
2.	Principles and Functions of Management			
3.	Principles and Functions of Management			
4.	Productivity and its Measures			
5.	Productivity and its Measures			

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6.	Ways to enhance Productivity	
7.	Management Challenges for Engineers	
8.	Operations Management and Its Scope	
9.	Production Systems	
10.	Plant Location and Site Selection – An Introduction	
11.	Factors affecting Plant Location	
12.	Plant Layout, Types and characteristics of a good plant layout	
13.	Procedure and Methods of Plant Layout	
14.	Procedure and Methods of Plant Layout	
15.	Factors affecting Plant Layout	
16.	Installation and evaluation of Plant Layout	
17.	Industrial Design& Morphology of Design	
18.	Product Life Cycle	
19.	Product Design and Approaches to Product Design	
20.	Product Design and Approaches to Product Design	
21.	Product Design and Approaches to Product Design	
22.	Introduction to Forecasting Methods	
23.	Forecasting Models	
24.	Quality Control and Quality Management– Introduction	
25.	Quality Circle and Total Quality Management	
26.	Supply Chain Management	
27.	Characteristics of Supply Chain Management	
28.	Application of SCM	
29.	Material Management – Purchasing	
30.	Inventory Models	
31.	Inventory Models	
32.	JIT Systems	
33.	Material Resource Planning	
34.	Introduction to Project Management– Planning, Scheduling & Controlling	
35.	CPM	
36.	PERT	
37.	Project Crashing	
38.	Financial management – Introduction & Its interface with other functions of Management	
39.	Financial Planning, Estimation of Financial Requirements of a Project	
40.	Working Capital Management	
41.	Break Even Analysis, Risk Analysis and Decision Trees	
42.	Concept and Functions of Marketing Management	
43.	Marketing Process – Marketing Mix	
44.	Marketing Environment and Marketing Research	
45.	Consumer & Business Buyer Behavior	
46.	Segmentation & Targeting	
47.	Distribution and Pricing	
48.	Organizational Behavior and Leadership	
49.	Organizational Behavior and LeadershipContd	
50.	Strategic Management	
51.	Statutory and Legal Issues.	

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Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program	B.Tech (Mechanical Engg.)	Semester V	Year III
Name of Course	Machine Design-2		
Course Code	ME24311		
Core/Elective/Other	Core		
Prerequisite:			
1.	Kinematics of Machines		
2.	Strength of Material		
3.	Dynamics of Machine		
Course Outcomes			
1.	Enables to apply the concept of fatigue in the design of different mechanical components		
2.	Enables to design and select of spur, helical, bevel and worm gears in different Machinery		
3.	Enables to design and select of lubrication bearing for machines using charts and tables		
4.	Enables to gain basic understanding of Creep, Centrifugal pump and Gear box in mechanical engineering design		
Description of Contents in brief			
1.	Fatigue - Importance in Engineering design, concept of fatigue, fatigue strength and endurance limit, stress concentration, Goodman and modified Goodman diagram, Soderberg Gerber hypotheses, effect of loading type, size, surface finish, notch, surface treatment, and corrosion, cumulative fatigue damage, applied problems.		
2.	Gears - Design consideration, Hertzian stresses, design load, beam strength, surface strength, design procedure for helical and spur gears, design calculation for bevel and worm gears.		
3.	Creep- Temperature considerations in design, designing for creep, thermal stresses, applied problems.		
4.	Bearing- Classification, design of hydrodynamic bearings, selection of ball and roller bearings.		
5.	Design of the Rotating Machines e.g. Centrifugal Pump, Gear Box. Introduction to various advanced CAD software's.		
List of Text Books			
1.	Shigley (2014). Mechanical Engineering Design:10/e, McGraw-Hill Education, ISBN:10: 9780073398204 New Delhi.		
2.	George Dieter, Linda Schmidt (2009): Engineering Design:, McGraw-Hill Education, ISBN 0072837039,the University of Michigan.		
3.	G.M.Maitra and L.V. Prasad (2009): Handbook of Mechanical Design, McGraw-Hill Education, ISBN:978-0-07-460238-6, New Delhi.		
4.	Robert L. Norton (2009): Machine Desgn:, Pearson Education, ISBN:978-81-317-0533-9, New Delhi.		
5.	Allen S. Hall, Alfred R. Holowenko, and Henman G. Laughlin. Machine Design. Schaum's Outline of Theory and Problems, Tata Mcgraw-Hill Publishing Company Limited,ISBN: 9780070634589; 0070634580 New Delhi.		
List of Reference Books			
1.	Siraj Ahmed (2014): Mechanical Engineering Design: Principles and concepts, PHI Learning Pvt. Ltd, ISBN-978-81-203-4931-5, New Delhi		
2.	David G. Ullman: The Mechanical Design Process. ISBN 978-0-07-297574-1McGraw-Hill, Inc. N.Y.		
Lecture Plan (about 40-50 Lectures)			
Lecture No.	Details		

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1.	Importance of Fatigue in engineering design, Concept of fatigue
2.	Stress concentration, Stress concentration factors, Reduction of stress Concentration
3.	Tutorial problems, Introduction to fatigue testing machine
4.	SN Diagram, Endurance limit estimation, Notch sensitivity
5.	Tutorial problems
6.	Miner's equation, Tutorial problems
7.	Introduction Soderberg, Goodman, Gerber and Modified Goodman diagram
8.	Tutorial problems
9.	Introduction to gears, classification
10.	Gear terminology, Force analysis
11.	Lewis equation, Spur gear design procedure
12.	Spur gear design consideration factors, wear strength
13.	Tutorial problems
14.	Tutorial problems
15.	Gear tooth failures and lubrication
16.	Introduction to helical gears, force analysis, Helix angle
17.	Beam and wear strength of helical gears
18.	Tutorial problems
19.	Design of bevel gears
20.	Tutorial problems
21.	Design of worm gears
22.	Tutorial problems
23.	Introduction to creep and its importance in engineering design, Consideration of temperature in design
24.	Designing for creep, thermal stresses
25.	Tutorial problems
26.	Bearings, classification
27.	Introduction to sliding contact bearings, types of lubrication
28.	Viscosity measurement, Petroff's equation
29.	McKee's Investigation, Design of sliding contact bearing using Raimondi and Boyd Charts and Graphs
30.	Tutorial problems
31.	Bearing materials, failures
32.	Tutorial problems
33.	Introduction to rolling contact bearings and its comparison with sliding contact Bearings
34.	Static and dynamic load carrying capacity, Design of rolling bearing from chart
35.	Tutorial problems
36.	Design of rolling bearings against cyclic loads, consideration of reliability
37.	Tutorial problems
38.	Bearing failures and lubrications
39.	Introduction to centrifugal pump, classification, blades
40.	Design of centrifugal pumps
41.	Tutorial problem
42.	Design of gear box
43.	Design of gear box
44.	Design of gear box
45.	Design of gear box

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46.	Tutorial problems
47.	Tutorial problems
48.	Introduction to various advanced CAD software's

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program	B.Tech (Mechanical Engg.)	Semester V	Year III
Name of Course	Machining Processes		
Course Code	ME24312		
Core / Elective / Other	Core		
Prerequisite if any:			
1.	Workshop Practice, Mechanisms of Machines		
2.	Introduction to Manufacturing processes		
Course Outcomes:			
1.	To understand conventional & modern machine tools used in industries.		
2.	To identify / select correct conventional manufacturing process/operations for manufacturing of the product.		
3.	To understand various operating/ cutting parameters and their effects on productivity & quality of the product.		
4.	To be aware of mass production, cutting fluids, quality & safety aspects.		
Description of Contents in brief:			
Unit 1.	Concept of productivity & mass production, Introduction to subtractive/additive machining, Types/classification of manufacturing processes / machine tools. Important cutting parameters. Cutting Fluids. Safety aspects on machining.		
Unit 2.	Semi automatic lathes, CNC turning centers, Examples on CNC programming.		
Unit 3.	Introduction to Milling Process & its applications, Conventional milling machine tools, Various milling operations. Numerical on cutting parameters.		
Unit 4.	Introduction to Broaching process & its applications, Conventional broaching machine tools, Various broaching operations.		
Unit 5.	Introduction to Abrasive machining & its applications, Grinding machine tools, Factors/parameters affecting grinding process.		
Unit 6	Introduction to threads and gears mass manufacturing processes, Metal surface finishing processes, Effects of cutting parameters/ operating conditions on quality of the finished job in various conventional manufacturing processes.		
List of Text Books:			
1.	Manufacturing Technology: Metal Cutting and Machine Tools, (Vol.2), P.N.Rao, Tata McGraw-Hill Education.		
List of Reference Books:			
1.	Metal Cutting Theory and Practice, David A. Stephenson, John S. Agapiou, CRC Press Taylor & Francis Group.		
2.	CNC Programming Handbook, Peter Smid, Industrial Press, Inc.		
URLs:			
1.	https://nptel.ac.in/courses/112105127		
2.	https://nptel.ac.in/courses/112103248		

Lecture Plan (about 40-50 Lectures):	
*Lecture No.	Topic
01	Concept of productivity & mass production

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02-03	Introduction to subtractive/additive machining
04-05	Types/classification of manufacturing processes / machine tools.
06-07	Important cutting parameters
08	Cutting Fluids
09	Safety aspects on machining
10-13	Semi automatic lathes
14-16	CNC turning centers
17-19	Examples on CNC programming
20	Introduction to Milling Process & its applications
21-24	Conventional milling machine tools, Various milling operations
25-26	Numerical on cutting parameters
27	Introduction to Broaching process & its applications
28-30	Conventional broaching machine tools
31-32	Various broaching operations
33-34	Introduction to Abrasive machining & its applications
35	Factors/parameters affecting grinding process
36-39	Grinding machine tools
40-42	Introduction to threads and gears mass manufacturing processes
43-45	Metal surface finishing processes
46-48	Effects of cutting parameters/ operating conditions on quality of the finished job in various conventional manufacturing processes

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester V	Year III
Name of Course		Fluid Mechanics		
Course Code		ME24313		
Core / Elective / Other		Core		
Prerequisite:				
1.	Engineering Mathematics			
2.	Fundamentals of Physics			
Course Outcomes:				
1.	Able to apply the basic concept fluid statics in real-life engineering.			
2.	Obtain analytical solution of the equation of motion for simple flow field.			
3.	Able to calculate losses associated with real engineering piping problems.			
4.	Predict the boundary layer thickness and other boundary layer properties.			
5.	Predict the occurrence of shock and calculate property changes across a shock wave.			
Description of Contents in brief:				
1.	Introduction and Basic Concepts: fluid definition, continuum concept, stress field, viscosity, Newtonian vs Non-Newtonian fluids, vapor pressure & cavitation, surface tension, compressibility, slip and no slip condition. Fluid Statics: pressure definition, Pascal's law, basic equation for pressure field, pressure variation with height, absolute and gage pressure, pressure measurement devices, hydrostatic force on a plane surface and curved surfaces, pressure distribution in rigid body motion, buoyancy, floatation and stability.			
2.	Fluid Kinematics: Eulerian and Lagrangian descriptions, acceleration field, material derivative, streamlines, pathlines, streaklines, deformation of fluid elements, vorticity and rotationality, Reynolds transport theorem, Bernoulli equation. Dimensional homogeneity, dimensional analysis and similarity, Buckingham's Pi theorem, non-dimensional parameter and their applications.			
3.	Finite Control Volume Analysis: control volume and control surface, conservation of mass, linear momentum, angular momentum, energy equation. Differential Analysis of Fluid Flow: mass conservation in cartesian and cylindrical coordinates, stream function, conservation of linear momentum, Euler's equation, Navier-Stokes equation, basics of potential flows, exact solution of N-S equations.			
4.	Flow in Pipe: Reynolds experiment, critical Reynolds number, laminar flow through a pipe – Hagen-Poiseuille equation, flow through closed conduits: Darcy Weisbach equation, friction factor, Moody's diagram, minor losses – at sudden expansion, contraction, at bends, etc., Fluid Flow Over Bodies: basics of external flows, lift and drag concept, boundary layer concept, displacement thickness, momentum thickness, momentum integral estimates, boundary layer equations, Blasius solution for flat plates, laminar and turbulent flow over flat plate, effects of pressure gradient.			
5.	Compressible Flow: speed of sound, one-dimensional form of the governing equations, isentropic gas relations, flow through nozzles, area-velocity relations, converging-diverging nozzle, normal shocks & oblique shocks, Prandtl-Meyer expansion.			
List of Text Books:				
1.	Robert W. Fox, Philip J. Pritchard, Alan T. McDonald, Introduction to Fluid Mechanics, John Wiley & Sons, Inc.			
2.	Bruce R. Munson, Theodore H. Okiishi, Wade W. Huebsch and Alric P. Rothmayer, Fundamentals of Fluid Mechanics, John Wiley & Sons, Inc.			
3.	Yunus A. Cengel and John Cimbala, Fluid Mechanics Fundamental and applications, McGraw-Hill Education.			
List of Reference Books:				
1.	Frank M. White, Fluid Mechanics, McGraw Hill.			

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2.	S. K. Som, Gautam Biswas, Suman Chakraborty, Introduction to Fluid Mechanics and Fluid Machines, McGraw-Hill Education.	
3.	G K Batchelor, An introduction to Fluid dynamics, Cambridge University Press.	
URLs:		
1.	https://nptel.ac.in/courses/112/104/112104118/	
2.	https://nptel.ac.in/courses/112/105/112105269/	
3.	https://nptel.ac.in/courses/112105171	
Lecture No.	Topic	No. of Lectures
1	Introduction to fluid mechanics and its application	1
2	Continuum, density and specific gravity	1
3	Concept of viscosity, Newtonian and non-Newtonian fluids	1
4	Concept of cavitation, surface tension, compressibility	1
5	Pressure at point and its variation with depth & Pressure measurement devices	1
6	Introduction to fluid statics and hydrostatics forces on submerged plane surfaces	1
7	Hydrostatics forces on submerged curved surfaces	1
8	Buoyancy and stability	1
9	Fluid in rigid body motion	1
10	Numerical of fluid statics and stability	
11	Acceleration field and material derivative	1
12	Lagrangian and Eulerian approaches	1
13	Introduction of pathlines, streaklines, stream tube and time lines	1
14	Deformation of fluid elements, vorticity and rotationality	1
15	Introduction Reynolds transport theorem	1
16	Bernoulli equation and its derivations	1
17	Dimensional analysis and Buckingham’s Pi theorem	1
18	Non-dimensional numbers and their applications.	1
19	Control volume and forces acting on them	1
20	Linear momentum equation in integral form and its special cases	1
21	Angular momentum, energy equation	
22	Differential approach of fluid element kinematics	1
23	Mass conservation in Cartesian and cylindrical coordinates	1
24	Stream function, conservation of linear momentum,	1
25	Euler’s equation, Navier Stokes equation	1
26	Basics of potential flows and exact solution of N-S equations	1
27	Some more exact solution of Navier-Stokes equations	1
28	Laminar and turbulent flow	1
29	Entrance and entry length	1
31	Viscous effects in pipes, laminar and turbulent regions	1
32	Darcy-Weisbach equation	1
33	Fully developed laminar pipe flow	1
34	Turbulent flow in pipes and its velocity profile	1
35	Minor losses	1
36	Basics of external flows, lift and drag concept	1
37	Flow separation	
38	Boundary layer concept and boundary layer equations	1
39	Calculation of displacement thickness and, momentum thickness	
40	Blasius solution for flat plates, laminar and turbulent flow over flat plate, effects of pressure gradient	1
41	Numerical on boundary layer theory	1

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42	Introduction to the 1-D compressible flow	1
43	Isentropic flow of an ideal gas	1
44	Subsonic flow, sonic and supersonic flows	
45	Isentropic flow in a converging nozzle	1
46	Shock wave and expansion waves	1
47	Introduction to oblique and Prandtl-Meyer expansion waves	1
48	Numerical on compressible flow	1
	Total No. of lectures	48

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester V	Year III
Name of Course:		Electrical Machines		
Course Code:		EE24332		
Core/Elective/other:		Core		
Prerequisite:- Fundamentals of basic electrical and electronics				
Course Outcome: after going through this course, students will get knowledge on				
1	Single phase and Three phase Circuit			
2	single phase transformer and Three phase transformer			
3	Fundamental knowledge of electronic devices and their applications			
4	Special machines like stepper, BLDC machines , Induction Motor, Power Electronics			
Description of Contents in brief: -,				
Unit 1	Polyphase systems: measurement of 3-phase power for balanced and unbalanced loads. Single phase transformer: - construction, phasor diagram, equivalent circuit, losses, V.R. , efficiency, all day efficiency,			
Unit 2	Three phase transformers- construction with 3 single phase and 3 phase connections – Scott Connection – Phasing of transformer– parallel operation of three phase transformers–tap changing transformers- tertiary winding., application			
Unit 3	Induction motor construction, equivalent circuit, torque equation and torque- slip characteristics, speed control. Classification, working and various characteristics for selection and applications of industrial motors, thyristor and their characteristics			
Unit 4	Basic chopper:- working principle , types, characteristics advantage disadvantages application			
Unit 5	Rectifier:- Introduction to SCR and Thyristor family, I-V Characteristics of self Commutated Self commutated switches such as MOSFET, IGBT etc., Basic concepts of firing and control circuit, gate/base drive circuits			
Unit 6	Inverter :- introduction to inverter circuit, topologies, operations waveform analysis and applications, Special machine:-Examples and construction features of stepper motor, servomotor and brushless permanent magnet motor.			
List of Text Books				
1.	G B Gupta, Principle of electrical motors and power electronics, S K Kataria and Sons, 2002			
2.	P.S.Bhimbra, Electrical Machine, Khanna publishers, 1 January 2011			
3.	G. Say, Performance & design of A.C. Machines, 3 rd edition , CBS, 1 December 2005			
4.	Fitzerald Kingsley Otmans, Electrical Machines, 7 edition , McGraw-Hill Education, 1 March 2013			
5.	Nagrath& Kothari, Electrical Machines, 4 edition, McGraw Hill Education, 7 July 2010			

List of Reference Books	
1.	SR Mishra, Basic electronic engineering.
2.	M D Singh , Power electronics, McGraw Hill, 1998
3	Charles. I. Hubert, Electric Machine, 2 edition, Prentice Hall, 16 October 2001
URL	https://nptel.ac.in/courses/108/105/108105017/
	https://nptel.ac.in/courses/108/102/108102146/
Lecture Plan (about 40-50 lectures)	
Lecture No	Topic
L1	Introduction to polyphase system,
L2	Generation of 3-phase voltages
L3	Star and Delta connected network, Relation between phase quantity and line Quantity
L4	Three phase power,
L5	Numerical on star and delta connections
L6	Measurement of 3-phase power: One, two and three wattmeter method
L7	Measurement of power factor using two wattmeter method
L8	Analysis of unbalance load
L9	TRANSFORMER: - Review of 1-phase transformer, construction, working Principle
L10	Phasor diagram on no load, on load
L11	Equivalent circuit parameters
L12	V.R., efficiency, all day efficiency, application
L13	Test: - Sumpner's test, per unit representation – inrush current –
L14	3 PHASE TRANSFORMER: -Connections of 3-phase transformer-1
L15	Open Delta connection
L16	Scott Connection
L17	MINI TEST
L18	Connections of 3-phase transformer-2
L19	Parallel operation of 1-phase transformer-1
L20	Parallel operation of 1-phase transformer-2
L21	IM:- Introduction of IM, construction, working principle
L22	Equivalent circuit, numericals based on it
L23	Torque equation and torque- slip characteristics,
L24	Speed control, motor characteristics
L25	Classification for selection and applications of industrial motors,
L26	Working and various characteristics for selection and applications of industrial motors,
L27	Introduction to SCR and Thyristor family,
L28	Half bridge rectifier, Full bridge rectifier
L29	I-V Characteristics of self Commutated switches such as MOSFET, IGBT etc.,
L30	Basic concepts of firing and control circuit, gate/base drive circuits

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L31	Basic chopper:- working principle, Classification
L32	Characteristics advantage disadvantages application
L33	Advantage disadvantages, Application
L34	Inverter :- introduction to inverter circuit,
L35	Topologies used,
L36	Operations waveform analysis and applications
L37	Special machine:- Stepper motor :- Examples and construction features of stepper motor
L38	Advantages , disadvantages and applications
L39	Examples and construction features of servomotor, Advantages , disadvantages and applications
L40	Examples and construction features of brushless permanent magnet motor
L41	Difference between BLDC and commutated D.C. Machine
L42	Advantages, disadvantages and applications of brushless permanent magnet Motor

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester V	Year III
Name of Course		Fluid Mechanics Lab		
Course Code		ME 24314		
Core / Elective / Other		Core Laboratory		
Prerequisite:				
1.	Knowledge of Engineering Mathematics			
2.	Knowledge of Fluid Mechanics			
Course Outcomes:				
At the end of the semester after completion of course, students will be able to				
1. experimentally verify the Bernoulli's theorem, able to analyze the type of flow with Reynolds experiment,				
2. verify the Impulse Momentum Principle, will be able to calibrate and calculate coefficient of discharge of Venturi meter, Orifice meter and Nozzle meter.				
3. to estimate the friction factor of commercial pipe to know the losses in pipe flow,				
4. to calculate the efficiency of Centrifugal pump, Reciprocating pump, Impulse turbine and Francis turbine.				
5. to experimentally classify fluid flows.				
Description of Contents in brief:				
1. Verification of Bernoulli's theorem,				
2. Classify the types of flow based on Reynolds number, verification of Impulse Momentum principle for flow,				
3. Calibration of Venturimeter, Orificemeter, Nozzlemeter and Effect of Reynolds number on coefficient of discharge, frictional loss in pipe, Reciprocating pump.				
List of Text Books:				
1.	Fluids Mechanics Lab Manual			
2.	Fluids Mechanics & Hydraulics Machines- Jain. A.K., Khanna Publisher, 1998			
3.	Mechanics of Fluids- Frank M. White, McGraw-Hill Series, 1998			
List of Reference Books:				
1.	Fluid Mechanics- Streeter & Wylie, McGraw Hill Education, 2017			
2.	Engineering Fluid Mechanics- Garde, R.J. & Mirajgaonker, A.G., Scitech, 2010			

Lecture Plan:

Lecture No	Title of experiment
1	Theoretical aspects of experiments- Lecture
2	Theoretical aspects of experiments- Lecture
3	Verification of Bernoulli's theorem

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4	Classify the types of flow based on Reynolds number
5	Verification of Impulse Momentum principle for flow
6	Calibration of Venturimeter and study of effect of Reynolds number on coefficient of discharge
7	Calibration of Orificemeter and study of effect of Reynolds number on coefficient of discharge
8	Calibration of Nozzlemeter and study of effect of Reynolds number on coefficient of discharge
9	Estimation of friction factor of commercial pipe
10	Determination of efficiency of Reciprocating pump.

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program	B.Tech (Mechanical Engg.)	Semester V	Year III
Name of Course:	Electrical Machinery Lab		
Course Code:	EE24333		
Core/Elective/other:	Core		
Prerequisite:			
1.	Knowledge of basic electrical machine.		
2.	Knowledge of basic electronics		
Course Outcome: after going through these lab experiments the students will get knowledge Of			
	Method of Power Measurement For Electrical Circuits		
	Induction motor starter and test on IM (block rotor and no load)		
	Parallel operation f transformer		
	Study of rectifier, chopper, inverter and power electronics devices		
Description of Contents in brief:			
1.	Measurement of 3 phase power by 2 wattmeter method		
2.	Measurement of reactive power using single wattmeter method		
3.	No load and blocked rotor test of 1 phase induction motor		
4.	To study of 3 phase induction motor starter		
5.	To study of parallel operation of 1 phase transformer.		
6	To Study of power electronics devices		
7	To Study of half wave rectifier		
8	To study of full wave rectifier		
9	To study of chopper		
10	To study of inverter		
List of Text books			
1.	Principle of electrical motors and power electronics G B Gupta		
2.	P.S.Bhimbra, Electrical Machine, Khanna, 1 January 2011		
3.	G. Say, Performance & design of A.C. Machines, 3rd edition , CBS, 1 December 2005		
4.	Fitzerald Kingsley Otmans, Electrical Machines, 7 edition , McGraw-Hill Education, 1 March 2013		
URL: -			
	http://www.vlab.co.in/ba-nptel-labs-electrical-engineering		
	https://nptel.ac.in/courses/108/105/108105131/		

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester V	Year III
Name of Course		Machining Processes Lab		
Course Code		ME24315		
Core / Elective / Other		Core		
Prerequisite if any:				
1.	Manufacturing Processes-I			
2.				
Course Outcomes:				
1.	To impart hands-on practical exposure on Milling Processes both on conventional and CNC machines.			
2.	To enable students to prepare CNC programs for various types of jobs on CNC milling Machine			
3.	To enable students to use measuring instruments for recording output parameters of Machining			
Description of Contents in brief:				
Expt 1.	Principal parts of tool, tool geometry, Demonstration on conventional machine: Various parts and its functions, job & tool holding procedure, operational aspects etc.,			
Expt 2.	Simple jobs on milling machine involving height reduction of cuboid shaped work Pieces			
Expt 3.	Practice in conventional milling machine for making cuboid shaped jobs from cylindrical work pieces. Measuring input and output parameters			
Expt 4.	Introduction to various parts of CNC milling machine, tool geometry, programming etc. Preparation of CNC programs for given jobs and making the jobs. Measurement of input and output parameters using given instruments.			
List of Text Books:				
1.	ASM Handbook Machining, 2002			
2.	Introduction to Manufacturing processes. Mikell Groover, Wiley, 2011			
3.	DeGarmo's Materials and Processes in Manufacturing J.T. Black, Wiley, 2011			
List of Reference Books:				
1.	Manufacturing Engineering &Technology Srope Kalpakijan Prentice Hall, 2009			
2.	Manufacturing Science Amitabha Ghosh, Pearson, 1985			
3.	A Textbook of Manufacturing Technology: Manufacturing Processes R.K. Rajput, 2007			
4.	Introduction to Manufacturing processes. John A Schey, McGraw Hill, 2007			
URLs:				
1.	http://www.nptel.iitm.ac.in/courses/Webcourse-contents			
2.	https://swayam.gov.in			

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Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester VI	Year III
Name of Course		Data Structures and Algorithm		
Course Code		CS24352		
Core / Elective / Other		Core		
Prerequisite if any:				
1.	Programming Languages			
2.				
Course Outcomes:				
1.	Concept and importance of data structures			
2.	Learn to implement various types of data structure			
3.	Learn how to determine algorithm correctness and its efficiency			
Description of Contents in brief:				
Unit 1.	Introduction to data structures, Algorithm Evaluation, Arrays, Multi-dimensional Arrays, Sparse Matrices, Structure, Pointers.			
Unit 2.	Stacks: representation of stacks and basic operations, application of stacks, prefix, postfix and infix notations and conversion, Recursion, towers of hanoi			
Unit 3.	Queues: Types of queues and its application, Linked lists: types of linked list, implementation of stack and queue using linked list			
Unit 4.	Polynomial representation and arithmetic, Trees: binary tree,n-ary tree, tree traversal AVL Trees, Binary search trees.			
Unit 5.	Graphs: representation, traversing, Searching: sequential search, binary search and Hashing			
Unit 6	Sorting: External and Internal Sort, Selection, Sort, bubble sort, insertion sort, radix sort, and bucket sort.			
List of Text Books:				
1.	Fundamentals of data structures by E.Horowitz and S.Sahni, Computer Science, Universal Press, 2008			
2.	Data Structure using C by A.M.Tanenbaum, PHI, 1989			
3.				
List of Reference Books:				
1.	Data Structures and Algorithms in C (second edition) by M.T.Goodriche and R.Tamassia, John Wiley and Sons, 2011			
2.	Data structures and algorithm analysis in C(second edition), by M.A.Weiss, Addison-Wesley, 2013.			
3.	Classic Data structures by D.Samantha, PHI, 2017			
4.	Data structures, Schaum's series, McGraw Hill, 2017			
URLs:				
1.	NOC:Programming, data structures and algorithms- https://nptel.ac.in/courses/10-6102064/			
2.	Stanford CS166: Data Structures- http://web.stanford.edu/classics166/			
Lecture Plan (about 40-50 Lectures):				
*Lecture No.	Topic			Remarks

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1.	Introduction to data structures, algorithm evaluation	
2	Time complexity analysis (Asymptotic notations)	
3	Arrays and its operations	
4	Multidimensional arrays	
5	Sparse matrices	
6	Structure, Pointers	
7	Recursion	
8	Linked list an operations on linked list	
9	Double linked list and its operations	
10	Applications of linked lists	
11	Storage pools, garbage collection	
12	Tutorial	
13	Tutorial	
14	Stacks and operations on a stack	
15	Prefix, postfix and infix notations	
16	Prefix, postfix and infix notations	
17	Difference between stacks and queues	
18	Postfix evaluation, parenthesis checking	
19	Tutorial	
20	Infix to postfix conversion	
21	Tutorial	
22	Quicksort	
23	Implementation of recursion using slacks	
24	Towers of Hanoi	
25	Tutorial	
26	Queues and Operations on a queue	
27	Queues application	
28	Circular queues, priority queue	
29	Tutorial	
30	Tutorial	
31	Trees: applications & representation in memory	
32	Binary tree: operations on binary tree	
33	Tutorial	
34	Tree Traversals	
35	Graphs: representation	
36	Graph traversals	
37	Tutorial	
38	Sequential search	
39	Tutorial	
40	Binary search	
41	Hashing	
42	Hash functions	
43	Hashing (collision resolution techniques)	
44	Sorting, techniques: bubble sort	
45	Tutorial	
46	Selection sort, insertion sort	
47	Merge sort	
48	Heap sort: Max & Min heap	
49	Radix sort	

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50	Tutorial	
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Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program	B.Tech (Mechanical Engg.)	Semester VI	Year III
Name of Course	Heat and Mass Transfer		
Course Code	ME24321		
Core / Elective / Other	Core		
Prerequisite: None			
1.			
Course Outcomes:			
1.	To introduce a basic study of the phenomena of heat and mass transfer involving three modes of heat transfer.		
2.	To develop methodologies for solving a wide variety of practical engineering problems.		
3.	To provide useful information concerning the performance and design of thermal systems such as heat exchangers and associated processes.		
Description of Contents in brief:			
1.	Conduction: Steady State Conduction: Fourier's law and general conduction equation in Cartesian coordinate, Analysis of composite slabs, cylinders and spheres, insulation desirable properties and critical thickness of insulation,. Unsteady state Heat Transfer: Newtonian heating/cooling, Lumped parameter analysis, periodic heat flow, solution of unsteady state problems using Heisler charts.		
2.	Convection: Analysis of free and forced convection using dimensional analysis, significance of various dimensionless numbers empirical co-relations for plates and pipes under natural/forced convection conditions. Concept of thermal and hydrodynamic boundary layers.		
3.	Radiation: Mechanism, electromagnetic spectrum, reflectivity, absorptivity, transmissivity, emissivity, emissive power, intensity of radiation, Planck's law, Wien's law, Stefan Boltzman's law and Kirchoff's law. View factor for simple geometries and view factor relations, Concept of black and gray body, Black body, Radiation heat exchange between black, grey and diffuse surfaces, radiation shields.		
4.	Heat Transfer Through Extended Surfaces: Fins: Heat transfer and temperature distribution in rectangular fins (Longitudinal & annular) of uniform cross section, effectiveness and efficiency of fin. Heat Exchanger Types – Overall Heat Transfer Coefficient – Fouling Factors – Analysis – LMTD method – NTU method.		
5.	Boiling and Condensation & Mass Transfer :Nusselt's theory of condensation- Regimes of Pool boiling and Flow boiling. Correlations in boiling and condensation. Basic Concepts – Diffusion Mass Transfer – Fick's Law of Diffusion – Steady state Molecular Diffusion – Convective Mass Transfer – Momentum, Heat and Mass Transfer Analogy –Convective Mass Transfer Correlations.		
List of Text Books:			
1.	P.K. Nag, Heat and Mass Transfer, Mc Graw Hill 2011		
2.	Incropera F.P. & Dewitt D.P. , Introduction to Heat Transfer, Wiley 2018		
3.	Yunus Cengel, Heat and Mass Transfer, Mc Graw Hill 2020		
List of Reference Books:			

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1.	Mahesh M. Rathore, Engg. Heat and Mass Transfer, Laxmi Publications, New Delhi, 2006
2.	J.P.Holman, Heat Transfer, McGraw Hill 2010
3.	Heat Transfer, A. Bejan, John Wiley, 1993
URLs:	
1.	http://www.nptel.ac.in
2.	https://swayam.gov.in/nc_details/NPTEL
Lecture Plan (about 40-50 Lectures):	
Lecture No.	Topic
1	Heat Transfer: Introduction and overview, Distinction with Thermodynamics, Modes of Heat Transfer, Mechanism of heat transfer,
2	Fourier's law of diffusion, Thermal conductivity for various materials of engineering importance.
3	Electrical analogy to heat transfer in Simple and composite slabs.
4	Overall Heat Transfer Coefficient. Related numerical problems.
5	Extending concept of electrical analogy to heat transfer for simple and composite cylinders. Overall Heat Transfer Coefficient. Related numerical problems.
6	Working out numerical on electrical analogy for heat transfer in cylindrical problems.
7	Concept of electrical analogy to heat transfer for simple and composite spheres. Overall Heat Transfer Coefficient. Related numerical problems.
8	Derivation of Characteristics Heat Equation in Cartesian Coordinate System.
9	Insulating Materials and concept of thickness of insulation, Derivation of critical thickness of insulation and related numerical problems
10	Numerical on critical thickness of insulation continues, Concept of variable thermal conductivity and thermal contact resistance.
11	Unsteady Heat Diffusion, Lumped Capacitance Method, Derivation of the Formulae, Electrical analogy of R-C circuits for transient response of thermal circuits.
12	Numerical problems of lumped capacitance method, Introduction of solving transient heat transfer problems using Heisler and Grober charts.
13	More numerical problems on transient heat transfer problems using Heisler and Grober charts.
14	Convection: Mechanism of forced and free convection heat transfer and concept of velocity and thermal boundary layers.
15	Significance of various dimensionless numbers e.g. Reynolds number, Prandtl number, Nusselt number, Derivation of functional dependence between Nusselt number, Prandtl number and Reynolds number.
16	Discussion on empirical correlations for forced convection heat transfer.
17	Solving numerical on forced convection heat transfer using empirical correlations.
18	Significance of various dimensionless numbers e.g. Grashoff number, Prandtl number, Nusselt number, Derivation of functional dependence between Nusselt number, Prandtl number and Grashoff number. Empirical correlations for free convection heat transfer.
19	Solving numerical on free convection heat transfer using empirical correlations.

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20	Radiation: Mechanism, electromagnetic spectrum, Conceptualizing measurement of thermal radiation and emissive power, Definition and discussion on intensity of radiation, emissive power.
21	Planck's law, Wien's law, Stefan Boltzman's law. Definitions of emitted radiation, incident radiation and radiosity.
22-23	Concept of black and gray body, Stefan Boltzman's law and Kirchoff's law, View factor for simple geometries and view factor relations
24-25	Numerical problems on view factor, Black body radiation exchange, radiation exchange between non-black bodies
26-27	Numerical problem and Radiation shields.
28-29	Heat Exchangers: Definition and classification, Overall heat transfer coefficient, fouling factor, Parallel and counter flow heat exchangers, concept and derivation of LMTD.
30-31	Heat exchanger analysis using LMTD and NTU method. Effectiveness of heat Exchanger
32-33	Discussion on effectiveness of heat exchanger and derivation with reference to parallel and counter flow heat exchanger continues.
34	Numerical problems
35-36	Fins: Introduction and classification of fins, Heat transfer analysis and temperature distribution in rectangular fins (Longitudinal & annular) of uniform cross section.
37-38	Heat transfer analysis and temperature distribution in rectangular fins of uniform cross section continues with discussion various boundary condition.
39	Fin performance: Effectiveness and efficiency of fin. Numerical problems on Fins
40	Numerical problems
41	Condensation and Boiling: Heat transfer in condensation process: Mechanism of condensation
42-43	Nusselt's theory, drop wise & film wise condensation
44-45	Boiling heat transfer, nature of vaporization, nucleate pool boiling
46	Empirical co-relation for boiling heat transfer, factors affecting boiling film Coefficients
47	Numerical Problems
48-49	Mass Transfer: Fick's law of diffusion, steady state diffusion of gases and liquids through solids, equi-molar-diffusion.
50-51	Convective Mass Transfer – Momentum, Heat and Mass Transfer Analogy – Convective Mass Transfer Correlations.
52	Numerical Problems

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	

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5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program	B.Tech (Mechanical Engg.)	Semester VI	Year III
Name of Course	Turbomachines		
Course Code	ME24322		
Core / Elective / Other	Core		
Prerequisite if any:			
1.	Engineering Thermodynamics		
2.	Fluid Mechanics		
Course Outcomes:			
1.	Apply thermodynamic concepts to understand the working of Turbo Machines		
2.	Apply the Euler's equation to analyze energy transfer in Turbo Machines		
3.	Understand the principle of operation of turbines, fans, compressors and pumps		
4.	Perform the preliminary design of Turbo Machines (turbines, compressors and pumps)		
5.	Analyze the performance of Turbo Machines		
Description of Contents in brief:			
Unit 1.	Basic Concepts of Turbo Machines. Continuity equation, momentum equation and energy equation. Airfoil theory		
Unit 2.	Steam Nozzles and Steam Turbines: Introduction, expansion of steam in nozzle, critical pressure, condition for maximum discharge, choking of nozzles. Effect of back pressure, super saturated flow through nozzles. Impulse and reaction Turbines, compounding of steam turbines, velocity diagrams, graphical and analytical methods, work done, thrust and power. Steam Turbine Efficiencies, condition for maximum efficiency. Governing of steam turbine.		
Unit 3.	Compressors: Principle of operation of centrifugal compressors, energy equation, velocity triangles, flow analysis. Principle of operation of axial compressors, analysis of flow, work done factor, stage efficiency, degree of reaction.		
Unit 4.	Hydraulic Turbines: Design aspects of Pelton turbine- its construction, power and efficiency for ideal case, characteristic curves. Design aspects of reaction turbines, construction, draft tube theory, characteristic curves, cavitations.		
Unit 5.	Centrifugal pumps: Various types and their important components, manometric, total head, specific speed, cavitations. Need for priming, Pumps in series and parallel, Principle of working and characteristic curves.		
List of Text Books:			
1.	Yadav R. Steam and Gas Turbines, Central Publishing House, Allahabad 2009.		
2.	Arasu AV. Turbo Machines, Vikas Publishing House 2013		
3.	An Introduction to Energy Conversion, Volume III, Turbo machinery, V. Kadambi and Manohar Prasad, New Age International Publishers, Reprint 2008		
4.	Fluids Mechanics & Hydraulics Machines R.K.Bansal		
5.	Fluids Mechanics & Hydraulics Machines A.K. Jain		
List of Reference Books:			
1.	<u>Kearton</u> WJ. <i>Steam Turbine Theory and Practice</i> , CBS PUBLISHERS AND DISTRIBUTORS 2004		
2.	<i>Shepherd D. G. Principles of Turbo machines</i> , The Macmillan Company (1964)		

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3.	<u>McMillan</u> GK. <i>Centrifugal and Axial Compressor Control</i> , Momentum Press 2010	
4.	<i>Dixon S. L. Fluid Mechanics & Thermodynamics of Turbo machines</i> , Elsevier (2005)	
5.	<i>Yahya S. M. Turbines, Compressors & Fans</i> , Tata McGraw Hill Co. Ltd., 2 nd Edn., 2002	
URLs:		
1.	<u>https://nptel.ac.in/noc/courses/noc18/SEM1/noc18-me34/</u>	
2.	<u>https://nptel.ac.in/content/storage2/courses/112104117/ui/TOC.htm</u>	
3.	<u>https://nptel.ac.in/courses/112/104/112104117/</u>	
Lecture Plan (about 40-50 Lectures):		
*Lecture No.	Topic	Remarks
1-2	Basic Concepts of Turbo Machines	
3-6	Continuity equation, momentum equation and energy equation and its significance	
7-8	Airfoil theory	
9-10	Steam Nozzles: Introduction, expansion of steam in nozzle	
11-14	Critical pressure, condition for maximum discharge, choking of nozzles, Effect of back pressure	
15-17	Super saturated flow through nozzles	
18-21	Steam Turbines: Impulse and reaction Turbines, compounding of steam turbines	
22-25	Velocity diagrams, graphical and analytical methods	
26-29	Work done, thrust and power. Steam Turbine Efficiencies, condition for maximum efficiency	
29-30	Governing of steam turbine	
31-32	Principle of operation of centrifugal compressors, energy equation	
33-34	Velocity triangles, flow analysis of centrifugal compressor	
35-36	Principle of operation of axial compressors, analysis of flow.	
37-38	Work done factor, stage efficiency, degree of reaction of axial Compressor	
39-40	Design aspects of Pelton turbine- its construction, power and efficiency for ideal case, characteristic curves.	
41-42	Design aspects of reaction turbines, construction, , characteristic curves	
42-43	Draft tube theory cavitations.	
44-45	Centrifugal pumps,various types and their important components, manometric, total head, specific speed	
46-47	Cavitations. Need for priming, Pumps in series and parallel	
47-48	Principle of working and characteristic curves.	

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester VI	Year III
Name of Course		Internal Combustion and Hybrid Engines		
Course Code		ME24323		
Core / Elective / Other		Core		
Prerequisite if any:				
1.	Engineering Thermodynamics			
2.	Fluid Mechanics and Hydraulic Machines			
Course Outcomes:				
1.	Able to understand working principles of Sark Ignition (SI) & Compression Ignition (CI) engines and its performance parameters.			
2.	Able to understand different fuels, emissions, alternative fuels, and fuel systems in SI and CI engine			
3.	Able to understand the combustion process in spark ignition and compression ignition engine, supercharging, turbocharging and its effect on engine performance.			
4	Able to understand Hydrogen engine and fuel cell.			
5	Understand the working of advancements in hybrid technologies and Electric vehicles.			
Description of Contents in Brief:				
Unit 1.	Introduction to I.C Engine-Classification-Components- Air standard cycles, characteristics of fuel-air mixtures, variation of specific heats, Actual cycles, actual processes taking place in importance of Port, Valve timing diagram.			
Unit 2.	Fundamentals Testing characteristics studies of SI and CI engines with variable speed, load, firing order, and engine operating temperature variation on different fuels. Emission and Environmental impact, BS norms.			
Unit 3.	Combustion and stages in S.I. and C.I. Engines: Detonation, knocking, Control detonation. Delay period, factors various systems of I.C. Engine, Lubrication and cooling system, function of lubricating system. Testing and performance on variable parameters, fuel, etc. Electronic fuel injection in S.I. engine. Requirements of diesel injection system, types of injection systems, fuel pumps. MPFI, CRDI.			
Unit 4.	Hydrogen system and fuel injection: Gasification of Hydrogen, Principle, Operation and Types of fuel cell, Integration of fuel cells to various thermal system, its Safety issues.			
Unit 5.	Introduction to Electric Vehicles (EVs), Overview of Electric Vehicles, Electric Powertrains: Types and Characteristics. Batteries: Chemistry, Types and Performance. Comparison with Internal Combustion Engines (ICE): Efficiency and Energy Conversion, Charging Infrastructure, Charging Technologies: AC vs DC, Charging Stations and Networks, Range and Charging Time Considerations. Integration of Electric Vehicles with IC Engines, Hybrid Vehicles: Types and Architectures, Challenges and Opportunities in Coexistence.			
List of Text Books:				
1.	V. Ganesan. Internal Combustion Engines, Tata McGraw-Hill, 2004			
2.	John B. Heywood. Internal Combustion Engine Fundamentals, McGraw Hill Education, 2017			
3.	H.N. Gupta. Fundamentals of Internal Combustion Engines, Prentice Hall of India Private Limited, 2006			
4.	M.L. Mathur, R.P. Sharma. Internal Combustion Engines, Dhanpat Rai Publications, 2014			
5.	V. Ganesan, Gas Turbines, TMH Publishers			
6.	Iqbal Hussein, Electric and Hybrid Vehicles, 2nd Edition, CRC Press,2010			
7.	A Emadi, Advanced Electric Drive Vehicles, CRC Press, 2015			

List of Reference Books:		
1.	Richard Stone. Introduction to Internal Combustion Engines, Macmillan International Higher Education, 2012	
2.	M Ehsani, Y Gao, S E Gay and A Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles, CRC Press, 2005	
3.	Richard Van Basshuysen, Fred Schaefer. Internal Combustion Engine Handbook, SAE International, 2016	
URLs:		
1.	https://nptel.ac.in/courses/112/104/112104033/	
2.	https://nptel.ac.in/courses/112/103/112103262/	
3.	https://nptel.ac.in/courses/108106170	
Lecture Plan (about 40-50 Lectures):		
Lecture No.	Topic	Remarks
1-2	IC engines working and classification, Mechanical cycle and thermodynamic cycle	
3-4	Air standard cycles-Diesel, Otto and Dual cycles	
5-6	Differences between 2-S and 4-S cycle engines and SI and CI engines	
7-8	S.I. and C.I. Engine operating parameters and performance Characteristics. Numerical problems on engine performance	
9-10	Fuels for SI and CI engine, Engine emissions, mechanism of formation of pollutants	
11-12	Need for alternate fuels, use of various alternate fuels in IC engines Factors affecting pollutant formation,	
13	Emission and Environmental impact, BS norms.	
14	SI and CI engine fuel injection systems	
15	Characteristics of a good combustion chamber-classification of combustion chambers	
16	Combustion in SI Engines, flame propagation	
17-18	Normal and abnormal combustion, Factors affecting combustion, detonation	
19	Combustion in C.I. Engines, Abnormal combustion in CI engines	
20	Ignition delay, factors affecting delay.	
21	Need of supercharging and advantages	
22	Supercharging types and classification, configurations of Supercharging	
23	Supercharging and turbocharging in engines, Supercharged engine cycle analysis	
24	Rotary combustion I.C. engine, Stratified charge engine, principle of working, and salient features	
25	Hydrogen system and fuel injection	
26	Gasification of Hydrogen, Principle, Operation and Types of fuel cell	
27-28	Integration of fuel cells to various thermal system	
29-30	Safety issue of Hydrogen and fuel cell.	
31	Introduction and Overview to Electric Vehicles (EVs).	
32-33	Electric Powertrains: Types and Characteristics. Types and Performance of Batteries used in EVs.	
34	Comparison with IC Engines (ICE): Efficiency and Energy Conversion	
35	Charging Infrastructure and Technologies: AC vs DC.	
36	Charging Stations and Networks, Range and Charging Time Considerations.	
37	Integration of Electric Vehicles with IC Engines,	

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38	Hybrid Vehicles: Types and Architectures, Challenges and Opportunities in Coexistence.	
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***Min 36 (for three credit course)**

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program	B.Tech (Mechanical Engg.)	Semester VI	Year III
Name of Course	Heat and Mass Transfer Lab.		
Course Code	ME24324		
Core / Elective / Other	Core		
List of the Experiments:			
Exp. 1	Measurement of Thermal conductivity of insulating material by lagged pipe method		
Exp. 2	Measurement of Thermal conductivity of metal rod.		
Exp. 3	Measurement of overall heat transfer coefficient for parallel and counter flow heat exchangers		
Exp. 4	Measurement of effectiveness of double pipe heat-exchanger		
Exp. 5	Measurement of overall heat transfer coefficient for air/water heat exchangers.		
Exp. 6	Determination of heat transfer coefficient in natural convection for Pin fin Arrangement		
Exp. 7	Determination of heat transfer coefficient in forced convection for Pin fin Arrangement		
Exp.8	Determination of emissivity by emissivity gray body		
Exp.9	Determination of heat transfer coefficient using Lumped Heat capacity analysis.		
Exp.10	Study of Thermocouples		

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program	B.Tech (Mechanical Engg.)	Semester VI	Year III
Name of Course	Turbomachines Lab		
Course Code	ME24325		
Core / Elective / Other	Core		
List of Experiments:			
Exp. 1	Study of Thermal Power Plan		
Exp. 2	Measurement of Dryness Friction of Steam By using separating and Throttling calorimeter.		
Exp. 3	Performance Measurement of Steam Power Plant		
Exp. 4	Performance Measurement of Centrifugal Blower		
Exp. 5	Study of models of compounding of Turbines (velocity compounding, Pressure compounding and pressure velocity compounding)		
Exp. 6	Determination of efficiency of Centrifugal pump		
Exp. 7	Determination of efficiency of Impulse turbine		
Exp. 8	Determination of efficiency of Francis turbine		
Exp. 9	Determination of efficiency of Kaplan turbine		

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester VI	Year III
Name of Course		Internal Combustion and Hybrid Engines Lab		
Course Code		ME24326		
Core / Elective / Other		Core		
Prerequisite if any:				
1.	Engineering Thermodynamics			
2.	Fluid Mechanics and Hydraulic Machines			
Course Outcomes:				
1.	Analyze energy distribution by conducting heat balance test on IC engine			
2.	Conduct variable ignition timing test on IC engine and analyze engine performance			
3.	Conduct Morse test on IC engines to determine its IP			
4.	Conduct variable speed load test and constant speed performance tests on IC engines and interpret their performance			
5.	Understand working of 2-Wheeler Chassis dynamometer			
Description of Contents in brief:				
Expt. 1	To estimate and draw the heat balance sheet for a Horizontal Ruston Diesel Engine			
Expt. 2	To find the effect of Ignition Timing on Newage petrol engine performance			
Expt. 3	To find the I.P. of Newage 4-cylinder petrol engine by Morse Test			
Expt. 4	To perform variable speed load test on Newage Petrol Engine			
Expt. 5	To find the I.P. of Suzuki 3-cylinder Petrol Engine by Morse test			
Expt. 6	To perform constant speed performance test on a Four-Stroke Single-Cylinder Diesel Engine			
Expt. 7	Study of two wheeler chassis dynamometer			
List of Text Books:				
1.	V. Ganesan. Internal Combustion Engines, Tata McGraw-Hill, 2004			
2.	H.N. Gupta. Fundamentals of Internal Combustion Engines, Prentice Hall of India Private Limited, 2006			
3.	M.L. Mathur, R.P. Sharma. Internal Combustion Engines, Dhanpat Rai Publications, 2014			
List of Reference Books:				
1.	John B. Heywood. Internal Combustion Engine Fundamentals, McGrawHill Education, 2017			
2.	Richard Stone. Introduction to Internal Combustion Engines, Macmillan International Higher Education, 2012			
3.	Richard Van Basshuysen, Fred Schaefer. Internal Combustion Engine Handbook, SAE International, 2016			
URLs:				
1.	https://nptel.ac.in/courses/112/104/112104033/			
2.	https://nptel.ac.in/courses/112/103/112103262/			

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Lecture Plan (about 40-50 Lectures): It is an experimental course
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Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester VII	Year IV
Name of Course		Engineering Economics and IPR		
Course Code		HUM24451		
Core / Elective / Other		Core		
Prerequisite:				
1.	Theoretical underpinning of the concepts related to Economics is crucial.			
2.	Technical knowledge and basic understanding of IPR laws is important.			
Course Outcomes:				
1.	Students would be in a position to link the concepts of Economics and Engineering			
2.	Understanding the production and related it with cash flow and payments			
3.	Students will understand the benefits of IPR			
4.	Understanding of Indian laws and acts regarding IPR			
Description of Contents in Brief:				
Unit 1	Introduction to Economics- Flow in an economy, Law of supply and demand, Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics – Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis – V ratio, Elementary economic Analysis – Material selection for product Design selection for a product, Process planning.			
Unit 2	Methods of comparison of alternatives – present worth method (Revenue dominated cash flow diagram), Future worth method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), Annual equivalent method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), rate of return method, Examples in all the methods.			
Unit 3	Make or buy decision, Value engineering – Function, aims, and Value engineering procedure. Interest formulae and their applications –Time value of money, Single payment compound amount factor, Single payment present worth factor, Equal payment series sinking fund factor, Equal payment series payment Present worth factor- equal payment series capital recovery factor – Uniform gradient series annual equivalent factor, Effective interest rate, Examples in all the methods.			
Unit 4	Basic concepts, characteristics and nature of Intellectual Property Right, IPR and Economic Development, major international instrument relating to the protection of IP. Meaning, Criteria for obtaining patents, Non Patentable inventions, procedure for registration, term of Patent, Rights of patentee, basic concept of compulsory license and government use of patent, infringement of patents and remedies in case of infringement, Relevant Sections.			
Unit 5	Meaning of mark, trademark, and categories of trademark: Certification Mark and well known mark and Non-conventional marks, concepts of distinctiveness. Designs, GI and other forms of IP, Designs: meaning design protection, concept of original design, term of protection, relevant sections.			
Unit 6	Geographical Indication: meaning of GI, difference between GI and Trade Mark, Concept of Authorized Use, Homonymous GI, Relevant section,. Trade-secret: meaning, Criteria of Protection, relevant sections. Plant Variety, Protection and Farmer’s Right: meaning, criteria of protection, relevant sections.			
List of Text Books:				
1.	A. Koutsoyiannis “Modern Microeconomics”. Macmillan Education, 1979			
2.	Subbaram N.R. “Handbook of Indian Patent Law and Practice “, S. Viswanathan, Printers and Publishers Pvt. Ltd.,1998			

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3.	Stephen Ross and Randolph Westerfield and Jeffrey Jaffe and Bradford Jordan, "Corporate Finance", Mc Graw Hill, 2019
List of Reference Books:	
1.	Chan Spark, "Contemporary Engineering Economics", Prentice Hall of India, 2011.
2.	Donald. Newman, Jerome.P.Lavelle, "Engineering Economics and analysis" Egg. Press, Texas, 2010.
3.	Degarmo, E.P., Sullivan, W.G and Canada, J.R, "Engineering Economy", Macmillan, New York, 2011.
4.	Zahid A khan: Engineering Economy, "Engineering Economy", Dorling Kindersley, 2012
5.	V.K. Ahuja , " Law related to Intellectual Property Rights". Publisher- Lexis-Nexi, 2009
6.	R. Radhakrishnan and S. Balasubramanian, "Intellectual Property Rights- Texts and Cases", publisher- Excel Books India, 2008
URLs:	
1.	https://nptel.ac.in/courses/109/104/109104125/
2.	https://nptel.ac.in/courses/110/107/110107144/
3.	http://www.ipindia.nic.in/
4.	https://nptel.ac.in/courses/109106100/
Lecture Plan (about 40-50 Lectures):	
Lecture No.	Topic
	Engg. Economics
1	Introduction to Economics and Flow in an economy
2	Law of supply and demand
3	Concept of Engineering Economics: Engineering efficiency
4	Economic efficiency
5	Scope of engineering economics
6	Element of costs: Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost
7	Break-even analysis: PV ratio
8	Elementary economic Analysis: Material selection for product Design selection for a product,
9	Process planning
10	Methods of comparison of alternatives: present worth method
11	Revenue dominated cash flow diagram
12	Future worth method (Revenue dominated cash flow diagram)
13	Future worth method (Cost dominated cash flow diagram)
14	Annual equivalent method (Revenue dominated cash flow diagram)
15	Annual equivalent method (Cost dominated cash flow diagram)
16	Rate of return method
17	Make or buy decision, Value engineering: Function, aims, and Value engineering Procedure
18	Interest formulae and their applications: Time value of money
19	Single payment compound amount factor
20	Single payment present worth factor
21	Equal payment series sinking fund factor
22	Equal payment series capital recovery factor
23	Equal payment series capital recovery factor
24	Uniform gradient series annual equivalent factor

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25	Effective interest rate
26	Introduction to IPR, its Importance, Need and Characteristics
27	IPR and Economic Development
28	Major International Instrument relating to the protection of IP
29	Patents : Meaning & Criteria for obtaining Patents
30	Procedure for Registration & Non Patentable inventions
31	Term of Patent and Rights of patentee
32	Basic concept of Compulsory License
33	Government use of Patent
34	Infringement of patents and Remedies in case of Infringement
35.	Relevant Sections of Patents
36.	Introduction to Mark and Trademark, Rights and Limitations of Trade Marks
37.	Categories of Trademark
38.	Certification Mark, Well known Marks and Non-Conventional Marks
39	Concepts of Distinctiveness
40.	Introduction to Design: Its meaning and Registration process
41.	Meaning of Design Protection, Concept of Original Design, Term of Design
42.	Relevant Sections of Design
43.	Meaning of Geographical Indication and Difference between GI and Trade Mark
44	Concept of Authorized Use
45.	Homonymous GI and Relevant section of GI
46.	Trade-secret: Meaning, Criteria of Protection, Relevant Sections of it.
47.	Plant Variety, Protection and Farmer's Right: Meaning, Criteria of Protection, Relevant Sections of it.
48.	Case Studies On – Patents (Basumati Rice, Turmeric, Neem, Etc.)

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester VII	Year IV
Name of Course		Refrigeration and Air Conditioning		
Course Code		ME 24411		
Core / Elective / Other		Core		
Prerequisite if any:				
1.	Engineering Thermodynamics (ME2305)			
2.	Heat and Mass Transfer (ME2602)			
Course Outcomes:				
1.	Ability of reasoning and understanding contextual issues of Refrigeration and Air conditioning relevant to the society.			
2.	Able to formulate Refrigeration and Air conditioning problems for different applications and to find solution using principles engineering sciences, mathematics and Literature			
3.	Ability to design and develop Refrigeration and Air conditioning component /system and processes that meets specific needs			
Description of Contents in brief:				
Unit 1.	Principles of refrigeration: Review of Second law of thermodynamics, Refrigeration machine, revised Carnot cycle, Coefficient of Performance, Ton of Refrigeration, Various types of Refrigeration systems. Air Refrigeration System: Bell Coleman Cycle, air cycle systems for aircraft. Boot Strap system, reduced ambient system, evaporative and regenerative system			
Unit 2.	Vapour compression refrigeration: Simple vapour compression cycles, representation of cycles on T-S and P-H diagrams, effects of sub cooling, super heating, wet compression, suction and discharge pressure on the performance of vapour compression refrigeration system, Actual vapour compression refrigeration cycle,			
Unit 3.	Compound vapour comparison systems: Limitations of simple vapour compression refrigeration system for the production of low temperature. Multi stage compression system, multi evaporator system, cascade system. Production of solid CO ₂ . Liquefaction of gases.			
Unit 4.	Absorption Refrigeration System: Simple Absorption cycle, use of heat exchanger, analysis and rectifier, the Electrolux system, Lithium– Bromide Water Absorption system Nonconventional Refrigeration System: Vortex tube refrigeration system, Steam jet and thermo-electric refrigeration systems, their principle of working and application Refrigerants: Classification and Nomenclature of Refrigerants, Desirable properties of important refrigerants, Primary and secondary refrigerants, Alternate eco friendly refrigerant.			
Unit 5.	Psychrometry: Properties of moist air, psychometric processes and their representation on psychometric chart for calculations. Psychrometry of air conditioning process i.e. Mixing process, sensible heating or cooling, humidification and dehumidification, Sensible heat factor, Bypass factor, Air washer.			
Unit 6	Air conditioning Systems: Summer and winter air conditioning, Thermal comfort, Air conditioning load calculation, Sensible and latent loads, principles for calculation of building heat transmission, solar heat gain, infiltration and occupancy loads, load due to electric motors and electric driven machineries, other sources of heat gain,			

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	Window and spilt air conditions system, Variable Refrigeration system.	
List of Text Books:		
1.	Arora C. P., Refrigeration and Air Conditioning,, Tata McGraw-Hill Education, 2000	
2.	P.L. Balaney Refrigeration and Air-conditioning, Khanna Publication 1972	
3.	R S Khurmi, Refrigeration and Air Conditioning, S Chand Publication, 2006	
List of Reference Books:		
1.	Dossat, R.J., Principles of Refrigeration, Pearson Education India, 1996	
2.	Whitman, Johnson & Tomczyk, Refrigeration and Air Conditioning Technology. Cengage Learning, 2009	
3.	Hundy, Trott&Welch, Refrigeration and Air Conditioning, Butterworth-Heinemann, 2008	
URLs:		
1.	https://www.ashrae.org/	
2.	https://ishrae.in/	
Lecture Plan (about 40-50 Lectures):		
S. No.	Topic	No. of Lecture
1.	Review of Second law of thermodynamics, Refrigeration machine, revised Carnot cycle, Coefficient of Performance, Ton of Refrigeration, Various types of Refrigeration systems	03
2.	Air Refrigeration System: Bell Coleman Cycle, air cycle systems for aircraft. Boot Strap system, reduced ambient system, evaporative and regenerative system, numerical example	05
3	Simple vapour compression cycles, effects various operating parameters on the performance of vapour compression refrigeration system, representation of cycles on T-S and P-H diagrams. Practical vapour compression cycle, numerical example	04
4	Limitations of simple vapour compression refrigeration system for the production of low temperature. Multi stage compression system, multi evaporator system, cascade system. Production of solid CO ₂ . Liquefaction of gases.	08
5	Simple Absorption cycle, use of heat exchanger, analysis and rectifier, the Electrolux system, Lithium– Bromide Water Absorption system	04
6	Vortex tube refrigeration system, Steam jet and thermo-electric refrigeration systems, their principle of working and application	03
7	Classification and Nomenclature of Refrigerants, Desirable properties of important refrigerants, Primary and secondary refrigerants, Alternate eco friendly refrigerant.	03
8	Properties of moist air, psychometric processes and their representation on psychometric chart for calculations. Psychrometry of air conditioning process i.e. Mixing process, sensible heating or cooling, humidification and dehumidification, Sensible heat factor, Bypass factor, Air washer	06
9	Factors affecting human comfort. Effective temperature, comfort chart and comfort zone.	02
10	Summer and winter air conditioning, Thermal comfort, Air conditioning load calculation, Sensible and latent loads, principles for calculation of building heat transmission, solar heat gain, infiltration and occupancy loads, load due to	10

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	electric motors and electric driven machineries, other sources of heat gain, Window and split air conditions system, Variable Refrigeration system	
	Total No Lecture required to cover the syllabus	48

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester VII	Year IV
Name of Course		Refrigeration and Air Conditioning Lab		
Course Code		ME24412		
Core / Elective / Other		Core		
List of Experiments:				
Exp. 1	Study of Window Air Conditioning system			
Exp. 2	Study of Domestic Refrigerator			
Exp. 3	Measurement of COP of Vapour compression Refrigeration system			
Exp. 4	Measurement of COP of Vapour Absorption Refrigeration system			
Exp. 5	Experiment on refrigeration test rig and calculation of various performance parameters			
Exp. 6	Experiment on air-conditioning test rig and calculation of various performance Parameters			
Exp. 7	Measurement of COP of Ice Plant			
Exp. 8	Performance measurement of Central Air Conditioning system			
Exp. 9	Measurement of By-pass factor of cooling coil of Air Conditioning system			
Exp. 10	Performance measurement of Auto Mobile Air Conditioning system			
Exp. 11	Performance measurement of Evaporative cooler			
Exp. 12	Study of Refrigerant charging Kit			
Exp. 13	Study of different types of Expansion Devices used in Refrigeration system			
Exp. 14	Study of various Tools used in Refrigeration & Air conditioning			

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program	B.Tech (Mechanical Engg.)	Semester VII	Year IV
Name of Course	Project Based Lab-2		
Course Code	ME24413		
Core/ Elective / Other	Core		
Prerequisite: Nil			
Course Outcomes:			
CO 1	Develop understanding of experimental and industrial projects		
CO 2	Develop understanding of solutions to problems of society		
Topics Covered as per Syllabus			
1.	Problem oriented small industrial projects		
2.	Solutions to societal problems		
3.	Visit to projects/industrial installations with latest technology		
4.	Innovative projects		
5.	Ideation and modelling		

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

LIST OF PROGRAMME ELECTIVES (GROUP A)

Group A Electives - Third Year		
S. No.	Course Code	Course Name
1.	ME24352	Gas Dynamics
2.	ME24353	Gas Turbines and Jet Propulsion
3.	ME24354	Automobile Engineering
4.	ME24355	An Introduction to Microfluidics
5.	ME24356	Robotics
6.	ME24357	Materials Handling
7.	ME24358	Service Operation Management
8.	ME24359	Statistical Quality Control
9.	ME24360	Mechatronics
10.	ME24361	Theory of Vibrations
11.	ME24362	Mechanics of Deformable Solids
12.	ME24363	Fracture Mechanics and Failure Analysis
13.	ME24364	Maintenance Engineering and Management
14.	ME24365	Product Design and Development
15.	ME24366	Theory of Elasticity and Plasticity
16.	ME24367	Material Management
17.	ME24368	Engineering Optimization
18.	ME24369	Mechanical Behaviour of Materials
19.	ME24370	Supply Chain Management

Group A Electives - Fourth Year		
S. No.	Course Code	Course Name
1.	ME24451	Energy Conversion Systems
2.	ME24452	Design of Heat Exchangers
3.	ME24453	Solar Energy
4.	ME24454	Non-Conventional Energy Sources
5.	ME24455	Energy Audit Carbon Sequestration
6.	ME24456	Computational Fluid Dynamics and Heat Transfer
7.	ME24457	Wind Energy Technology
8.	ME24458	Additive Manufacturing Technologies
9.	ME24459	Advanced Production Engineering
10.	ME24460	Nano Manufacturing
11.	ME24461	Lean Manufacturing
12.	ME24462	Composite Materials

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13.	ME 24463	Smart Materials
14.	ME24464	Sustainable Supply Chain Management
15.	ME24465	Accounts and Financial Planning
16.	ME24466	Organizational Behaviour
17.	ME24467	Total Quality Management
18.	ME24468	Marketing Management
19.	ME24469	CAD/CAM
20.	ME24470	Advanced Operations Research
21.	ME24471	Industrial Tribology
22.	ME24472	Mechanics of Composite Materials
23.	ME24473	Computational Methods
24.	ME24474	Analysis and Design of Mechanical Control System
25.	ME24475	Advanced Machine Design

ELECTIVES GROUP-A

Name of Program	B.Tech (Mechanical Engg.)	Semester: V/VI	Year: III
Name of Course	Gas Dynamics		
Course Code	ME24352		
Core / Elective / Other	Elective		
Prerequisite if any:			
1.	Engineering Thermodynamics		
2.	Fluid Mechanics		
Course Outcomes:			
1.	Solve flow equations for quasi one dimensional flow through variable area ducts.		
2.	Analyze the flow through constant area ducts with friction and heat transfer.		
3.	Analyze flows with normal and oblique shocks		
4.	Solve flow problems with supersonic velocities using shock-expansion theory		
5.	Solve linearized velocity potential equation for multi-dimensional flows.		
Description of Contents in brief:			
Unit 1.	Introduction: Review of basic fluid dynamic and thermodynamic principles, Conservation equations for inviscid flows		
Unit 2.	One Dimensional flow: One-dimensional wave motion, normal shock waves, Oblique shock waves, Prandtl-Meyer expansions and applications, Generalized one-dimensional Flow		
Unit 3.	Nozzle Flow: Isentropic flow with area change, Flow with friction (Fanno flow), Flow with heat addition (Rayleigh flow), Method of characteristics (application to one-dimensional unsteady isentropic flow)		
Unit 4.	Supersonic Flow: Velocity Potential Equation, Numerical Techniques for Steady Supersonic Flow, Time Marching Technique for Supersonic Blunt Bodies and Nozzles		
List of Text Books:			
1.	R. D. Zucker, Oscar Biblarz, Fundamentals of Gas Dynamics, JOHN WILEY & SONS, INC, 2002		
2.	Yahya, S.M., Fundamentals of Compressible Flow, New age International Pub., 2013.		
3.	P. Balachandran, Fundamentals of Compressible Fluid Dynamics, PHI Learning, 2009		
List of Reference Books:			
1.	Michel A. Saad, Compressible Fluid Flow, Prentice Hall, 2 nd Ed., 1993		
2.	A. Alexandrou, Fluid Mechanics, Prentice Hall, 2001		
3.	Int J. of Heat and Mass Transfer, Elsevier		
URLs:			
1.	http://www.nptel.ac.in		
2.	https://swayam.gov.in/nc_details/NPTEL		
Lecture Plan (about 40-50 Lectures):			
*Lecture No.	Topic		Remarks

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1-8	Review of basic fluid dynamic and thermodynamic principles, Conservation equations for inviscid flows	
8-20	One Dimensional flow: One-dimensional wave motion, normal shock waves, Oblique shock waves, Prandtl-Meyer expansions and applications, Generalized one-dimensional flow	
21-32	Nozzle Flow: Isentropic flow with area change, Flow with friction (Fanno flow), Flow with heat addition (Rayleigh flow), Method of characteristics (application to one-dimensional unsteady isentropic flow)	
32-42	Supersonic Flow: Velocity Potential Equation, Numerical Techniques for Steady Supersonic Flow, Time Marching Technique for Supersonic Blunt Bodies and Nozzles	

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester: V/VI	Year: III
Name of Course		Gas Turbines and Jet Propulsion		
Course Code		ME24353		
Core / Elective / Other		Elective		
Prerequisite if any:				
1.	Engineering Thermodynamics			
2.	Fluid Mechanics			
Course Outcomes:				
1.	Understand the basic principles and theory of gas turbine and jet propulsion.			
2.	Working knowledge of the basic operation and design requirements of propulsion turbo-machinery components (inlets, compressors, combustors, turbines, afterburners, and nozzles).			
3.	Analyse the performance and operating/design constraints for inlets, compressors, combustors, turbines and nozzles.			
4.	Analyze the thermodynamic performance of jet engine cycles and compute relevant performance parameters			
Description of Contents in brief:				
Unit 1.	Gas Turbines: Introduction, classification, application, gas turbine and its components, gas turbine power plants. Optimum pressure ratio for maximum specific and thermal efficiency in actual gas turbine cycle. Effect of operating variables on thermal efficiency, air rate and work ratio.			
Unit 2.	Combustion Chamber: Types of combustion chamber, factors affecting combustion chamber design, combustion processes, combustion chamber performance, fuel injection systems. Axial flow turbines & combustion chamber: Classification, elementary theory, vortex theory, limiting factors in turbine design, overall turbine performance, design performance of gas turbine plant, matching of turbine components.			
Unit 3.	Centrifugal Compressors: Pre-whirling, adiabatic efficiency, performance characteristics, pressure coefficient and slip factor, losses, surging, compressor design calculations, Mach Number.			
Unit 4.	Axial flow compressors: Principles of operation, simple design method, blade design, calculation of stage, overall performance, compressor characteristics, Mach Number, Reynolds Number.			
Unit 5.	Jet Propulsion: Turbojet, turbo prop, ram jet, rocket engines thrust power, propulsive efficiency and thermal efficiency, jet propulsion performance, specifying thrust and specific fuel consumption in each case for turbo jet and turbo propulsion units.			
List of Text Books:				
1.	Sarvanamuttoo, Cohen H. & Rogers GFC, Gas Turbine Theory, Pearson, 2001			
2.	Zucrow N.J., Principles of Jet Propulsion and Gas Turbines, John Wiley and Sons, New York, 1970.			
3.	Mattingly Jack, Element Gas Turbine Propulsion, Mc Graw Hill, 2009			
List of Reference Books:				
1.	Cohen H. & Rogers GFC, Theory of Gas Turbine, Pearson, 2018			
2.	Ganesan, V., Gas Turbine, Mc Graw Hill Publishing Company, 2010			
3.	Int J. of Heat and Mass Transfer, Elsevier			

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URLs:		
1.	http://www.nptel.ac.in	
2.	https://swayam.gov.in/nc_details/NPTEL	
Lecture Plan (about 40-50 Lectures):		
*Lecture No.	Topic	Remarks
1-8	Gas Turbines: Introduction, classification, application, gas turbine and its components, gas turbine power plants. Optimum pressure ratio for maximum specific and thermal efficiency in actual gas turbine cycle. Effect of operating variables on thermal efficiency, air rate and work ratio.	
8-20	Combustion Chamber: Types of combustion chamber, factors affecting combustion chamber design, combustion processes, combustion chamber performance, fuel injection systems. Axial flow turbines & combustion chamber: Classification, elementary theory, vortex theory, limiting factors in turbine design, overall turbine performance, design performance of gas turbine plant, matching of turbine components.	
21-32	Centrifugal Compressors: Pre-whirling, adiabatic efficiency, performance characteristics, pressure coefficient and slip factor, losses, surging, compressor design calculations, Mach Number.	
32-42	Jet Propulsion: Turbojet, turbo prop, ram jet, rocket engines thrust power, propulsive efficiency and thermal efficiency, jet propulsion performance, specifying thrust and specific fuel consumption in each case for turbo jet and turbo propulsion units.	

***Min 48 (for four credit course) Evaluation Criteria:**

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester: V/VI	Year: III
Name of Course		Automobile Engineering		
Course Code		ME24354		
Core / Elective / Other		Elective		
Prerequisites if any				
1.		Not any		
Course Outcomes:				
1		To enable students to understand functions of various components/subassemblies of automobiles		
2		To enable students to apply engineering design principles to components of Automobiles		
3		To enable students to understand recent trends in alternate fuels and safety systems		
Description of Contents in brief:				
Unit 1.		Fuels and fuel systems: general introduction. SI Engines fuel injection systems: Requirement and need for fuel injection. Classification of systems in practice. MPFI system operation construction and working of important sensors used in FI injection system. CI Engine fuel injection systems: Requirement of Diesel injection systems. Classification-injectors for CI Engines, alternate fuels for CI engines.		
Unit 2.		Engine induction and Exhaust Systems: Requirements and considerations. Manifold flowpaths and tuning. Introduction to exhaust gas extraction. Turbocharging, types, variable geometry turbocharger.		
Unit 3.		Engine valve operating systems: Effect of Valve timing and valve lift on engine operation; variable valve lift and variable valve timing. Valve operating conditions. Multi valve engines. General: Development & Advances in Automobile engineering		
Unit 4.		Engine types Advanced Engine systems: Ignition systems for petrol engines. Advanced cooling concepts, radiators and thermostat. Wind shield wiper fuel gauge. Chassis and suspension: Requirements and general consideration of strength and stiffness. Engine mountings, types of suspension.		
Unit 5.		Transmission: Clutch, types, fluid flywheel, torque converter, gear boxes, universal joint, propeller shaft, differential, rear axles and their types, front axles and their types. Steering: Factor controlling rolling and directional stability, castor angle, wheel camber, steering geometry and system, power assisted steering.		
Unit 6		Brakes: Principle of braking system, braking mechanism, mechanical and hydraulic brakes, power brakes, vacuum and air brakes. Wheels and Tyres: Wheel drum, tyre, materials and manufacturing of tyres, trouble shooting and maintenance and safety.		
List of Text Books:				
1.		R. B. Gupta, Automobile Engineering, Satya Publishers, 2016.		
2.		GBS Narang, Automobile Engineering, Khanna Publishers, 1995		
3.		Rajput R K, Automobile Engineering, Laxmi Publications, 2008		
List of Reference Books:				
1.		Joseph Heitner, Automotive Mechanics, CBS, 2004		
2.		Nunney M J, Light & Heavy Vehicle Technology, Elsevier, 2007		
3.		William Crouse & Donald Anglin, Automobile Engineering Mechanics, McGraw Hill, 2007.		

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URLs:

1.	https://nptel.ac.in/courses/107/106/107106088/
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Lecture Plan (about 40-50 Lectures):

*Lecture No.	Topic	Remarks
1.	Introduction to Automobile Engineering, history and scope of automobile industry in India	
2	Fuels and fuel systems: general introduction. SI Engines fuel injection systems:	
3	Requirement and need for fuel injection. Classification of systems in practice. MPFI system	
4	operation construction and working of important sensors used in FI injection system	
5	CI Engine fuel injection systems	
6	Requirement of Diesel injection systems, Classification – injectors for CI Engines	
7	Alternate fuels for CI engines	
8	Engine induction and Exhaust Systems	
9	Requirements and considerations. Manifold flow paths and tuning	
10	Introduction to exhaust gas extraction	
11	Turbocharging, types, variable geometry turbocharger.	
12	Turbocharging, types, variable geometry turbocharger.	
13	Engine valve operating systems	
14	MINI TEST	
15	Effect of Valve timing and valve lift on engine operation	
16	variable valve lift and variable valve timing	
17	Valve operating conditions. Multi valve engines.	
18	Valve operating conditions. Multi valve engines.	
19	General: Development & Advances in Automobile Engineering	
20	Engine types Advanced Engine systems	
21	Ignition systems for petrol engines.	
22	Advanced cooling concepts, radiators and thermostat.	
23	Wind shield wiper fuel gauge.	
24	Chassis and suspension	
25	Requirements and general consideration of strength and Stiffness	
26	Engine mountings, types of suspension.	
27	Transmission: Clutch, types, fluid flywheel, torque converter	
28	gear boxes, universal joint, propeller shaft, differential	
29	rear axles and their types, front axles and their types	
30	Steering: Factor controlling rolling and directional stability	
31	castor angle, wheel camber	
32	steering geometry and system, power assisted steering	
33	steering geometry and system, power assisted steering	
34	Brakes: Principle of braking system, braking mechanism	
35	mechanical and hydraulic brakes	
36	power brakes, vacuum and air brakes.	
37	Wheels and Tyres: Wheel drum, tyre materials	
38	manufacturing of tyres	
39	trouble shooting and maintenance	
40	Safety systems of automobiles	

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Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program	B.Tech (Mechanical Engg.)	Semester: V/VI	Year: III
Name of Course	An Introduction to Microfluidics		
Course Code	ME24355		
Core / Elective / Other	Elective		
Prerequisite if any:			
1.	Fluid Mechanics		
Course Outcomes:			
1.	The student will understand the flow physics involved in microchannels.		
2.	The student will able to analyze the problems of gas and liquid flows in microchannels.		
3.	The student will able to design the microchannel system.		
Description of Contents in brief:			
Unit 1.	Introduction: Origin, Definition, Benefits, Challenges, Applications, Physics of miniaturization, Scaling laws, Conservation of Mass, Momentum, Energy and Species conservation equation, Boundary conditions.		
Unit 2.	Pressure-Driven Microflows: Fully developed flow, Hagen-Poiseuille flow, Low Reynolds Hydrodynamics, Stokes Problem, Unsteady flows, Stokes drag on sphere		
Unit 3.	Capillary flows: Surface tension and interfacial energy, Contact angle, Capillary length and capillary rise, Interfacial boundary conditions, Marangoni effect.		
Unit 4.	Electrokinetics: Electrokinetic effects, Electroosmosis, Dielectrophoresis, Magnetophoresis.		
Unit 5.	Microfabrication Technique: Materials, Clean room, Silicon crystallography, Photolithography - mask, spin coating, exposure and development, Etching, Bulk and Surface micromachining, Polymer microfabrication, PMMA/COC/PDMS substrates, micro-molding, hot embossing, fluidic interconnections		
Unit 6	Biomicrofluidics: An introduction to bio-microfluidics, and some applications Computational modelling of micro-flows: MD and DSMC methods		
List of Text Books:			
1.	Tabeling, P., <i>Introduction to microfluidics</i> , Oxford University Press Inc., 2005.		
2.	Nguyen, N. T., Werely, S. T., <i>Fundamentals and applications of Microfluidics</i> , Artech house Inc., 2002.		
3.	Colin, S., <i>Microfluidics</i> , John Wiley & Sons, 2009.		
List of Reference Books:			
1.	Madou, M. J., <i>Fundamentals of Microfabrication</i> , CRC press, 2002.		
2.	Bruus, H., <i>Theoretical Microfluidics</i> , Oxford University Press Inc., 2008.		
URLs:			
1.	https://nptel.ac.in/courses/112/105/112105187/		
2.	https://nptel.ac.in/courses/112/106/112106169/		
3.	https://canvas.harvard.edu/courses/8157/assignments/syllabus		
Lecture Plan (about 40-50 Lectures):			
*Lecture No.	Topic	Remarks	
1	Introduction to microfluidics		
2	Applications		
3	scaling Laws		
4	Conservation of mass		
5	Navier-Stoke equations		

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6	Derivation of Navier-Stokes equation	
7	Energy equation	
8	Species conservation equation	
9	Flow driven by pressure gradient	
10	Fully developed flow between two parallel plates	
11	Hagen-Poiseuille flow	
12	Low Reynolds hydrodynamics	
13	Unsteady flows	
14	Stokes 1 st Problem	
15	Stokes 2 nd Problem	
16	Stokes drag on sphere	
17	Surface driven flows	
18	Young Laplace equation	
19	Contact angle: Interpretation of Young law	
20	Capillary rise and pump	
21	Interfacial boundary conditions	
22	Marangoni effect	
23	Problem solving session	
24	Fundamental of electrohydrodynamic	
25	The Debye layer	
26	Electric double layer	
27	Ideal electroosmotic flow	
28	Electroosmotic flow with back pressure	
29	The cascade electroosmotic pump	
30	Electrophoresis of particle	
31	Electrophoretic velocity dependence on particle size	
32	Dielectrophoresis	
33	Induced polarization and dielectric forces	
34	Point dipole in a dielectric fluid	
35	The dielectrophoretic forces on a dielectric sphere	
36	Dielectric particle tracking	
37	Magnetostatics	
38	Basic equation for magnetophoresis	
39	Material used in the microfabrication	
40	Photolithography- mask and spin coating, exposure	
40	Etching and resists stripping	
41	Bulk and surface micromachining	
42	Polymer microfabrication	
43	PMMA/COC/PDMS substrates, micro-molding	
44	Hot embossing, fluidic interconnections	
45	Microfluidics components	
46	Introduction to Biomicrofluidics	
47	Drug Delivery, Diagnostics, and Bio Sensing	
48	Scope of computational modelling in microflows	

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Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program	B.Tech (Mechanical Engg.)	Semester: V	Year: III
Name of Course	Robotics		
Course Code	ME24356		
Core/Elective/Other	Departmental Elective		
Prerequisite, if any:			
1.	Theory of Machine		
2.	Basic knowledge on mathematics concepts involving Trigonometry, Vectors, Matrices, Differentiations, Integrations.		
Course Outcomes:			
1.	Awareness on field of robotics and knowledge on coordinate system, configurations, components , workspace & basic motions of robots used in manufacturing industries.		
2.	Understanding the frames, mapping, rotation matrices & transformation to design & control the end action/use of series industrial manipulator.		
3.	Knowledge on Direct or forward kinematics, and selection & design of end effectors.		
4	Knowledge on actuators & sensors as applicable to industrial manipulators.		
5	Understanding on controllers. Application based understanding on use & selection of robots for manufacturing Industries.		
Description of Contents in Brief:			
Unit1.	Robots, Robotics and laws of Robotics, Need of automation & robots in manufacturing industries, Types of Robots, Robot Anatomy/components - Links, Joints, Degree of freedom, Arm & Wrist configuration etc., Robots classification by Coordinate system, Concept of work space, Basic robot motions.		
Unit2.	Coordinate frames: Mapping, Mapping between rotated frames, Mapping between translated frames and Mapping between rotated & translated frames. Description of objects in space, Transformations and fundamentals of rotation matrices.		
Unit3.	Kinematic Modelling of the manipulator, D-H Representation, Forward Kinematics Examples. End effectors; classifications, selection, design.		
Unit4.	Actuators; Pneumatic, Hydraulic and Electrical actuators. Sensors; Position sensors, Potentiometers, Force sensors, Encoders, etc.		
Unit5.	Control of robotic systems: Basics of control; PD, PI and PID controller; Force control; Adaptive control. Robot applications in Manufacturing; Welding, Assembly, Material handling, Loading and unloading, spray painting etc.		
List of Text Books:			
Title of Book		Author, publication year and publisher	
Robotics and Control		R.K. Mittal &I.J.Nagrath, 2 nd ed., Tata McGraw Hill	
Industrial Robotics, Technology, Programming and Applications		Mikell P. Groover, Mitchell Weiss, , 2 nd ed., Mc.Graw Hill International.	
Introduction to Robotics		S.K. Saha,, 2 nd ed., Tata McGraw Hill, 2009.	
Fundamentals of Robotics		D. K Pratihar, Narsa Publishers, 2018.	
List of Reference Books:			
Title of Book		Author, publication year and publisher	
Robotics Control sensing, Vision and Intelligence		K.S. Fu., R.C.Gonzalez and C.S.G.Lee, , 1st ed., McGraw Hill International, 2nd reprint 2008.	
Introduction to Robotics Analysis, Systems, Applications		Saeed B.Niku, 2nd ed., PHI Learning Publication, 2009.	

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URLs:	
1.	https://youtu.be/rYWJdZ5qg6M
2.	https://nptel.ac.in/courses/112/101/112101099/
3.	https://ocw.mit.edu/courses/mechanical-engineering/2-12-introduction-to-robotics-fall-2005/lecture-notes/
Lecture Plan (about 40-50 Lectures):	
Lecture No.	Topic
1	Introduction & need of automation & robots in manufacturing industries
2	Robotics, laws of Robotics, history of Robots
3-5	Robot Anatomy/components
6-7	Coordinate system & configurations
8	Concept of work space & basic motions.
9	QUIZ – I
10	Coordinate frames
11	Description of objects in space
12-13	fundamentals of rotation matrices
14-16	Mapping between frames & solving the numerical problems
17-18	Transformations based numerical problems
19	MINI TEST
20-22	D-H Representation
23-25	Forward Kinematics based numerical problem solving
26	QUIZ – II
27-29	End effectors; classifications, selection, design.
30-33	Actuators; Pneumatic, Hydraulic and Electrical actuators
34-37	Sensors; Position sensors, Potentiometers, Force sensors, Encoders, etc.
38	SURPRISE TEST
39-43	Basics of control; PD, PI and PID controller; Force control; Adaptive control.
44-46	Robot applications in Manufacturing

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program	B.Tech (Mechanical Engg.)	Semester: V/VI	Year: III
Name of Course	Materials Handling		
Course Code	ME24357		
Core / Elective / Other	Elective		
Prerequisite if any:			
1.	Facility management & layout planning		
2.	Industrial Engineering and Operations Research		
Course Outcomes:			
1.	Able to understand the importance of material handling in improving productivity and to identify various material handling equipments and select them as per their application in Industries.		
2.	Able to automate the safe & quick movement/retrieval of various types of materials within shop floor or at machine(s) itself or in storage areas.		
3.	To know the operation and maintenance of various material handling equipments as per industry standards.		
Description of Contents in detail			
Unit 1.	Definition & scope of Material Handling (MH) in industries. Engineering and economic factors. MH relationship to plant layout, productivity & safety. Principles of material handling.		
Unit 2.	Objectives of material handling, Characteristics/features of material(s).Unit load concept & design. Categories of Material Handling Equipments.		
Unit 3.	Factors Affecting the selection of Materials Handling Equipments. Transport equipments, Positioning equipments, Unit load formation equipments.		
Unit 4.	Storage equipments, Identification & control equipments. Automated storage and retrieval systems (AS/RS).		
Unit 5.	Automatic guided vehicles (AGV), Robotics in material handling.		
Unit 6	Maintenance of Materials Handling Equipments		
List of Text Books:			
1.	Materials Handling and Storage Textbook - by Duvall, Edition 2016-2017.		
List of Reference Books:			
1.	Material Handling System Design-James Apple, Ronald Press, 1972		
2.	Hand Book of Industrial Engineering- G. SALVENDY ,3 rd Edition, A Wiley-Interscience Publication, Wiley, 2001		
3.	Materials Handling Handbook, Raymond A. Kulwiec, 2nd Edition, Wiley, 1986		
URLs:			
1.	https://www.mhi.org/casestudies		
2.	https://www.mhi.org/publications		

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Lecture Plan (about 40-50 Lectures):		
*Lecture No.	Topic	
1-2	Introduction to material handling; Definition, Scope & terminology	
3-5	Engineering and economic factors, MH relationship to plant layout, productivity & safety	
6-8	Principles of MH, Objectives/advantages/limitations of materials handling	
9-10	Characteristics/features of material(s)	
11-14	Categories of Material Handling Equipments, Unit load concept, Unit load design considerations	
15-18	Factors Affecting the selection of Materials Handling Equipments, Various transport equipments (Types, Function, construction, specifications, working, application etc.)	
19-22	Positioning equipments (Types, Function, construction, specifications, working, application etc.)	
23- 26	Unit load formation equipments (Types, Function, construction, specifications, working, application etc.)	
27-29	Storage equipments, Identification & control equipments	
30-31	Automated storage and retrieval systems (AS/RS).	
32-36	Automatic guided vehicles (AGV), Robotics in material handling	
37-40	Maintenance of Materials Handling Equipments	

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester: V/VI	Year: III
Name of Course		Service Operation Management		
Course Code		ME24358		
Core / Elective /Other		Elective		
Prerequisite:				
1.	Nil			
Course Outcomes:				
1.	To enable students to understand scope of services operations management			
2.	To formulate and solve real world problems related to industries			
3.	To design methods to improve competitiveness and effective utilization of services			
Description of Contents in brief:				
Unit 1.	Introduction of Services Operations Management, Nature and Characteristics of services, Functions of Management, Vision, Mission, Leadership Style, Theories of Motivation, Competitiveness			
Unit 2.	Service Operations Strategy, Balance Score card, Production Processes, Selection of Processes, Break even analysis			
Unit 3.	Service Quality Control, Quality control tools, Deming's 14 Points, Process control charts, Process Capability, Six Sigma, Acceptance Sampling			
Unit 4.	Factors affecting Service Facility Location decision, Service Facility Layout			
Unit 5.	Service Supply Chains, Queuing management, HR management in Service industries			
Unit 6.	Forecasting methods in service industries, MCDM Techniques for service applications			
List of Text Books:				
1.	Operations Management by Russel & Taylor; Wiley			
2.	B. Fitzsimmons, James A., and Mona J. Fitzsimmons,Service Management: Operations,Strategy, and Information Technology, 6th Ed., Irwin/McGraw-Hill, 2007.			
3.	C. Haksever, Render B., Russel S. R. and Murdick R. G.,Service Management and Operations, 2nd Ed.,Prentice Hall, 2007.			
List of Reference Books:				
1.	Handbook of Industrial Engineering: Technology and Operations Management by Gavriel Salvendy; Wiley publication			
2.	Modern production/operations management by Buffa: Wiley India			
3.	Operations management by Krajewski; pearson			
URLs:				
1.	https://www.youtube.com/watch?v=_VJkKZFuRvE&list=PL4FjpOEssq4HuaN7Q3pU9mL5uZuPBV_tf			

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2.	https://www.youtube.com/watch?v=aSd8Hbg-tuY&list=PLLy_2iUCG87A-kHGx4YUY97ShTTqBfA6-	
Lecture Plan :		
Lecture No.	Topic	Remarks
1.	Introduction of service operations management,	
2.	Nature and Characteristics of services	
3.	Competitiveness	
4.	Functions of Management	
5.	Theories of Motivation	
6.	Service Operations Strategy	
7.	Balance Score card,	
8.	Selection of Processes,	
9.	Break even analysis	
10.	QFD,	
11.	Quality Control,	
12.	Quality control tools,	
13.	TQM	
14.	Process control charts,	
15.	Six Sigma	
16.	Acceptance Sampling	
17.	Case discussion	
18.	Factors affecting of service Facility Location decision	
19.	Methods of service facility location	
20.	Methods of service facility location	
21.	Service Facility Layout	
22.	Service Facility Layout	
23.	Case discussion	
24.	Service Supply Chains	
25.	Service Supply Chains	
26.	Queuing management	
27.	Queuing management	
28.	Queuing management	
29.	HR management in Service industries	
30.	HR management in Service industries	
31.	HR management in Service industries	
32.	Forecasting methods in service industries	
33.	Forecasting methods in service industries	
34.	Forecasting methods in service industries	
35.	Forecasting methods in service industries	
36.	MCDM Techniques	
37.	MCDM Techniques	
38.	MCDM Techniques	
39.	MCDM Techniques	

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40.	Seminar	
41.	Seminar	
42.	Seminar	

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester: V/VI	Year: III
Name of Course		Statistical Quality Control		
Course Code		ME24359		
Core / Elective / Other		Elective		
Prerequisite if any:				
1.	Nil			
Course Outcomes:				
1.	To introduce students, the importance of Quality and Reliability in Manufacturing Industry,			
2.	To impart knowledge of Quality Control activity in Manufacturing Industries,			
3.	To give practice of drawing control charts with practical cases, and			
4.	To give exposure to acceptance sampling concepts and reliability to students.			
Description of Contents in brief:				
Unit 1.	Introduction to Quality Control, Fundamentals of statistical concepts and techniques in quality control and improvement, graphical methods and data representation, Magnificent seven tools of quality			
Unit 2.	Statistical process control using control charts, design of control charts, Control charts for variables and attributes, X-bar, np, p, c, u charts, and Process capability analysis.			
Unit 3.	Acceptance sampling plans for attributes and variables, operating characteristic curves, A & L system for Lot by Lot acceptance sampling, Sampling plans, MILSTD411, Dodge -Romig sampling plans, LTPD, AOQL.			
Unit 4.	Special sampling plans, Chain sampling, Continuous sampling, Skip lot, Economic design of sampling plans.			
Unit 5.	Life testing, Life cycle curve and probability distributions in modeling reliability, system reliability. Experimental Design and Taguchi Methods, Factorial designs, Signal to noise ratio, Taguchi definition of Quality, robust design concept.			
List of Text Books:				
1.	Introduction to Statistical Quality Control by Douglas C. Montgomery, Wiley publishers, 2016			
2.	Statistical Quality Control by Eugene L Leavenworth, McGraw Hill, 2017			
3.	Quality and Reliability Engineering by Chandrupatla, Cambridge Publications, 2009			
List of Reference Books:				
1.	Quality planning and analysis by J.Juran, McGraw Hill Education, 2017			
2.	Statistical Quality Control by M.Mahajan, DhanpatRai and Co, 2016			
Lecture Plan (about 40-50 Lectures):				
*Lecture No.	Topic			Remarks
1.	Introduction to SQC, definition and application areas in Industry			
2.	Fundamentals of statistical concepts, discrete and continuous Distributions			

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3	Practice on problem solving: Hyper geometric, binomial and Poisson dist.	
4	Quality Control stages in industry and relevance of SQC in QC	
5	Seven statistical tools of QC: Frequency diagram and Histogram	
6	Interpretation of Histogram and Quality Control	
7	Run chart, Pareto diagram, Cause and effect diagram and Box Plot	
8	Stem and Leaf plot, normal probability plot and examples	
9	Practice on Histogram and Box plots	Mini test
10	Introduction to control charts and design of control charts	
11	Definition of variables and attributes and associated statistical Distributions	
12	Control charts for variables and attributes : similarities and Differences	
13	Rules applied for acceptance of control charts and examples	
14	Introduction to X bar and R charts, solution of example Problems	
15	X bar R charts, Scrap and Rework calculations and use of Tables	
16	Attribute type charts p, c and u charts and use of tables	
17	Practice on variable and attribute charts	
18	Practice on variable and attribute charts	
19	Process Capability definition and six sigma concepts	
20	Analysis of Process capability and problem solving	MID Exam syllabus
21	Summary of Control Charts and Process Capability Analysis	
22	Introduction to acceptance sampling, variables and attributes	
23	Definition and relevance of OC curves in AS and example Problems	
24	Types of OC curves and how to refer them	
25	Sampling Plans and use of statistical tables, single, double, Multiple	
26	Sampling Plans and use of statistical tables, single, double, Multiple	
27	Sampling schemes, AQL, AOQL, LTPD, α - risk and β - risk, ASN, API	Assignment
28	Sampling systems: MILSTD 411	
29	Sampling systems: Dodge-Romig sampling plan	
30	Practice problems on sampling systems	Quiz
31	Chain sampling, continuous sampling, flow charts, context of Application	
32	Skip lot sampling and economic design of sampling plans	
33	Summary of Acceptance Sampling plans, schemes and systems	
34	Introduction to life testing and Reliability	
35	Bath tub curve and its significance in reliability	

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36	Probability distributions used for modelling Reliability: Weibull distn.	
37	System reliability, series and parallel systems and combined Systems	
38	Introduction to Experimental design and Taguchi Methods	Practice Problems
39	Taguchi definition of Quality and how to choose experimental Design	
40	Introduction to factorial design, 2 factorial and 3 factorial designs.	
41	Introduction to signal to noise ratio and its significance in choosing levels	
42	Summary of Reliability and Experimental Design	End Sem Examination

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester: V/VI	Year: III
Name of Course		Mechatronics		
Course Code		ME24360		
Core / Elective / Other		Elective		
Prerequisite if any:				
1.	NIL			
Course Outcomes:				
1.	Identify various components of a mechatronic system and their correlations and explain dynamic characteristics of the system			
2.	Devise mathematical model various closed loop control systems and explain their Working			
3.	Select transducers, sensors, operational amplifiers, signal condition and data acquisition systems for various applications and explain their working			
4.	Explain the working of various components and internal architecture of microprocessors and microcontrollers and write program to accomplish simple tasks			
5.	Select various mechanical, electrical, hydraulic and pneumatic actuators for a particular application.			
Description of Contents in brief:				
Unit 1.	Introduction: Evolution of Mechatronics, Elements of Mechatronics system, Measurement Systems, Dynamics response of systems			
Unit 2.	Controllers: Control Systems, Feedback, open loop and closed loop control Basic control actions. Proportional, integral and derivative control. Op Amp based PID controller, Transfer function, block diagram reduction			
Unit 3.	Sensors & Transducers: Performance terminology, Various types of sensors and transducers and their applications.			
Unit 4.	Signals and Signal conditioning: Operational amplifiers and its applications, analogue to digital and digital to analogue conversion. Data acquisition			
Unit 5.	Microprocessors: Logic building and processing, logic gates, combinational and sequential logic, fuzzy logic, microprocessor and its programming, microcontroller. Introduction to ladder programming (for PLCs like Allen Bradley, Siemen etc used in industries)			
Unit 6	Actuation systems: Mechanical actuators, Applications, Electrical actuators and their applications, Hydraulic and pneumatic actuation systems. Hydraulic and pneumatic circuit for industrial applications			
Unit 7	Autonomous/Driverless Vehicles (AVs) and Flying Drones: Introduction to AV's and Flying Drones, Components (Actuators & Sensors) involved in AV and Drone Technology, Working and Case Studies on AVs and Drones			
List of Text Books:				
1.	W. Bolton, Mechatronics A multidisciplinary approach, Pearson India, Chennai, 4th Ed., 2016.			

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2.	D.G. Alciatore, M.B. Hstand, Introduction to mechatronics and measurement systems, McGraw Hill Education (India) Private Ltd., Chennai, 4th Ed., 2014	
List of Reference Books:		
1.	K. Ogata, Modern Control Engineering, Pearson Education, New Delhi, 4th Ed., 2002.	
2.	John Crisp, Introduction to Microprocessors and Micontrollers, Elsevier, 2nd Edition, 2004	
3.	Norman S Nise, Control Systems Engineering, John Wiley and Sons, Inc., USA, 6th Ed., 2011.	
4.	C.A. Alexander, M.N.O. Sadiku, Fundamentals of Electrical circuits, McGraw Hill Education, USA, 3rd Ed.	
5.	Andrew Parr, Hydraulics and Pneumatics, Elsevier, 3 rd Edition, 2011.	
6.	Hong Cheng, “Autonomous Intelligent Vehicles: Theory, Algorithms and Implementation”, Springer, 2011.	
7.	Shaoshan Liu, Liyun Li, “Creating Autonomous Vehicle Systems”, Morgan and Claypool Publishers, 2017.	
8.	Sachi Nandan Mohanty, J. V. R. Ravindra, G. Surya Narayana, Chinmaya Ranjan Pattnaik, Y. Mohamed Sirajudeen, “Drone Technology: Future Trends and Practical Applications”, John Wiley & Sons, 2023.	
URLs:		
1.	https://howtomechatronics.com/arduino-projects/	
2.	https://mechatronics.colostate.edu/video-demos/	
Lecture Plan (about 40-50 Lectures):		
*Lecture No.	Topic	Remarks
1.	Introduction to the course, components of a mechatronic System	
2.	Review of basic electrical and electronic components	
3.	Review of various electrical circuit theorems	
4.	Review of Laplace transformations	
5.	Review of Inverse Laplace transformations	
6.	Dynamic response of zero and first order systems, examples	
7.	Dynamic response of second order system, examples	
8.	Introduction to transfer function G(s), G(s) for first and second order systems	
9.	Control Systems, Feedback, open loop and closed loop control, basic control actions	
10.	Representation of closed loop control system with block diagram, reduction of block diagram	
11.	Closed loop controllers, various control modes: two step mode, proportional mode, derivative control mode, integral control mode, PID controller, implementation	

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12.	Position and speed measurement sensors, potentiometer, LVDT	
13.	Digital optical encoders, absolute and incremental encoders, construction, working and applications	
14.	Electrical resistance strain gauge, measurement of resistance change with a wheat stone bridge, gauge factor	
15.	Measuring different states of stress with strain gauge, force measurement with load cell	
16.	Laws of Thermocouple, Types of thermocouple, Thermocouple tables and calibration	
17.	Piezo resistive and piezoelectric sensors, applications	
18.	Introduction to operational amplifiers	
19.	Inverting, Non-inverting, summing amplifiers, respective Applications	
20.	Integrating and differentiating amplifiers, difference amplifiers, respective applications	
21.	Logarithmic amplifiers, comparators	
22.	Analogue to digital conversion, Sampling theorem	
23.	Digital to analogue conversion	
24.	Analogue to digital converters, successive approximation AD Converters	
25.	Ramp form AD converters, Flash type AD converters, specifications of AD converters	
26.	Weighted resistor Digital to analogue converters	
27.	Review of Hexadecimal numbers, Conversion of denary to hexadecimal numbers and vice-versa, Conversion of binary to hexadecimal number and viceversa	
28.	Review of Logic gates and their applications	
29.	Sequential and combinational circuits, Concept of S-R Latch and clock	
30.	S-R flip flop, D-flip flop, Registers and their types	
31.	General architecture of microprocessor system, types of buses and functions	
32.	Internal architecture of a microprocessor, Functions of each component, Common type of registers.	
33.	Types of memory, Input/output devices. Examples of microprocessors, microcontrollers, Basic programming of microprocessors, Assembly language programs.	
34.	Hydraulic systems: Hydraulic power supply and accumulator, gear pump, vane pump, radial and axial piston pump.	
35.	Pneumatic systems: Pneumatic compressors, directional control valves pressure control valves, Servo and proportional control valves,	

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	process control valves.	
36.	Mechanical actuation system: Review of cams, gears, belt and chain drives and bearings.	
37.	Electrical actuation systems: Solenoids, AC and DC motors, stepper motors.	
38.	Autonomous/Driverless Vehicles: Introduction, Components: sensors and actuators involved in AVs, Working of AVs: Software, Hardware and Wireless technologies involved in AVs.	
39.	Drones: Introduction to drone technology, Drone design and assembly, Components: motors, sensors and actuators involved in drones, Working of Drones, Basics of flight mechanics and dynamics.	
40.	Commercial and Industrial applications of AVs and Drones, Case studies on AVs and Drones.	

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program	B.Tech (Mechanical Engg.)	Semester: V/VI	Year: III
Name of Course	Theory of Vibrations		
Course Code	ME24361		
Core / Elective / Other	Elective		
Prerequisite if any:			
1.			
2.			
Course Outcomes:			
At the end of the course, the student shall be able to:			
1.	Learn the phenomenon of vibrations and methods of analysis.		
2.	Learn the balancing of machines through vibration analysis.		
3.	Analyze the single degree of freedom systems related complexities of vibration problems.		
4.	Formulate the simple models for mechanical vibration of machines, vehicles, and structures.		
5.	Implement the numerical methods for finding out the natural frequencies, mode shapes and free and forced vibration response.		
Description of Contents in brief:			
Unit 1.	Fundamentals of Vibrations, Free Undamped Vibrations, Methods of Analysis		
Unit 2.	Damped Free Vibrations, Types of Damping, Viscous and Coulomb damping		
Unit 3.	Forced Vibrations, Constant Harmonic Excitation, Rotating and Reciprocating Unbalance, Support Motion		
Unit 4.	Forced Vibrations with Coulomb damping, Non-harmonic Excitation, Vibration Isolation and Transmissibility, Vibration Measuring Instruments		
Unit 5.	Torsional Vibrations, Two rotor & Three rotor systems, Geared Systems, Forced Vibrations		
Unit 6	Transverse Vibrations of beams, Dunkerlays and Rayleigh Method		
List of Text Books:			
1.	G K Grover, 2009, Mechanical Vibrations, Nem Chand & Bros, Roorkee.		
2.	W. T. Thomson, M. D. Dahleh and C. Padmanabhan, 2008, Theory of Vibration with Applications, Pearson Education India: New Delhi.		
3.	S. S. Rao, 2003, Mechanical Vibrations, 4 th Edition, and Pearson India: New Delhi.		
4.	S. Graham Kelly, 2000, Fundamentals of Mechanical Vibrations, McGraw-Hill: Singapore.		
List of Reference Books:			
1.	T. Proulx, Vibration Problems in Engineering, 2008, Technology & Engineering, 2 nd edition, New York.		
2.	J S Rao, 1999, Introductory Course on Theory and Practice of Mechanical Vibrations, New Age International, New Delhi.		

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3.	L. Meirovitch, 2001, Elements of Vibration Analysis, Tata McGraw-Hill: New Delhi.	
4.	J. P. Den Hartog, 1985, Mechanical Vibrations, Dover Publications: New York.	
URLs:		
1.	https://nptel.ac.in/courses/112/107/112107212/	
2.	https://nptel.ac.in/courses/112/103/112103111/	
3.	https://nptel.ac.in/courses/112/103/112103112/	
Lecture Plan (about 40-50 Lectures):		
*Lecture No.	Topic	Remarks
1.	Introduction of fundamentals of vibrations	Unit 1
2.	Simple Harmonic Motion; Periodic Motion	
3.	Fourier Series; Few Properties of Fourier series	
4.	Free Vibration of Spring-mass System	
5.	Formulation of Governing Equation of Motion of SDOF System	
6.	Free Vibration of Spring-mass-dashpot System	
7.	Methods of analyses: Energy method; Rayleigh’s method;	
8.	Equilibrium method	
9.	Different cases of the spring-mass-dashpot system:	Unit 2
10.	Underdamped; Overdamped and Critically damped	
11.		
12.	Logarithmic Decrement in Underdamped case.	
13.		
14.	Free Vibration of a Spring-mass System with Coulomb	Unit 3
15.	Damping.	
16.	Harmonic Forced Vibration of Spring-mass-dashpot System;	
17.		
18.	Complex Frequency Response	
19.	Vibration Isolation	
20.	Rotating and Reciprocating Unbalance	
21.		
22.	Support Motion: Absolute and Relative motions	
23.		
24.	Harmonic Forced Vibration due to Rotating Unbalance; Rotor	Unit 4
25.	Unbalance	
26.	Whirling of Rotating Shafts	
27.	Harmonic Excitation of the Dynamical System by the Motion	
28.	of the Support Point	
29.	Energy Dissipated by Viscous Damping; Equivalent Viscous	
30.	Damping; Structural Damping; Sharpness of Resonance	
31.	Vibration Measuring Instruments: Seismometer and	
32.	Accelerometer;	
33.	Phase Distortion	
34.	Application of Laplace Transform to Solve Differential Equation of SDOF System	

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35.	Response of the Undamped Spring-mass system to Different Pulse Excitations	
36.	Shock Response Spectrum and Shock Isolation	
37.	Finite Difference Numerical Computation of Transient Vibration of SDOF System	
38.	Normal Mode Analysis of Multi-Degree-of-Freedom (MDOF) System Free Vibration	Unit 5
39.	Illustration of Coordinate Coupling is a Choice of Coordinate Selection to Define the Motion of a MDOF System	
40.	Forced Harmonic Vibration Response of a Multi-Degree-of-Freedom System: Two rotor & Three rotor systems	
41.	Orthogonality of Mode Shapes (Eigen vectors); Modal Matrix; Decoupling of undamped Forced Vibration	
42.	Modal Damping in Forced Vibration; Rayleigh Damping; Normal Mode Summation	
43.	Application of Finite Difference Method to compute Forced Vibration Response of MDOF System	
44.	Tuned Vibration Absorber; Centrifugal Pendulum Vibration Absorber	
45.	Transverse Vibration of String	Unit 6
46.	Transverse Vibrations of beams	
47.	Dunkerlays and Rayleigh Methods	
48.	Lateral Vibrations of Euler Beam	

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester: VI	Year: III
Name of Course		Mechanics of Deformable Solids (MODS)		
Course Code		ME24362		
Core / Elective / Other		Elective		
Prerequisite if any:				
1.	Engineering Mechanics			
2.	Mechanics of Materials			
Course Outcomes:				
1.	Understand the generalized notion of Stress & Strain.			
2.	Develop familiarity with Strain Gauges.			
3.	Develop insight into Unsymmetrical Bending.			
4.	Design Curved Flexural Members.			
5.	Differentiate between the behavior of Circular and Non-circular Shafts subjected to Torsion.			
Description of Contents in brief:				
Unit1(8L)	Stress Tensor, Stress at a Point, Generalized Stress Components, Stresses on Arbitrary Planes, Principal Stresses, Stress Invariants, Mohr's Circle for Three-Dimensional (3D) State of Stress, Octahedral Stresses.			
Unit2(8L)	Strain Tensor, Generalized Strain Components, Strain Transformation Laws, Generalized Hooke's Law, Volumetric Strain.			
Unit3(8L)	Strain Rosettes, Strain Gauges, Electrical Resistance Strain Gauges, Gauge Sensitivity, Gauge Factor, Temperature Compensation, Semiconductor Strain Gauges.			
Unit4(8L)	Statically Indeterminate Structures, Stiffness and Flexibility Methods, Unsymmetrical Bending of Beams, Stresses and Deflections in Beams subjected to Unsymmetrical Bending, Plasticity, Plastic Deformation of Beams, Introduction to Limit Analysis.			
Unit5(8L)	Curved Flexural Members, Circumferential Stresses in Curved Members, Winkler-Bach Theory, Stresses in Crane Hooks, Stresses in Open Rings, Stresses in Closed Rings, Deformation of Curved Members, Stresses in Chain Links.			
Unit6(2L)	Torsion of Non- circular Shafts, Elliptical, Rectangular and Equilateral Triangular Sections, Membrane Analogy, Torsion of Thin-walled Sections.			
List of Text Books:				
1.	Advanced Mechanics of Solids and Structures, N.Krishnaraju, McGraw-Hill Education India.			
2.	Experimental Stress Analysis, 2014 E,U.C.Jindal, Pearson.			
3.	Strength of Materials, G.H.Ryder, Palgrave Macmillan.			
List of Reference Books:				
1.	Mechanics of Materials 1,3 E,E.J.Hearn, Butterworth Heinemann.			
2.	Mechanics of Materials 2,3E,E.J.Hearn, Butterworth Heinemann.			
URLs:				
1.	https://archive.nptel.ac.in/courses/112/101/112101095/			
2.	https://archive.nptel.ac.in/courses/112/106/112106068/			
Lecture Plan (about 40-50 Lectures):				

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*Lecture No.	Topic	Remarks
1.	Introduction to Stress Tensor, Stress at a Point	
2.	Generalized Stress Components	
3.	Stresses on Arbitrary Planes	
4.	Principal Stresses, Stress Invariants	
5.	Mohr's Circle for Three-Dimensional State of Stress-1	
6.	Mohr's Circle for Three-Dimensional State of Stress-2	
7.	Octahedral Stresses	
8.	Numerical Problems	
9.	Strain Tensor-1	
10.	Strain Tensor-2	
11.	Generalized Strain Components	
12.	Strain Transformation Laws	
13.	Mohr's Circle for Strains-1	
14.	Mohr's Circle for Strains-2	
15.	Generalized Hooke's Law	
16.	Volumetric Strain	
17.	Strain Rosettes	
18.	Numerical Problems-1	
19.	Numerical Problems-2	
20.	Electrical Resistance Strain Gauges	
21.	Gauge Sensitivity	
22.	Gauge Factor	
23.	Temperature Compensation	
24.	Semiconductor Strain Gauges	
25.	Statically Indeterminate Structures	
26.	Flexibility Method-1	
27.	Flexibility Method-2	
28.	Stiffness Method-1	
29.	Stiffness Method-2	
30.	Unsymmetrical Bending of Beams	
31.	Stresses and Deflections in Beams subjected to Unsymmetrical Bending	
32.	Plasticity, Plastic Deformation of Beams, Limit Analysis	
33.	Curved Flexural Members	
34.	Circumferential Stresses in Curved Members, Winkler-Bach Theory	
35.	Stresses in Crane Hooks	
36.	Stresses in Open Rings	
37.	Stresses in Closed Rings	
38.	Deformation of Curved Members	
39.	Stresses in Chain Links	
40.	Numerical Problems	
41.	Torsion of Non-circular Shafts, Elliptical, Rectangular and Equilateral Triangular Sections.	
42.	Membrane Analogy, Torsion of Thin-walled Sections.	

***Min 48 (for four credit course)**

***Min 36 (For Three credit Course)**

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Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester: V/VI	Year: III
Name of Course		Fracture Mechanics and Failure Analysis		
Course Code		ME24363		
Core / Elective / Other		Elective		
Prerequisites if any:				
1.	Mechanics of Materials			
2.	Materials Science			
Course Outcomes:				
1.	Understand the mathematical and physical aspects involved in fracture mechanics.			
2.	Apply the concepts and principles of fracture mechanics in component and system design.			
3.	Basic understanding of mechanical behaviour of materials having microscopic flaws.			
4.	Basic knowledge of experimental methods used for analyzing failure and fracture.			
Description of Contents in brief:				
Unit 1.	Causes of Structure Failure, Atomic View, Failure Connotations, Objectives of Failure Analysis, Modes of Failure			
Unit 2.	Stress Concentrations, Effect of Flaws on Stress Concentrations, Overview of Fracture, Types of Fracture, Fracture Modes, Effect of Material Properties on Fracture			
Unit 3.	Elements of Fracture Mechanics, Fracture Mechanics Approach to Design, Introduction to Linear Elastic Fracture Mechanics (LEFM), Griffith Theory of Fracture, Stress Intensity Factor (SIF) , Determination of SIF, Crack Tip Plasticity, Irwin Approach			
Unit 4.	Introduction to Elastic - Plastic Fracture Mechanics (EPFM), Crack Tip Opening Displacement (CTOD), J Contour Integral, Relationship between J and CTOD, Resistance Curve, Cleavage Fracture, Crack Arrest			
Unit 5.	Fracture Mechanisms in Metals and Nonmetals, Ductile Fracture, Void Nucleation, Void growth, Ductile Crack Growth, Brittle Fracture, Cleavage, Cleavage Initiation Mechanisms, Fracture Mechanisms in Nonmetals			
Unit 6	Fracture Toughness Testing of Metals and Nonmetals, Fatigue Analyses of Engineering Failures, Specimen Configurations and Orientations, K _{IC} Testing, CTOD Testing, Introduction to NDT, NDT v/s Mechanical testing, Basics of Scanning Electron Microscopy (SEM)			
List of Text Books:				
1.	Prashant Kumar, Elements of Fracture Mechanics, McGraw Hill India, 2009E			
2.	Bahram Farahmand, Fatigue and Fracture Mechanics of High Risk Parts, Springer, 1 st Edition			

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3.	Baldev Raj, et al, Practical Non-Destructive Testing, Narosa Publishing House, 2009 Edition	
List of Reference Books:		
1.	Richard Hertzberg, Deformation and Fracture Mechanics of Engineering Materials, John Wiley, 5 th Edition	
2.	Ted L. Anderson, Fracture Mechanics: Fundamentals and Applications, CRC Press, 4 th Edition	
3.	Louis Cartz, Nondestructive Testing, ASM International	
URLs:		
1.	https://web.mit.edu/course/3/3.11/www/modules/frac.pdf	
2.	https://www.fracturemechanics.org/	
Lecture Plan (about 36-42 Lectures for a three credit course):		
*Lecture No.	Topic	Remarks
1.	Causes of Structure Failure	
2.	Atomic View	
3.	Failure Connotations	
4.	Objectives of Failure Analysis	
5.	Modes of Failure – I	
6.	Modes of Failure – II	
7.	Stress Concentrations	
8.	Effect of Flaws on Stress Concentrations	
9.	Overview of Fracture	
10.	Types of Fracture	
11.	Fracture Modes	
12.	Effect of Material Properties on Fracture	
13.	Elements of Fracture Mechanics	
14.	Fracture Mechanics Approach to Design – I	
15.	Fracture Mechanics Approach to Design - II	
16.	Linear Elastic Fracture Mechanics (LEFM) – I	
17.	Linear Elastic Fracture Mechanics (LEFM) – II	
18.	Griffith Theory of Fracture	
19.	Stress Intensity Factor (SIF)	
20.	Determination of SIF	
21.	Crack Tip Plasticity	
22.	Irwin Approach	
23.	Elastic - Plastic Fracture Mechanics (EPFM) - I	
24.	Elastic - Plastic Fracture Mechanics (EPFM) - II	
25.	Crack Tip Opening Displacement (CTOD)	
26.	J Contour Integral	
27.	Relationship between J and CTOD	
28.	Resistance Curve and Cleavage Fracture	
29.	Crack Arrest Concept	
30.	Fracture Mechanisms in Metals and Nonmetals	
31.	Void Nucleation and Void growth	

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32.	Ductile Fracture and Ductile Crack Growth	
33.	Brittle Fracture	
34.	Cleavage and Cleavage Initiation Mechanisms	
35.	Fracture Mechanisms in Nonmetals	
36.	Fracture Toughness Testing - I	
37.	Fracture Toughness Testing - II	
38.	Fracture Toughness Testing - III	
39.	Fatigue Analyses of Engineering Failures	
40.	K _{IC} Testing, CTOD Testing,	
41.	Introduction to NDT, NDT v/s Mechanical testing	
42.	Basics of Scanning Electron Microscopy (SEM)	

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester: V/VI	Year: III
Name of Course		Maintenance Engineering & Management		
Course Code		ME24364		
Core / Elective / Other		Elective		
Prerequisite:				
1.	Construction & Working of Machines/equipments used in Manufacturing/Production processes.			
2.	Basic understanding on Machines units/assemblies / operating mechanisms and automation.			
3.	Conceptual Knowledge on Design principles, Materials applications, Reliability and Factors affecting industrial production i.e. Productivity, Cost, Quality, Delivery, Safety, Energy & its conservation, Pollution, Inventory.			
Course Outcomes:				
C01	Students will understand meaning & significant importance of Maintenance Engineering & Management in context to various manufacturing/production industries objectives and production strategies.			
C02	Students will understand traditional and latest concepts & strategies of machine/equipment maintenance. Planning, scheduling & execution of maintenance system.			
CO3	Student's technical skill enhancement on machines/equipments mechanisms, their Failures identification/trouble shooting and application of latest diagnostic techniques (online/offline).			
Description of Contents in brief:				
1.	Meaning/definition of Maintenance. Brief evolution of maintenance concept in industries and its significant role in context to latest manufacturing/production systems and technologies. Importance of effective maintenance actions on machine/plant productivity, safety, product quality, profitability, inventory control, energy conservation, pollution control etc. Maintenance objectives, Types/classification of traditional & latest maintenance concepts/strategies.			
2.	Description of physical/productive assets; life cycle, failures/faults, physical degradation/deterioration, up/down time etc. Unplanned/emergency maintenance and offline preventive maintenance strategies; their types, working principles, advantages & disadvantages, Planning & implementation with examples etc.			
3.	Tribology and its application in maintenance; practical examples of metal/non metal parts/components failures related to friction & wear mechanism, their root causes and prevention system/actions in various types of			

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	machines/equipments. Online Preventive maintenance strategy; Condition based /predictive maintenance system, Modern CBM techniques & their working process/advantages/limitations/applications.
4.	Total Productive Maintenance concept; meaning/definition, objectives, advantages, 8 Pillars implementation. Computer aided maintenance management, organization of maintenance department.
5.	Reliability Centered Maintenance; meaning/definition, objectives, advantages, implementation examples. Performance metrics of Maintenance function.
List of Reference Books:	
1.	Total Productive Maintenance; proven strategies and techniques to keep equipment running by Steven Borris, Mc-Graw Hill
2.	Methodologies and Techniques for Advanced Maintenance; Lorenzo Fedele, Springer London Dordrecht Heidelberg New York
3.	RCM by John Moubray, Butterworth-Heinemann.
4	Maintenance for Industrial Systems; Riccardo Manzini · Alberto Regattieri Hoang Pham · Emilio Ferrari, Springer Dordrecht Heidelberg London New York
5	An introduction to predictive maintenance by <i>R. Keith Mobley</i> , Elsevier Butterworth-Heinemann
Lecture Plan (about 40-50 Lectures):	
Lecture No.	Topic
1.	Meaning/definition of Maintenance. Brief evolution of maintenance concept in industries.
2.	Its significant role in context to latest manufacturing/production systems and technologies.
3.	Importance of effective maintenance actions on machine/plant productivity, safety, product quality.
4	Importance of effective maintenance actions on profitability, inventory control, energy conservation, pollution control etc.
5	Maintenance objectives & Qualities required for Maintenance Engineer
6	Types/classification of traditional maintenance concepts/strategies.
7	Types/classification of latest maintenance concepts/strategies.
8	Part I: Description of physical/productive assets; life cycle, failures/faults, physical degradation/deterioration, up/down time etc.
9	Part II: Description of physical/productive assets; life cycle, failures/faults, physical degradation/deterioration, up/down time etc.

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10	Unplanned/emergency maintenance strategies; their types, working principles, advantages & disadvantages
11	Part I: offline preventive maintenance strategies; their types, working principles, advantages & disadvantages
12	Part II: offline preventive maintenance strategies; their types, working principles, advantages & disadvantages
13	Part I: offline preventive maintenance strategies: Planning & implementation with examples etc.
14	Part II: offline preventive maintenance strategies: Planning & implementation with examples etc.
15	Tribology and its application in maintenance
16	Tribology: practical examples of metal/non metal parts/components failures related to friction & wear mechanism
17	Part I: friction & wear mechanism, their root causes and prevention system/actions in various types of machines/equipments.
18	Part II: friction & wear mechanism, their root causes and prevention system/actions in various types of machines/equipments.
19	Online Preventive maintenance strategy; Condition based /predictive maintenance system.
20	Modern CBM techniques & their working process
21	Part I: Vibration monitoring technique
22	Part II: Vibration monitoring technique
23	Part III: Vibration monitoring technique
24	Thermography technique – I
25	Thermography technique – II
26	Wear debris analysis
27	NDT – I
28	NDT-II
29	Total Productive Maintenance concept; meaning/definition, objectives, advantages.
30	Total Productive Maintenance 8 Pillars
31	TPM: Training and education
32	TPM: Zishu Hozen/Autonomous Maintenance
33	TPM: Kobetsu Kaizen/OEE
34	TPM: Kobetsu Kaizen/OEE
35	Computer aided maintenance management
36	Organization of maintenance department.

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37	Reliability Centered Maintenance; meaning/definition, objectives, Advantages
38	Part I: Reliability Centered Maintenance implementation process
39	Part II: Reliability Centered Maintenance implementation process
40	Performance metrics of Maintenance function

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester: V/VI	Year: III
Name of Course		PRODUCT DESIGN AND DEVELOPMENT		
Course Code		ME24365		
Core / Elective /Other		Elective		
Prerequisite if any:				
1.	Basic knowledge of engineering fundamentals. Ability to create sketches with proper conventions and abbreviations			
Course Outcomes:				
1.	Able to learn how to think, design and develop new parts/products.			
2.	Able to understand the existing designs, synthesize and analyze the information for modification or addition in the existing components			
3.	Able to improve quality of processes / products by applying the specified procedures of product development			
Description of Contents in brief:				
Unit 1	Engineering design process stages and activities, categories of product design, opportunity analysis, need analysis and information gathering Methods			
Unit 2	Concept generation and development, selection, and evaluation methods, creative thinking methods, decision making models, product design specifications, benchmarking			
Unit 3	Product design stage, identification of alternatives, product architecture, modular and integral designs, process design, prototyping, modeling and simulation			
Unit 4	Industrial design, detail design, design for manufacturing and environment, robust design, cost evaluation, legal and ethical issues			
Unit 5	Materials selection, design with materials, material selection with decision matrices, design for recycling and reusability			
List of Text Books:				
1.	Engineering Design, George E. Dieter and Linda C. Schmidt, Mc Graw hill.			
2.	Product Design and Development, Karl T. Ulrich and Steven D. Eppinger, Mc Graw Hill.			
3.	Product Design for Engineers, Devdas Shetty, Cengage Learning.			
List of Reference Books:				
1.	Engineering Design Methods, Nigel Cross, Wiley.			
2.	Materials Selection in Mechanical Design, Michael F. Ashby			
3.	Product Design, Techniques in Reverse Engineering and New Product Development, Kevin Otto, Kristin wood, Pearson Education			

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URLs:		
1.	https://www.digimat.in/nptel/courses/video/112104230/L01.html	
2.	https://nptel.ac.in/courses/110/105/110105087/	
Lecture Plan (about 40-50 Lectures):		
*Lecture No.	Topic	Remarks
1.	Introduction	
2.	Product, process, and materials cycle	
3.	Categories of designs	
4.	Opportunity analysis and information gathering	
5.	Concurrent engineering approach	
6.	Problem definition and need identification	
7.	Concept generation and development techniques	
8.	Concept map or mind map	
9.	Benchmarking techniques	
10.	Product dissection or reverse engineering	
11.	Kano's model for quality attributes	
12.	House of quality configurations	
13.	Product functional decomposition and structure	
14.	Morphological methods for design	
15.	Axiomatic design domains	
16.	Problem solving methods	
17.	Decision making models (certainty and uncertainty)	
18.	Decision making models (risk and conflict)	
19.	Concept evaluation based on absolute criteria	
20.	Pugh concept selection method	
21.	Measurement scales and weighted decision matrix	
22.	Product design specifications	
23.	Embodiment design phase	
24.	Product architecture, modular and integral	
25.	Configuration design analysis	
26.	Prototyping	
27.	Types of prototypes	
28.	Design for experimentation	
29.	Modeling and simulation	
30.	Design for manufacture	
31.	Design for assembly	
32.	Design for environment	
33.	Robust design	
34.	Industrial design	
35.	Human factors design	
36.	Assessing the quality of industrial design	
37.	Detail design activities	

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38.	Final design review	
39.	Materials selection to design	
40.	Performance characteristics of materials	
41.	Material performance indices	
42.	Material selection with decision matrices	
43.	Design for recycling and reusability	
44.	Cost evaluation methods	
45.	Design to cost	
46.	Product liability	
47.	Legal and ethical domains	
48.	Case study I	
49.	Case study II	
50	Summary	

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester: V/VI	Year: III
Name of Course		Theory of Elasticity and Plasticity		
Course Code		ME24366		
Core/Elective/Other		Elective		
Prerequisite if any:				
1.	Nil			
Course Outcomes:				
At the end of the course, the student shall be able to:				
1.	Understand of the thermodynamics and the theory of thermo-elasticity and plasticity.			
2.	Analyze the structure and define new mathematical models of engineering structures.			
3.	Analyze the state of stress in the elements of constructions.			
4.	Creative and prepared for the design with the use of more advanced models.			
5.	Develop expertise in the analysis of stress and deformation of the body.			
Description of Contents in brief:				
Unit 1.	Basic elasticity-cartesian tensor, three dimensional stress and strain systems, Navier's equations, Airy's stress function, Mohr's circle for three-dimensional stress and strain systems, viscoelasticity.			
Unit 2.	Torsion - torsion of noncircular bars, elastic analysis, membrane analogy.			
Unit 3.	Introduction to plasticity-mechanical behaviour in the plastic range, fundamentals of plasticity theory, solution of elastoplastic problem, Bausschinger effect-yield locus, yield surface.			
Unit 4.	Yield criteria and flow rules-Tresca theory and von Mises yield criterion, their geometrical representation, experimental evidence for the criteria.			
Unit 5.	Slip line field theory–two-dimensional plasticity, slip lines, basic equations, Hencky's first theorem, Geiringer's velocity equation, application of slip line field theory to plane strain problems.			
Unit 6.	Slab method, Upper bound theorem, Lower bound theorem, Application to metal forming, plastic analysis of structures. Thermo-mechanical modelling of metal forming processes. Autofreitage Process. Elasto-plastic analysis of Autofreitage process.			
List of Text Books:				
1.	P M Dixit and U S Dixit, Plasticity: Fundamentals and Applications, CRC Press, 2014.			
2.	S.P. Timoshenko and J.N. Goodier, Theory of Elasticity, McGraw-Hill, 1970.			
3.	J. Chakroborty, Theory of Plasticity, McGraw Hill, 1987.			
List of Reference Books:				
1.	I.S. Sokolnikoff, Mathematical Theory of Elasticity, McGraw-Hill, 1957.			
2.	A. Khan and S. Huang, Continuum Theory of Plasticity, Wiley, 1995.			
URLs:				
1.	https://nptel.ac.in/courses/105/108/105108070/			

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2.	https://nptel.ac.in/courses/105/105/105105177/	
3.	https://nptel.ac.in/courses/113/103/113103072/	
Lecture Plan (about 40-50 Lectures):		
Lecture No.	Topic	Remarks
1.	Introduction of elasticity and plasticity concepts in the brittle and ductile metals.	
2.	Basic elasticity-cartesian tensor	
3.		
4.	Three dimensional stress and strain systems	
5.		
6.	Navier's equations	
7.	Airy's stress function	
8.		
9.	Mohr's circle for three-dimensional stress and strain systems	
10.		
11.		
12.		
13.	Viscoelasticity.	
14.	Constitutive modelling of elastic behaviour materials	
15.		
16.		
17.	Torsion of noncircular bars,	
18.		
19.	Elastic analysis of noncircular bars	
20.		
21.	Membrane analogy of noncircular bars	
22.		
23.	Introduction to plasticity-mechanical behaviour in the plastic range	
24.		
25.		
26.	Fundamentals of plasticity theory	
27.	Solution of elastoplastic problem	
28.		
29.	Bausschinger effect-yield locus and yield surface.	
30.		
31.	Yield criteria and flow rules-Tresca theory and von Mises yield criterion	
32.		
33.	Geometrical representation of Tresca theory and von Mises yield criterion	
34.		
35.	Experimental evidence of Tresca theory and von Mises yield Criterion	
36.		
37.	Slip line field theory-two-dimensional plasticity,	
38.	α and β slip lines	
39.	Basic equations of Hencky's first theorem,	

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40.	Geiringer's velocity equation	
41.	Application of slip line field theory to plane strain problems	
42.	Indentation problem solved by slip line field theory	
43.		
44.	Slab method	
45.	Upper bound theorem	
46.	Lower bound theorem	
47.	Application to metal forming	
48.		
49.	plastic analysis of structures	
50.		

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester: V/VI	Year: III
Name of Course		Material Management		
Course Code		ME24367		
Core / Elective / Other		Elective		
Prerequisite if any:				
1.	B.Tech Mechanical VI Semester			
Course Outcomes:				
CO1	Enables to understand Forecasting& Purchasing			
CO2	Work as a team with other disciplines related to Inventory and Warehouse Management.			
CO3	Planning of material flow, advantages of planned material flow, flow planning principles, flow patterns, analysis of material flow.			
CO4	Enables to understand Spare parts management.			
CO5	Enables to understand Store Planning, Store keeping and Management Codification			
Description of Contents in brief:				
Unit 1.	Forecasting & Purchasing: Forecasting in purchase and sales, methods of purchasing, Functions, organization of purchase department, mass production purchasing and its procedure, Functions and organization of purchase department source selection, negotiation, make or buy decision how much to buy.			
Unit 2.	Inventory planning (MRP) and Spare parts Management: Types of Inventory, Computer control in materials planning, factors affecting ordering quantity, in process inventories, raw materials supplies, The problem of spare parts, pattern of failure, Reliability and variety, reduction, classification of spares replenishment, service level, work-in-process.			
Unit 3.	Store keeping and Management Codification: Objectives of storekeeping, function of store organization, store organization, location of storekeeping department, factor affecting location, centralized and decentralized storing.			
Unit 4.	Inventory Controls and its Various Models: Ordering procedures, re-ordering, reorder point and quantity, economic lot size, economic ordering quantity, quantity discount, influence of uncertainty, continuous supply. Selection Control, ABC, XYZ, HML, VED, FSN, SDE, and SOS analysis.			
Unit 5.	Spare parts management of spares Reliability and Quality of spares. Spare parts procurement, spare parts marketing and pricing. Management of absolute spares.			
List of Text Books:				
S.No	Title of Book		Author, publication year and publisher	
19.	Materials Management		S.C. Sharma	
20.	An Integrated Concept of Materials Management		N.M. Shah	
21.	Maintenance & Spare parts Management		P. Gopalakrishnan,K.Bannerjee	

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22.	Introduction to Materials Management	Arnold J.R.T and Chapman S.N
23.	Purchasing and Materials Management	Leendors M.R and Fearson H.E
List of Reference Books:		
S.No	Title of Book	Author, publication year and publisher
1.	Introduction to Supply Chain Management	Handfield R.B and Nichols E.L
2.	Logistics Management	Bowersox D.J and Closs D.J
URLs:		
1.	https://nptel.ac.in	
2.	https://www.managementstudyguide.com/material-handling.htm	
3.	https://onlinecourses.nptel.ac.in/noc20_mg17/preview	
Lecture Plan (about 40-50 Lectures):		
*Lecture No.	Topic	Remarks
85.	Introduction to material management	
86.	Forecasting in purchase and sales	
87.	Forecasting in purchase and sales	
88.	methods of purchasing, Functions, organization of purchase department	
89.	mass production purchasing and its procedure, Functions and organization of purchase department source selection, negotiation, make or buy decision how much to buy	
90.	mass production purchasing and its procedure, Functions and organization of purchase department source selection, negotiation, make or buy decision how much to buy	
91.	Types of Inventory, Computer control in materials planning, factors affecting ordering quantity, in process inventories, raw materials supplies	
92.	Types of Inventory, Computer control in materials planning, factors affecting ordering quantity, in process inventories, raw materials supplies	
93.	The problem of spare parts, pattern of failure, Reliability and variety, reduction, classification of spares replenishment, service level, work-in-process	
94.	The problem of spare parts, pattern of failure, Reliability and variety, reduction, classification of spares replenishment, service level, work-in-process	
95.	Ordering procedures, re-ordering, reorder point and quantity, economic lot size, economic ordering quantity, quantity discount, influence of uncertainty, continuous supply	

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96.	Ordering procedures, re-ordering, reorder point and quantity, economic lot size, economic ordering quantity, quantity discount, influence of uncertainty, continuous supply	
97.	Selection Control, ABC, XYZ, HML, VED, FSN, SDE, and SOS Analysis	
98.	Selection Control, ABC, XYZ, HML, VED, FSN, SDE, and SOS Analysis	
99.	Spare parts management of spares Reliability and Quality of Spares	
100.	Spare parts management of spares Reliability and Quality of Spares	
101.	Spare parts procurement , spare parts marketing and pricing	
102.	Spare parts procurement , spare parts marketing and pricing	
103.	Management of absolute spares	
104.	Management of absolute spares	
105.	Objectives of storekeeping, function of store organization, store organization, location of storekeeping department, factor affecting location, centralized and decentralized storing	
106.	Objectives of storekeeping, function of store organization, store organization, location of storekeeping department, factor affecting location, centralized and decentralized storing	
107.	Methods of store-keeping, moving materials into and out of stock, protection of stores	
108.	Methods of store-keeping, moving materials into and out of stock, protection of stores	
109.	codification, materials requisition	
110.	codification, materials requisition	
111.	Preservation of stores, disposal of surplus & scrap.	
112.	Preservation of stores, disposal of surplus & scrap.	
113.	Tutorial	
114.	Introduction to Logistics Management	
115.	Planning, Control of flow and storage of goods, services.	
116.	Planning, Control of flow and storage of goods, services.	
117.	Distribution, Transportation, International Logistics, Inventory control.	
118.	Introduction to Logistics Technology including RFID AND ERP Systems	
119.	Introduction to Logistics Technology including RFID AND ERP Systems	
120.	Introduction to Logistics Technology including RFID AND ERP Systems	
121.	CASE STUDIES	
122.	CASE STUDIES	
123.	CASE STUDIES	
124.	CASE STUDIES	

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125.	CASE STUDIES	
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Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester: V/VI	Year: III
Name of Course		Engineering Optimization		
Course Code		ME24368		
Core / Elective / Other		Elective		
Prerequisite if any:				
1.	Operations Research			
Course Outcomes:				
1.	Formulate engineering problems as mathematical optimization problems			
2.	Explain the techniques of optimization for engineering problems.			
3.	Apply computer software to solve engineering optimisation problems.			
4.	Explain the heuristic optimization methods.			
Description Of Contents In Brief:				
Unit 1.	Introduction: Statement of An Optimization Problem, Classification of Optimization Problems, Mathematical Formulation of Optimization Problems, Engineering Applications of Optimization;.			
Unit 2.	Fundamental Concepts In Optimization: Concave Functions, Convex Functions, Local Optima, Global Optima; Principles of Optimization,Unconstrained and Constrained Problems, Necessary and Sufficient Conditions of Optimality			
Unit 3.	Constraint Optimisation Techniques, Active and Inactive Constraints, Interior and Exterior Penalty Functions, Integer Programming: Branch-and-Bound Algorithm. Algorithms for Non-Linear Optimization Problems:			
Unit 4.	Algorithms For Single Variable Optimization Problems, Golden Section Search Method, Newton-RaphsonMethod; Algorithms For Multi-Variable Optimization Problems: Steepest Descent Method, Quadratic Programming; Solving Optimization Problems Using Solvers (Excel, LINGO, AMPL).			
Unit 5.	Heuristic Optimization Methods: Working Principles ofGenetic Algorithm, Simulated Annealing, Ant Colony Optimization, and Particle Swarm Optimization;			
Unit 6	Multi-Objective Optimization: Concept Of Pareto-Optimality, Multi-Criterion Decision Problems,Analytic Hierarchy Process			
List Of Text Books:				
1.	J. S. Arora, Introduction To Optimum Design, 3rd Ed. Academic Press, 2011			
2.	A. D. BelegunduAnd T. R. Chandrupatla, Optimization Concepts And Applications In Engineering, 2nd Ed. Cambridge University Press, 2011.			
3.	K. Deb, Optimization For Engineering Design, 2nd Ed. Prentice-Hall Of India, 2011			
List Of Reference Books:				
1.	D. Nagesh Kumar, Optimization Methods. [Online] Available: Http://Nptel.Ac.In/Course.Php			
2.	S. S. Rao, Engineering Optimization, 3rd Ed. New Age International, 2013			
3.	A. Ravindran, K. M. Ragsdell, And G. V. Reklaitis, Engineering Optimization: Methods And Applications, 2nd Ed. Wiley India, 2006			
4	H. A. Taha, Operations Research: An Introduction, 8th Ed. Prentice-Hall Of India,1998.			
Urls:				

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1.	https://Nptel.Ac.In/Courses/111/105/111105039/	
2.	https://Nptel.Ac.In/Courses/103/103/103103164/	
3.	http://Www.Nptelvideos.In/2012/11/Numerical-Optimization.Html	
Lecture Plan (About 40-50 Lectures):		
*Lecture No.	Topic	Remarks
1.	Introduction:	
2.	Statement Of An Optimization Problem,	
3	Classification of Optimization Problems,	
4	Mathematical Formulation of Optimization Problems,	
5	Mathematical Formulation of Optimization Problems	
6	Mathematical Formulation of Optimization Problems	
7	Engineering Applications of Optimization	
8	Engineering Applications of Optimization	
9	Fundamental Concepts In Optimization	
10	Concave Functions,	
11	Convex Functions,	
12	Local Optima, Global Optima;	
13	Principles of Optimization of Unconstrained and Constrained Problems	
14	Necessary and Sufficient Conditions Of Optimality	
15	Constraint Optimisation Techniques	
16	Active and Inactive Constraints	
17	Interior and Exterior Penalty Functions	
18	Integer Programming:Branch-and-Bound Algorithm	
19	Algorithms For Non-Linear Optimization Problems	
20	Algorithms For Non-Linear Optimization Problems	
21	Algorithms For Single Variable Optimization Problems	
22	Algorithms For Single Variable Optimization Problems	
23	Golden Section Search Method, Using Solvers (Excel, LINGO, AMPL).	
24	Golden Section Search Method, Using Solvers (Excel, LINGO, AMPL	
25	Golden Section Search Method, Using Solvers (Excel, LINGO, AMPL	
26	Newton-Raphson Method;	
27	Newton-Raphson Method;	
28	Algorithms For Multi-Variable Optimization Problems:	
29	Algorithms For Multi-Variable Optimization Problems:	
30	Steepest Descent Method,	
31	Quadratic Programming;	
32	Solving Optimization Problems	
33	Heuristic Optimization Methods;;	
34	Working Principles Of Genetic Algorithm,	
35	Simulated Annealing,	

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36	Ant Colony Optimization,	
37	Ant Colony Optimization	
38	Particle Swarm Optimization	
39	Particle Swarm Optimization	
40	Multi-Objective Optimization:	
41	Multi-Objective Optimization:	
42	Concept Of Pareto-Optimality	
43	Multi-Criterion Decision Problems	
44	Multi-Criterion Decision Problems	
45	Analytic Hierarchy Process	

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program	B.Tech (Mechanical Engg.)	Semester: VI	Year: III
Name of Course	Mechanical Behavior of Materials		
Course Code	ME24369		
Core / Elective / Other	Elective		
Prerequisite if any:			
1.	Mechanics of Materials		
2.	Materials Science and Engineering		
Course Outcomes:			
1.	State stress and strain tensor for given loading condition and evaluate principal stress, strain values and their directions for 3D stress state. Apply generalized Hooke's law and identify number of independent elastic constants for various crystal systems.		
2.	Identify important attributes of stress strain curves, Evaluate the failure for a given stress state, Calculate the hydrostatic and deviatoric stress and strain components. Differentiate between elastic, plastic, viscoelastic and viscoplastic deformation.		
3.	Classify and identify different imperfection in the materials, Calculate the elastic stress field around point defects, line defects and grain boundaries. Analyse the interaction between the elastic field of defects and understand strengthening mechanisms		
4	Differentiate between the theoretical and real strength of solids, differentiate between various crack propagation modes, understand the toughening mechanism of fracture.		
Description of Contents in Brief:			
Unit 1.	State of stress, Stress transformation in 2D and 3D, stress tensor, strain, stress and strain deviator, Mohr's circle of stress and strain, strain energy, Origins of Elasticity, Elastic constants in isotropic and anisotropic materials.		
Unit 2.	Plastic deformation, Stress-strain curves, Failure criterion and yield locus, Octahedral shear stress and strain, plastic stress-strain relations, viscoelastic and viscoplastic deformation.		
Unit 3.	Perfect crystal structures, Imperfections in crystalline solids, Dislocation theory, microscopic basis of plastic deformation in crystalline and non-crystalline materials, strengthening via microstructure and physical size.		
Unit 4.	Fracture of materials, introduction to fracture mechanics, linear elastic fracture mechanics, Fracture toughness, the physics of fracture and toughening mechanisms. Creep and fatigue failure.		
Unit 5.	Tension test, Hardness test, Impact test, fatigue test, creep and stress rupture test, plain strain toughness testing.		
List of Text Books:			
1.	Thomas H. Courtney, Mechanical Behavior of Materials, McGraw Hill Education (India) Pvt. Ltd, Second Edition, 2000.		
2.	J. Rosler, H. Harders, M. Baker, Mechanical behavior of engineering materials, Springer, 2007.		
3.	N. E. Dowling, Mechanical Behavior of Materials, Prentice-Hall, 1993.		
4.	Marc Andre Meyers, Krishna Kumar Chawla, Mechanical Behavior of materials, Cambridge University Press, 2009.		
List of Reference Books:			

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1.	G. E. Dieter, <i>Mechanical Metallurgy</i> , McGraw-Hill, 1986.
2.	L. D. Landau and E. M. Lifshitz, <i>Theory of Elasticity</i> , Pergamon Press, 1986.
3.	Oscar Hoffman and George Sachs, Introduction to the theory of plasticity for engineers, McGraw-Hill Book Company, 1953.
4.	Wei Cai, W.D. Nix, Imperfections in Crystalline Solids, Materials Research Society and Cambridge University Press, 2016.
5.	D. J. Bacon, and D. Hull. <i>Introduction to Dislocations</i> , Pergamon Press, 1984
6.	J. Weertman and J.R. Weertman, Elementary Dislocation theory, Macmillan, 1964.
7.	D. Broek, Elementary engineering fracture mechanics, Springer Science + Business Media, 1982.
8.	T.L. Anderson, Fracture Mechanics, Fundamentals and Applications, CRC Press, 2017.

URLs:

1.	https://www.youtube.com/watch?v=z33I3CEW6rE&list=PLxQw8LdroTlPNimLKW-MWldJQHVLBESGs ((Mechanical behaviour of Materials, Dr. Niraj Chawake, IIT Kanpur)
2.	https://www.youtube.com/watch?v=hmkFR5J_Ifw&list=PLfIFNJ1DPG4nwAQAY8aEi2-1JPwCRj9Gg (Mechanical behaviour of Materials, Dr. Rajesh Prasad, IIT Delhi)
3.	

Lecture Plan (about 40-50 Lectures):

Lecture No.	Topic	Remarks
1-2	Introduction to the subject, Concept of stress at a point, Introduction to 3D stress state	
3-4	Independence of stress components, Voigt notation, Principal stresses and directions through Eigen Value and Eigen vectors, Concept of stress tensor,	
5-6	Transformation of general stress tensor, 3D Mohr's Circle, Hydrostatic stress and deviatoric stresses, Orthogonal normal and shear stresses	
7-8	Rigid body motion, Concept of strain at a point, Displacement gradient, and rotation tensor, Principal strains and directions	
9-10	Transformation of strains in 2 dimensions, strain measurements through strain rosetts. Hydrostatic stress and strain	
11-12	Elastic stress-strain relations, Isotropic elasticity, Generalized Hooke's Law	
13	Anisotropic elasticity	
14-15	Plastic deformation, Concept and importance of true stress, true strain, Stress strain curves and their measurements	
16-17	Failure criterion, Maximum shear stress criterion, Distortion energy criterion, Failure criterion in 3D principal stress space, Viscoelastic and viscoplastic deformations	
18	Classification of defects in materials, Classification of point defects, Substitutional and interstitial defects	
19-20	Octahedral and tetrahedral voids and their size in FCC, BCC materials, Stress and strain state in cylindrical and spherical coordinates, Elastic field due to spherically symmetric point defects	
21	Introduction to dislocations, Role of dislocations in plastic deformation, Geometry of dislocations, types of dislocations	

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22	Burgers circuit and Burgers vector, Dislocation motion and slip, Dislocation Sources	
23	Elastic fields of dislocations, Energy of dislocation	
24	Dislocation line tension and forces on dislocations,	
25-26	Dislocation interactions, Concept of partial dislocations	
27-28	Grain boundary geometry and grain boundary mechanics	
29-30	Strengthening mechanisms via interaction of elastic field between the defects	
31	Atomic view of fracture, Fracture modes, Theoretical strength of solid,	
32-33	Introduction to fracture mechanics, Linear elastic fracture mechanics,	
34	Griffith theory of Brittle fracture, Irwin theory of ductile fracture, Crack propagation modes	
35	Design Philosophy for fracture, Physics of fracture	
36	Metallographic aspects of fracture, Toughening mechanisms	
37	Concept of Ductile to Brittle transition temperature	
38	Creep and Fatigue failure	

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester: VI	Year: III
Name of Course		Supply Chain Management		
Course Code		ME24370		
Core / Elective / Other		Elective		
Prerequisite if any:				
1.	Nil			
Course Outcomes:				
1.	Understanding different types of supply chains			
2.	Design supply chain network and understating supply chain drivers			
3.	Analyse supply chain coordination parameters			
Description of Contents in brief:				
Unit 1.	Introduction Of Supply Chain Management, Inbound And Outbound Logistics, Efficient And Responsive Supply Chain, Supply Chain Case Studies			
Unit 2.	Different Types Of Supply Chains: Agile And Lean Supply Chains, Green Supply Chain Management, Food Supply Chain Management, Humanitarian Logistics, Local &Global Supply Chain Management			
Unit 3.	Supply Chain Drivers, Supply Chain Network Design, Warehousing, Facility Location			
Unit 4.	Inventory Strategies and Management, Inventory Systems, Stochastic Inventory Model, Demand Forecasting			
Unit 5.	Transportation, Third Party Logistics, Reverse Logistics, Distribution Planning			
Unit 6	Supply Chain Coordination, Bullwhip Effect, Information Technology Tools In Supply Chains,			
List of Text Books:				
1.	Supply Chain Management Strategy, Planning And Operations,Chopra, S., And Meindl, P.,Prentice Hall, 2001			
2.	Designing And Managing The Supply Chain: Simchi-Levi And Ravi Shankar: Tata Mcgraw Hill, 2008			
3.	Operations And Supply Chain Management: RusselAnd Taylor Wiley Publication, 2016			
List Of Reference Books:				
1.	Logistics And Supply Chain Management, Martin Christopher, Pearson., 2016			
2.	Introduction To Supply Chain Management, R.B. HandfieldAnd E.L. Nochols, Jr..Prentice Hall., 1998			
3.	Business Logistics And Supply Chain Management- R Ballou, Pearson (Indian Edition), 2007			
URLs:				
1.	https://nptel.ac.in/courses/110/107/110107074/			
2.	https://nptel.ac.in/courses/110/105/110105141/			
Lecture Plan (about 40-50 Lectures):				
*Lecture No.		Topic		Remarks
1.		Introduction Of Supply Chain Management		
2.		Scope Of Supply Chain Management		
3		Inbound And Outbound Logistics,		

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4	Efficient And Responsive Supply Chain,	
5	Supply Chain Case Studies	
6	Supply Chain Case Studies	
7	Supply Chain Case Studies	
8	Agile And Lean Supply Chains,	
9	Green Supply Chain Management	
10	Food Supply Chain Management,	
11	Humanitarian Logistics,	
12	Local & Global Supply Chain Management	
13	Supply Chain Drivers,	
14	Supply Chain Drivers	
15	Supply Chain Network Design,	
16	Supply Chain Network Design,	
17	Warehousing,	
18	Facility Location	
19	Facility Location	
20	Inventory Strategies And Management,	
21	Inventory Systems	
22	Stochastic Inventory Model	
23	Stochastic Inventory Model	
24	Demand Forecasting	
25	Forecasting Methods	
26	Forecasting Methods	
27	Forecasting Methods	
28	Transportation,	
29	Transportation,	
30	Third Party Logistics,	
31	Reverse Logistics,	
32	Distribution Planning	
33	Distribution Planning	
34	Supply Chain Coordination,	
35	Bullwhip Effect,	
36	Causes Of Bullwhip Effect	
37	Information Technology Tools In Supply Chains	
38	Supply Chain Softwares	
39	ERP	
40	ERP	
41	Seminar	
42	Seminar	

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	

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5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program	B.Tech (Mechanical Engg.)	Semester: VII	Year: IV
Name of Course	Energy Conversion Systems		
Course Code	ME24451		
Core / Elective / Other	Elective		
Prerequisite if any:			
1.	Engineering Thermodynamics		
Course Outcomes:			
1.	Proficiency in Thermodynamics of energy conversion and Study of various parameters for measuring the performance of the output.		
2.	Ability in understanding atomization in Industrial Sector.		
3.	Understand the energy conversion systems for thermal power plants.		
Description of Contents in brief:			
Unit 1.	Introduction Classification of Energy Sources, Principle fuels for energy conversion, Conventional and Renewable Energy Sources, Conversion of primary into secondary energy sources, Various power plants.		
Unit 2.	Thermal and Mechanical Energy, Site selection of thermal power plant, Layout of modern thermal power plant, Thermal energy using fossil fuels, Conversion of Thermal Energy to Mechanical energy and Power, Turbines, Steam turbines, Hydraulic turbines.		
Unit 3.	Thermal and Mechanical Energy Utility systems, Types of Boilers, combustion in boilers, firing arrangement and types of burners, FBC Boilers, mechanism of fluidized bed combustion, advantages, types of FBC boilers, operational features, retrofitting FBC system to conventional boilers.		
Unit 4.	Environmental Aspects of Power Generation, Methods of Pollution control, Waste Heat Recovery, Power station economics, performance evaluation, analysis of losses, feed water treatment, blow down.		
Unit 5.	Fuel Cell Technology Overview of fuel cells, Fuel cell thermodynamics, fuel cell efficiency, Fuel cell characterization, Fuel cell modelling and system integration, Hydrogen production from renewable sources and storage, life cycle analysis of fuel cells.		
List of Text Books:			
1.	G. Petrecca, Energy Conversion and Management: Principles and Applications, Springer, 2014		
2.	P.K.Nag, Power Plant Engineering, Tata McGraw Hill, 2006		
3.	S. Domkundwar, Power Plant Engineering, Dhanpat Rai,1984		
List of Reference Books:			
1.	G.D. Rai, Khanna, Power Plant Engineering, 1996		
2.	G.R. Nagpal, Power Plant Engineering, Khanna Publishers, 2007		
3.	M.K. Gupta, Power Plant Engineering, PHI Learning, 2015		
URLs:			
1.	www.swayam.gov.in		
2.	www.nptel.ac.in		
Lecture Plan (about 40-50 Lectures):			
*Lecture No.	Topic		Remarks

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1.	Introduction	
2.	Classification of Energy Sources	
3.	Principle fuels for energy conversion	
4.	Conventional and Renewable Energy Sources	
5.	Conventional and Renewable Energy Sources	
6.	Conversion of primary into secondary energy sources,	
7.	Conversion of primary into secondary energy sources,	
8.	Various power plants	
9.	Thermal and Mechanical Energy	
10.	Site selection of thermal power plant	
11.	Layout of modern thermal power plant	
12.	Thermal energy using fossil fuels	
13.	Conversion of Thermal Energy to Mechanical energy and Power	
14.	Turbines, Steam turbines, Hydraulic turbines	
15.	Thermal and Mechanical Energy Utility systems	
16.	Types of Boilers	
17.	Combustion in boilers	
18.	Firing arrangement and types of burners	
19.	FBC Boilers	
20.	Mechanism of fluidized bed combustion	
21.	Types of FBC boilers	
22.	Operational features, retrofitting FBC system to conventional boilers.	
23.	Environmental Aspects of Power Generation	
24.	Environmental Aspects of Power Generation	
25.	Methods of Pollution control	
26.	Waste Heat Recovery	
27.	Power station economics, performance evaluation,	
28.	Power station economics, performance evaluation,	
29.	Analysis of losses	
30.	Feed water treatment, blow down	
31.	Fuel Cell Technology Overview of fuel cells	
32.	Fuel Cell Technology Overview of fuel cells	
33.	Fuel cell thermodynamics	
34.	Fuel cell efficiency	
35.	Fuel cell characterization	
36.	Fuel cell modelling and system integration	
37.	Hydrogen production from renewable sources and storage	
38.	Life cycle analysis of fuel cells.	

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Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester: VII	Year: IV
Name of Course		Design of Heat Exchangers		
Course Code		ME24452		
Core / Elective / Other		Elective		
Prerequisite if any:				
1.	Heat and Mass Transfer , Mathematics, Thermodynamics			
2.	Fluid Mechanics			
Course Outcomes:				
1.	To analyze and solve heat exchanger problems by applying principles of mathematics, Science and engineering.			
2.	Learn to use modern tools, techniques and skills to fulfill industrial needs related to design of heat exchanger.			
3.	To develop skills in the analysis of heat exchanger with mathematical modelling for applications in research or design.			
4.	To develop design systems as per the desired needs based on economical, social, environmental issues associated with engineering practices.			
Description of Contents in brief:				
Unit 1.	Classification, temperature distribution for parallel flow, counter flow, cross flow, heat exchanger, evaporators and condensers, concept of LMTD and overall heat transfer coefficient. Correction factors (F) for various flow arrangement, comparison of different methods, NTU method for gauging exchanger performance, LMTD for parallel, counter and cross flow heat exchangers, methods of effectiveness.			
Unit 2.	Important design considerations: Design methodology, Selection criteria, general selection guide lines, thermodynamic modelling and analysis, material selection and optimization of heat exchangers. Vibrations induced by flow, International Standards for heatexchangers.			
Unit 3.	Film Coefficients of Fluids and Tubes, Equivalent diameter for fluids flowing in Annuli, Film coefficients for fluids in Annuli, Fouling factors, The Caloric or Average Fluid Temperature, Heat load, LMTD and NTU methods of evaluation of heat exchangers, The calculation of double pipe exchanger: Double pipe exchangers in series – parallel arrangements			
Unit 4.	Tube layouts, Baffle spacing, types of shell and tube exchangers, the calculations of shell andtube exchangers shell side film coefficients, shell side equivalent diameter, The true temperature difference in a 1-2 exchanger. Influence of approach temperature on correction factor, Shell- side pressure drop, Tube side pressure drop, Analysis of Performanceof 1-2exchangers and Design calculation of shell and tube heat exchangers.			
Unit 5.	Gasketed, brazed rating and sizing, design considerations, surface geometrics, pressure drop calculations, limiting cases for design.			
List of Text Books:				
1.	Donald Q. Kern, “Process Heat Transfer”, Tata McGraw-hill Publishing Company, Ltd. Second edition 1997.			
2.	Fundamentals of Heat Exchanger Design, John Wiley & Sons. R K Shah and D P Sekulic,2003			

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3.	Heat Exchangers, CRC Press, A Kakac, H Liu, 2002	
4.	Handbook for Heat Exchangers and Tube Banks Design D. Annaratone , Springer Verlag, 2010	
5.	Compact Heat Exchangers, Pergamon, J.E. Hesselgreaves, 2001	
List of Reference Books:		
1.	Robert W. Serth, “Process heat transfer principles and applications”, Academic press, Elsevier, 2007	
2.	Sarit Kumar Das, “Process heat transfer”, Alpha Science International, 2005	
3.	John E. Hesselgreaves, “Compact heat exchangers: selection, design, and operation”, Elsevier science Ltd, 2001.	
4.	Kuppan. T., “Heat exchanger design hand book”, New York : Marcel Dekker, 2000.	
URLs:		
1.	www.nptel.ac.in	
2.	https://swayam.gov.in/nc_details/NPTEL	
Lecture Plan (about 40-50 Lectures):		
*Lecture No.	Topic	Remarks
1.	Introduction of heat exchangers ,Classification	
2.	Temperature distribution for parallel flow, counter flow, cross flow, heat exchanger evaporators and condensers	
3.	Temperature distribution for cross flow, heat exchanger evaporators and Condensers	
4.	Concept of LMTD and overall heat transfer coefficient.	
5.	Correction factors (F) for various flow arrangement	
6.	Comparison of different methods, NTU method for gauging exchanger performance,Methods of effectiveness	
7.	Problems on LMTD and overall heat transfer coefficient	
8.	Problems on NTU method and Effectiveness	
9.	Important design considerations, Design methodology	
10.	Selection criteria, General selection guide lines, Material selection	
11.	Thermodynamic modelling and analysis	
12.	Thermodynamic modelling and analysis	
13.	Optimization of heat exchangers	
14.	Optimization of heat exchangers	
15.	Vibrations induced by flow	
16.	International Standards for heat exchangers	
17.	Film Coefficients of Fluids and Tubes	
18.	Equivalent diameter for fluids flowing in Annuli	
19.	Film coefficients for fluids in Annuli	
20.	Fouling factors - The Caloric or Average Fluid Temperature	
21.	Heat load - LMTD and NTU methods of evaluation of heat exchangers	
22.	Heat load - LMTD and NTU methods of evaluation of heat exchangers	
23.	Design of Double pipe exchangers in series – parallel arrangements	

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24.	Design of Double pipe exchangers in series – parallel arrangements	
25.	Design of Double pipe exchangers in series – parallel arrangements	
26.	Design of Double pipe exchangers in series – parallel arrangements	
27.	Design of Double pipe exchangers in series – parallel arrangements	
28.	Design of Double pipe exchangers in series – parallel arrangements	
29.	Design of Double pipe exchangers in series – parallel arrangements	
30.	Types of shell and tube exchangers, Tube layouts, Baffle spacing	
31.	The calculations of shell and tube exchangers shell side film coefficients	
32.	Shell side equivalent diameter, The true temperature difference in a 1-2 exchanger	
33.	Influence of approach temperature on correction factor	
34.	Shell- side pressure drop -Analysis of Performance of 1-2 exchangers	
35.	Tube side pressure drop- -Analysis of Performance of 1-2 exchangers	
36.	Design calculation of shell and tube heat exchangers	
37.	Design considerations for Compact heat exchanger	
38.	Design considerations for Compact heat exchanger	
39.	Gasketed, brazed rating and sizing for Compact heat exchanger	
40.	Surface geometrics	
41.	Pressure drop calculations	
42.	Limiting cases for design	

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

**MAULANA AZAD NATIONAL INSTITUTE OF
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Name of Program	B.Tech (Mechanical Engg.)	Semester: VII	Year: IV
Name of Course	Solar Energy		
Course Code	ME24453		
Core / Elective / Other	Elective		
Prerequisite if any:			
1.	Engineering Thermodynamics		
2.	Heat and Mass Transfer		
Course Outcomes:			
1.	Identify renewable energy sources and their utilization		
2.	Understand the basic concepts of solar radiation geometry and radiation estimation		
3.	Design solar air heater, solar water heater and parabolic concentrating systems and analyze losses		
4	Analyze various solar thermal systems		
5	Understand energy storage and solar PV systems		
Description of Contents in brief:			
Unit 1.	Introduction: Global and Indian scenario of energy sources, energy crisis, potential uses of solar energy, technical and economic viability of solar energy		
Unit 2.	Solar Energy: Fundamentals of solar radiation, estimation of solar radiation on horizontal and inclined surfaces, measurement of solar radiation data.		
Unit 3.	Solar Collectors: Flat plate collectors, characteristics of flat plate collectors, loss coefficients and heat transfer to the flowing medium, design and performance of solar water heaters, evacuated tube collector and solar air heater. Steady state and transient analysis. Types of focusing collectors, performance characteristics and design of focussing collectors.		
Unit 4.	Solar Systems: Performance analysis of solar cooling systems, solar drying-agriculture and industrial drying, cabinet type dryer-general considerations, solar stills-portable and large units, theoretical consideration performance.		
Unit 5.	Energy Storage: Need for energy storage, thermal and chemical storage, modeling of energy storage systems. Solar PV System: Basics, types of solar PV systems, VI characteristics, grid connected and stand alone PV systems, thin film technology. Sustainability of solar PV system		
List of Text Books:			
1.	H.P. Garg, J.Prakash. Solar Energy Fundamentals and Applications, Tata McGraw Hill Education, 2000		
2.	S.P. Sukhatme, J.K. Nayak. Solar Energy, McGrawHill Education, 2017		
3.	G.N. Tiwari. Solar Energy: Fundamentals, Design, Modelling and Applications, CRC Press, 2002		
List of Reference Books:			
1.	John A. Duffie, William A. Beckman. Solar Engineering of Thermal Processes, John Wiley & Sons, 2013		

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2.	G.N. Tiwari, A. Tiwari, Shyam. Handbook of Solar Energy: Theory, Analysis and Applications, Springer, 2016	
3.	D.Y. Goswami. Principles of Solar Engineering, Taylor and Francis, 2015	
URLs:		
1.	https://nptel.ac.in/courses/112/105/112105050/	
2.	https://nptel.ac.in/courses/121/106/121106014/	
Lecture Plan (about 40-50 Lectures):		
Lecture No.	Topic	Remarks
1	Global and Indian scenario of energy sources	
2-3	Energy crisis, potential uses of solar energy	
4	Technical and economic viability of solar energy	
5-6	Fundamentals of solar radiation	
7-10	Estimation of solar radiation on horizontal and inclined surfaces	
11-12	Measurement of solar radiation data	
13-14	Flat plate collectors, characteristics of flat plate collectors	
15-16	Loss coefficients and heat transfer to the flowing medium	
17-20	Design and performance of solar water heaters, evacuated tube collector and solar air heater	
21-22	Steady state and transient analysis	
23	Types of focusing collectors	
24-26	Performance characteristics and design of focussing collectors	
27-29	Performance analysis of solar cooling systems	
30-31	Solar drying-agriculture and industrial drying, cabinet type dryer-general considerations	
32-34	Solar stills-portable and large units, theoretical consideration Performance	
35-36	Need for energy storage, Thermal and chemical storage	
37	Modelling of energy storage systems	
38	Solar PV System: Basics, types of solar PV systems, VI characteristics	
39-40	Grid connected and stand alone PV systems, thin film technology. Sustainability of solar PV system	

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

**MAULANA AZAD NATIONAL INSTITUTE OF
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Name of Program	B.Tech (Mechanical Engg.)	Semester: VII	Year: IV
Name of Course	Non-Conventional Energy Sources		
Course Code	ME24454		
Core / Elective / Other	Elective		
Prerequisite if any : Nil			
Course Out comes:			
1.	Understanding the physics of solar radiation. Ability to classify the solar energy Collectors and methodologies of storing solar energy.		
2.	Knowledge in applying solar energy, wind energy and biomass with its economic Aspects		
3.	Knowledge in capturing and applying other forms of energy sources like wind, biogas, Geothermal Tidal, Wave, Small-hydro etc.		
Description of Contents in brief:			
Unit1.	General Introduction to Energy Sources, Energy consumption as measure of prosperity, world energy futures, Energy sources and their availability, Prospects of Renewable energy sources.		
Unit2.	Solar Radiation and its Measurement Introduction, Solar constant, Solar Radiation at The earth's surface, Solar radiation geometry, Solar radiation measurements ,Solar radiation data, Estimation of average solar radiation, Solar radiation on tilted surfaces.		
Unit3.	Solar Photo Voltaic effect, p-n junction, different types, characteristics, Effect of temperature, insolation level & tilt and other angles, Solar cell Technologies, Thin film, Wafer, Emerging ones, Solar cell I-Vcharacteristics, fill factor and other parameters, Photovoltaic modules, Solar P V Applications. Sustainability of Solar P V Systems.		
Unit4.	Solar thermal conversion devices and applications, Solar thermal collectors and their types and performance analysis, solar ponds, dryers, distillation, solar cooker, central receiver thermal power plant, solar energy storage, solar energy storage systems.		
Unit5.	Wind Energy, Introduction, Basic Principles of Wind energy conversion, Classifications of Wind Energy, Analysis of Aerodynamic Forces acting on the blade, Performance of Wind Machines, Application of wind energy, Environmental aspects.		
Unit6.	Renewable Energy Sources , Biomass, Tidal, Wave, Open and Closed OTEC cycles, Small hydro, Geothermal energy, etc.		
List of Text Books:			
1.	Renewable Energy Resources by John Twidell & Tony Weir		
2.	Solar Energy by S P Sukhatme		
3.	Renewable Energy by Godfrey Boyle		
List of Reference Books:			
1.	G. D. Rai, Non-Conventional Energy Sources, Khanna Publishers, New Delhi, 1999.		
2.	H P Garg, Solar Energy,		
3.	G. N. Tiwari, Solar Energy-Fundamental Design, Modelling and Applications, Narosa Publishing House, New Delhi, 2002.		

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Lecture Plan		
LectureNo.	Topic	Remarks
1	General Introduction to Energy Sources,	
2	Energy consumption as measure of prosperity,	
3	World energy futures,	
4	Energy sources and their availability,	
5	Prospects of renewable energy sources.	
6	Solar Radiation and its Measurement	
7	Introduction Solar constant	
8	Solar Radiation at the earth's surface,	
9	Solar radiation geometry ,	
10	Solar radiation measurements,	
11	Solar radiation data,	
12	Estimation of average solar radiation,	
13	Solar radiation on tilted surfaces.	
14	Solar Photo Voltaic effect,	
15	p-n junction different types,	
16	Characteristics; Effect of temperature,	
17	Insolation level & tilt and other angles,	
18	Solar cell Technologies,	
19	Thin film, Wafer, Emerging ones,	
20	Solar cell I-V characteristics,	
21	Fill factor and other parameters,	
22	Photovoltaic modules.	
23	Solar PV Applications.	
24	Sustainability of Solar PV Systems.	
25	Solar thermal conversion devices And applications,	
26	Solar Thermal Collectors	
27	Types of Solar Thermal Collectors and performance analysis,	
28	Solar Ponds, Dryers, Distillation,	
29	Solar cooker, Central Receiver Thermal Power plant,	
30	Solar energy storage, Solar energy storage systems	
31	Wind Energy: Introduction, Basic Principles of wind energy conversion	
32	Classifications of Wind Energy,	
33	Analysis of Aerodynamic Forces acting on the blade,	
34	Performance of Wind Machines,	
35	Application of Wind energy, Environmental aspects.	
36	Renewable Energy Sources,	
37	Biomass, Tidal, Wave, Open and Closed OTEC Cycles,	
38	Small-hydro,	
39	Geothermal energy, etc.	

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Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

**MAULANA AZAD NATIONAL INSTITUTE OF
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Name of Program		B.Tech (Mechanical Engg.)	Semester: VII	Year: IV
Name of Course		Energy Audit and Carbon Sequestration		
Course Code		ME24455		
Core / Elective / Other		Elective		
Prerequisite if any:				
1.	Basics of mechanical engineering			
2.	Thermodynamics			
Course Outcomes:				
1.	To understand basics of energy audit: definition, types, cost, performance, optimization			
2.	To understand the methods used in energy audit for complete information			
3.	Able to clearly understand the management part of energy audit			
4	Able to understand the carbon capture in the environment.			
5	Develop the potential to understand carbon sequestration and management			
Description of Contents in brief:				
Unit 1.	Basics of Energy Audit Definition, need of energy audit, types of energy audit: preliminary energy audit, Targeted energy audit, detailed energy audit, energy costs, energy conservation, benchmarking of energy performance, optimizing energy input. maximizing system efficiencies, input and output of energy audit.			
Unit 2.	Energy Audit Methodology Preliminary energy audit methodology, Detailed energy audit methodology, financial analysis, sensitivity analysis, energy monitoring and training, electrical energy audit, mechanical system, thermal energy audit, water audit and conservation, data collection, data analysis, recommendation for better energy efficiency, effects of instruments on energy audit.			
Unit 3.	Principles and Objectives of Energy Management Definition, principles of energy management, energy performance, economic aspects of machines, optimum energy and utilization, minimizing energy cost and environmental effects, energy management cycle, energy management system, design of management programs, duties of energy manager, Indian need of energy management.			
Unit 4.	Carbon Capture, Energy and Atmosphere The carbon cycle, climate models, energy and electricity, introduction to carbon capture, absorption, adsorption, membranes, geological carbon sequestration, pre combustion capture and post combustion capture, carbon dioxide utilization, carbon negative technologies.			
Unit 5.	Carbon Sequestration and Management Geological sequestration, ocean sequestration, terrestrial sequestration, Carbon management through abiotic sequestration, carbon sources and carbon sinks, carbon sequestration in vegetation, deep saline aquifers deposit, carbon farming and carbon			

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	trading, carbon auditing, methane source and sink, Strategic management of carbon emissions: Future predictions, best Management Practices, types of certification.	
List of Text Books:		
1.	A. Thumann, T. Niehus, W. J. Younger, Handbook of energy audits, CRC Press, 2013.	
2.	W. C. Turner, S. Doty, Energy management handbook, Fairmont press, 1982.	
3.	B. Smit, J. R. Reimer, C. M. Oldenburg, I. C. Bourg, Introduction to carbon capture and sequestration, Impireal College Press, 1962.	
List of Reference Books:		
1.	Y. P. Abbi, Energy Audit: thermal power, combined cycle, and cogeneration plants,TERI Press, 2012.	
2.	B. L. Capehart, W. C. Turner, W. J. Kennedy, Guide to energy, CRC Press, 2015.	
3.	H. J. Herzog, Carbon capture, MIT Press 2018.	
URLs:		
1.	https://beeindia.gov.in/sites/default/files/1Ch3.pdf	
2.	https://www.researchgate.net/publication/309463130_Energy_Audit_Management	
3.	http://www.cres.gr/kape/pdf/download/guide_a_uk.pdf	
4.	https://www.researchgate.net/publication/6079761_Carbon_sequestration	
Lecture Plan (about 40-50 Lectures):		
*Lecture No.	Topic	Remarks
1-4	Definition, need of energy audit, types of energy audit: preliminary energy audit, Targeted energy audit, detailed energy audit.	-
5-8	Energy costs, energy conservation, benchmarking of energy performance, optimizing energy input. maximizing system efficiencies, input and output of energy audit.	-
9-12	Preliminary energy audit methodology, Detailed energy audit methodology, financial analysis, sensitivity analysis, energy monitoring and training.	-
12-15	Electrical energy audit, mechanical system, thermal energy audit, water audit and conservation, data collection, data analysis, recommendation for better energy efficiency, effects of instruments on energy audit.	-
16-19	Definition, principles of energy management, energy performance, economic aspects of machines, optimum energy and utilization, minimizing energy cost and environmental effects.	-
20-23	Energy management cycle, energy management system, design of management programs, duties of energy manager, Indian need of energy management.	-
24-28	The carboncycle, climate models, energy and electricity, introduction to carbon capture, absorption, adsorption, membranes.	-

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29-32	Geological carbon sequestration, pre combustion capture and post combustion capture, carbon dioxide utilization, carbon negative technologies.	-
33-36	Geological sequestration, ocean sequestration, terrestrial sequestration, Carbon management through abiotic sequestration, carbon sources and carbon sinks, carbon sequestration in vegetation	-
37-41	Deep saline aquifers deposit, carbon farming and carbon trading, carbon auditing, methane source and sink, Strategic management of carbon emissions: Future predictions, best Management Practices, types of certification.	-

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

**MAULANA AZAD NATIONAL INSTITUTE OF
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Name of Program		B.Tech (Mechanical Engg.)	Semester: VII	Year: IV
Name of Course		Computational Fluid Dynamics and Heat Transfer		
Course Code		ME24456		
Core / Elective / Other		Elective		
Prerequisite if any:				
1.	Fluid Mechanics			
2.	Heat Transfer			
Course Outcomes:				
1.	Students will able to understand various discretization method.			
2.	Students will be able to state various convective and diffusion scheme.			
3.	Students will be able to apply finite difference, finite volume and finite element methods to fluid flow problems.			
4.	Students will be able to analyze the accuracy of a numerical solution for different grid arrangement.			
5.	Student will able to design numerical algorithm and develop a computer code for fluid flow and heat transfer problem.			
Description of Contents in brief:				
Unit 1.	Introduction: Introduction to CFD and its applications, Governing equations for fluid flow: Continuity, Momentum and Energy, Classification of partial differential equations, General behavior of different classes of PDE: parabolic, hyperbolic and elliptic, Initial and boundary conditions.			
Unit 2.	Finite Difference Method Taylor series expansion, Finite difference equations (FDE) of 1 st and 2 nd order derivatives, Truncation errors, Order of accuracy, Steady and unsteady one-and two-dimensional heat conduction equations, One-dimensional wave equations, Explicit and Implicit approach, Solutions of simultaneous equations: direct and indirect method, Jacobi, Gauss-Seidel method, Gauss-elimination, TDMA, Gauss Jordan.			
Unit 3.	Finite Element Methods: Introduction and formulation, Weighted Residual method, Shape function, Boundary conditions, Unsteady 1-D heat conduction			
Unit 4.	Finite Volume Method: Control volume formulation, Steady 1-D conduction, Unsteady one-dimensional conduction, Two and Three-dimensional conduction, Over and under relaxation, Steady one- dimensional convection and diffusion.			
Unit 5.	CFD Techniques: Lax-Wendroff technique, MacCormack Technique, Relaxation technique, Aspects of numerical dissipation and dispersion, Alternating-direction implicit (ADI) technique.			
Unit 6.	N-S Equations for Incompressible Flow: Vorticity-Streamfunction approach, Boundary conditions, Need of staggered grid, SIMPLE algorithms, MAC algorithm, Introduction to commercial CFD solvers.			
List of Text Books:				
1.	J. D. Anderson, Computational fluid Dynamics, McGraw Hill, 1 st edition, 1995.			
2.	G.S. Ghosdastidar, Computational Fluid Dynamics & Heat Transfer, Cengage India Pvt Ltd, 1 st Edition, 2017.			
3.	K. Muralidhar and T. Sundararajan, Computational Fluid Flow and Heat Transfer, Narosa Publishing House, 2 nd edition, 2014 .			
4.	T. J. Chung, Computational Fluid Dynamics, Cambridge University Press, 2 nd Edition, 2002.			

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List of Reference Books:		
1.	S V. Patankar. Numerical Heat Transfer and Fluid Flow, CRC press, 1 st edition, 1980.	
2.	J. C. Tannehill, D. A. Anderson and R. H. Pletcher, Computational Fluid Mechanics and Heat Transfer, CRC Press, 3 rd Edition, 2011.	
3.	J. Blazek, Computational Fluid Dynamics: Principles and Applications, Butterworth-Heinemann, 3 rd edition, 2015.	
4.	H. K. Versteeg & W. Malalasekera, An Introduction to Computational Fluid Dynamics, Pearson, 2 nd edition, 2007.	
URLs:		
1.	https://nptel.ac.in/courses/112/105/112105045/	
2.	https://nptel.ac.in/courses/101/106/101106045/	
3.	https://www.cfd-online.com/	
4.	https://nptel.ac.in/courses/112/104/112104030/	
Lecture Plan (about 40-50 Lectures):		
*Lecture No.	Topic	Remarks
1	An introduction to the computational fluid dynamics	
2	Applications and advantage of CFD	
3	Governing equation for fluid flow and heat transfer	
4	Control volume approach& derivation of continuity equation	
5	Derivation of Navier-Stokes equations	
6	Derivation of energy equations	
7	Initial and boundary conditions	
8	Classification of partial differential equations – Parabolic	
9	Elliptic and Hyperbolic equation	
10	Initial and boundary conditions	
11	Introduction to Taylor series expansion	
12	1 st and 2 nd order finite difference derivatives,	
13	Truncation error and order of accuracy	
14	1-D & 2-D heat conduction equations	
15	1-D wave equations	
16	Explicit and Implicit method	
17	Direct and iterative methods	
18	Jacobi and Gauss-Seidel method	
19	Gauss-elimination and Gauss Jordon	
20	Tridiagonal matrix algorithms (TDMA)	
21	Unwinding of convective term and its significance	
22	Introduction to finite element method	
23	Formulation of weighted residual method	
24	Shape function and their evaluations	
25	One dimensional heat conduction	
26	Introduction to finite volume method and control volume Formulation	
27	Solution of 1-D heat conduction equation with FVM	
28	Unsteady 1-D heat conduction equation	
29	Discretization of equation for two dimension	
30	Solution of algebraic equations	

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31	Overrelaxation and underrelaxation	
32	Steady one- dimensional convection and diffusion	
33	Lax-Wendroff technique	
34	MacCormack Technique	
35	Alternating-direction implicit (ADI) technique	
36	Aspect of numerical dissipation and dispersion	
37	Vorticity-stream function formulations	
38	Need of staggered grid	
39	The pressure correction formula	
40	The SIMPLE algorithm	
41	Boundary conditions for pressure correction method	
42	MAC algorithm	

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

**MAULANA AZAD NATIONAL INSTITUTE OF
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Name of Program		B.Tech (Mechanical Engg.)	Semester: VII	Year: IV
Name of Course		Wind Energy Technology		
Course Code		ME24457		
Core / Elective / Other		Elective		
Prerequisite if any:				
1.	Nil			
Course Outcomes:				
1.	Enables to understand the basic principles of wind energy technology.			
2.	Enables to understand the wind characteristic parameters such as speed, direction, height, turbulence, gust and topography for measuring the wind resource at any site.			
3.	Enables to apply the blade momentum theory of betz coefficient calculation.			
4.	Enables to analyze and compare different wind turbine performance curves.			
5.	Enables to gain knowledge about wind turbine controlling mechanisms, electrical components, wind farm siting criteria, environmental aspects and application of remote sensing in wind energy.			
Description of Contents in brief:				
Unit 1.	Introduction- Modern Wind Energy and its Origins : Historical perspective, latest developments, state of art of wind energy technology, turbine rating, cost of energy, wind power plant economics, installation and operation costs, decommissioning, national scenario and worldwide developments, present status and future trends.			
Unit 2.	Wind Characteristics and Resources: Nature of atmospheric winds; wind resource characteristics and assessment; anemometry; wind statistics; speed frequency distribution, effect of height, wind rose, Weibull distribution, atmospheric turbulence, gust wind speed, effect of topography.			
Unit 3.	Aerodynamics of Wind Turbines : Aerodynamics of aerofoil; lift; drag; stall; effect of Reynold's number; actuator disc; momentum theory and Betz coefficient; design of wind turbine blade; effect of stall and blade pitch on coefficient of power vs tip speed ratio and coefficient of torque vs tip speed ratio characteristics, optimal choice of cut-in, rated and cut-out wind speeds, blade materials. Vertical and horizontal axis turbines, design characteristics, multiple stream tube theory, vortex wake structure; tip losses; rotational sampling, wind turbine design programs, aerodynamic loads, tower shadow, wind shear, blade coning, gyroscopic, transient and extreme loads. Aerodynamic damping and stability, teetering motion, stiff and soft towers.			
Unit 4.	Wind Turbine design: Aerodynamic damping and stability, teetering motion, stiff and soft towers. Power train dynamics, design standards. Innovative designs and recent advances in wind energy conversion systems. Pitch control, yaw control, aerodynamic braking, and teetering mechanism.			
Unit 5.	Electrical & Control systems: Wind turbine dynamics with DC and AC generators: induction and synchronous generators, permanent magnet generator, variable speed operation, effect of wind turbulence. Power electronics, Converter and Inverter interfaces for wind energy utilization system for isolated and grid connected system. Wind farm electrical design.			

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Unit 6.	Siting, Wind farm design: Planning of wind farms, special application for developing countries, maintenance and operation, wind farm management, site selection.
Unit 7.	Environmental impact: Environmental assessment; noise emission, visual impact, avian mortality, telecommunication interference etc.
Unit 8.	Instrumentation and Remote sensing: Instrumentation, data loggers, remote monitoring and control. Remote sensing applications like SODAR, LIDAR, SAR etc.

List of Text Books:

1.	Ahmad Hemami (2012) Wind Turbine Technology. Cengage Learning. ISBN: 1435486463, 9781435486461
2.	Trevor M. Letcher (2017). Wind Energy Engineering: A Handbook for Onshore and Offshore Wind Turbines. Academic Press. ISBN: 012809429X, 9780128094297
3.	Mathew Sathyajith (2006). Wind Energy: Fundamentals, Resource Analysis and Economics. Springer Science & Business Media. ISBN: 3540309063, 9783540309062

List of Reference Books:

1.	Ahmed Siraj (2016). WIND ENERGY: Theory and Practice, 3/e PHI, Eastern Economy Edition ISBN 978-81-203-5163-9 New Delhi.
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Lecture Plan (about 40-50 Lectures):

*Lecture No.	Topic	Remarks
1.	Application to computer in mechanical component design and assembly	
2.	Introduction to modern wind energy and its origins	
3.	General Characteristics of the Wind Resource	
4.	Wind Data Analysis and Resource Estimation	
5.	Wind Turbine Energy Production Estimates Using Statistical Techniques	
6.	Regional Wind Resource Assessment	
7.	Wind Prediction and Forecasting	
8.	Wind Measurement and Instrumentation	
9.	Advanced Topics	
10.	One-dimensional Momentum Theory and the Betz Limit	
11.	One-dimensional Momentum Theory and the Betz Limit	
12.	Ideal Horizontal Axis Wind Turbine with Wake Rotation	
13.	Airfoils and General Concepts of Aerodynamics	
14.	Blade Design for Modern Wind Turbines	
15.	Blade Design for Modern Wind Turbines	
16.	Momentum Theory and Blade Element Theory	
17.	Generalized Rotor Design Procedure	
18.	Generalized Rotor Design Procedure	
19.	Simplified HAWT Rotor Performance Calculation Procedure	
20.	Computational and Aerodynamic Issues in Aerodynamic Design	
21.	Tutorial Problems	
22.	Tutorial Problems	
23.	Tutorial Problems	
24.	Tutorial Problems	
25.	Wind Turbine Loads	

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26.	General Principles of Mechanics	
27.	General Principles of Mechanics	
28.	Wind Turbine Rotor Dynamics	
29.	Material Fatigue	
30.	Wind Turbine Materials	
31.	Machine Elements	
32.	Principal Wind Turbine Components	
33.	Design Procedure	
34.	Wind Turbine Topologies	
35.	Wind Turbine Standards, Technical Specifications, and Certification	
36.	Wind Turbine Design Loads	
37.	Power Curve Prediction	
38.	Design Evaluation	
39.	Wind Turbine and Component Testing	
40.	Electrical Aspects of Wind Turbines	
41.	Wind Turbine Control	
42.	Wind Turbine Siting, System Design, and Integration	
43.	Wind Energy Applications	
44.	Wind Energy System Economics	
45.	Wind Energy Systems: Environmental Aspects and Impacts	
46.	Tutorial Problems	
47.	Tutorial Problems	
48.	Tutorial Problems	

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

**MAULANA AZAD NATIONAL INSTITUTE OF
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Name of Program		B.Tech (Mechanical Engg.)	Semester: VII	Year: IV
Name of Course		Additive Manufacturing Technologies		
Course Code		ME24458		
Core / Elective / Other		Elective		
Prerequisite if any:NIL				
Course Outcomes:At the end of the course, the student will be able to:				
1.	Understand the basics of various of additive manufacturing (AM) technologies			
2.	Design machine and select the suitable materials for AM technologies			
3.	Apply mathematical elements of geometric modeling for AM technologies			
4.	Analyze the influence of pre and post processing parameters on performances			
5.	Explore the applications of AM technologies in various fields			
Description of Contents in brief:				
Unit 1.	Introduction to additive manufacturing, Traditional manufacturing v/s Additive Manufacturing (AM), Classification of AM technologies: Vat Photopolymerization, Extrusion, Sheet lamination, Powder bed fusion and Directed energy deposition, Break-even analysis for product-AM technology fit, Benefits and limitations of AM technologies, Application areas of AM technologies			
Unit 2.	Design of AM machine- necessary parts, Functional description and design analysis, Build process, Future improvements, Materials: The Building block for AM, State of material working principle for AM technologies, Importance of Materials, Materials for AM, Materials Selection Considerations, Technology specific materials			
Unit 3.	Geometric representation- Implicit, explicit, parametric equations, 2D & 3D transformations of geometry, Design of curves, surfaces and solids, CAD Data exchange formats and applications, AM data formats, STL format, STL file problems, Consequences of building a valid and invalid tessellated model, STL file repair, Model slicing and contour data organization, Support structure generation, Direct and adaptive slicing, Tool path generation, Introduction of AM software			
Unit 4.	Design for AM, AM benchmarks parts and types, Pre-processing of geometric model, Orientation of geometric model, volumetric error, shape deviations, staircase effect, surface roughness, material shrinkage or swelling, warpage, etc., Post processing of AM parts: Support material removal, surface finish and accuracy improvements, Cost model, Build time model			
Unit 5.	Rapid tooling (RT), Differences between Conventional and RT, Classification of RT: Direct and Indirect Tooling methods; Applications of RT and case studies, Scanning and Reverse Engineering (RE): Introduction, Measuring devices, Computer aided design (CAD) model construction from point cloud, Data handling and reduction methods, Applications of RE and case studies			
List of Text Books:				
1.	Chua C K, Leong K F, Chu S L, Rapid Prototyping: Principles and Applications in Manufacturing, World Scientific.			
2.	Noorani R, Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley & Sons.			
3.	D. F. Rogers and J. A. Adams, Mathematical Elements for Computer Graphics, McGraw Hill, 2002.			
List of Reference Books:				

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1.	Liou W L, Liou F W, Rapid Prototyping and Engineering applications: A tool box for prototype development, CRC Press.
2.	Kamrani A K, Nasr E A, Rapid Prototyping: Theory and practice, Springer
3.	Gibson D W Rosen, Brent Stucker, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer.
4.	Gibson, I., Software Solutions for Rapid Prototyping, Professional Engineering Publishing Limited, 2002

URLs:

1.	https://nptel.ac.in/courses/112/104/112104265/
2.	http://www.nptelvideos.com/lecture.php?id=14981
3.	https://www.youtube.com/watch?v=ICjQ0UzE2Ao
4.	https://www.youtube.com/watch?v=gcia0aqZMf0

Lecture Plan (about 40-50 Lectures):

*Lecture No.	Topic	Remarks
1.	Introduction to additive manufacturing, Traditional manufacturing v/s Additive Manufacturing (AM)	
2.	Classification of AM technologies: Vat Photopolymerization	
3.	Classification of AM technologies: Extrusion	
4.	Classification of AM technologies: Sheet lamination	
5.	Classification of AM technologies: Powder bed fusion	
6.	Classification of AM technologies: Directed energy deposition	
7.	Break-even analysis for product-AM technology fit	
8.	Application areas and limitations of AM technologies	
9.	Design of AM machine- necessary parts	
10.	Functional description and design analysis	
11.	Build process, Future improvements	
12.	Materials: The Building block for AM, State of material working principle for AM technologies	
13.	Importance of Materials, Materials for AM	
14.	Materials Selection Considerations, Technology specific Materials	
15.	Geometric representation- Implicit, explicit, parametric Equations	
16.	2D transformations of geometry	
17.	3D transformations of geometry	
18.	Design of curves	
19.	Design of surfaces	
20.	Design of solids	
21.	CAD Data exchange formats and applications	
22.	AM data formats, STL format	
23.	STL file problems	
24.	Consequences of building a valid and invalid tessellated model	
25.	STL file repair	
26.	Model slicing	
27.	Contour data organization, Support structure generation	

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28.	Direct slicing, Adaptive slicing	
29.	Tool path generation, Introduction of AM software	
30.	Design for AM, AM benchmarks parts	
31.	AM benchmarks types	
32.	Pre-processing of geometric model, Orientation of geometric Mode	
33.	Volumetric error, shape deviations	
34.	Staircase effect, surface roughness	
35.	Material shrinkage or swelling, warpage, etc.,	
36.	Post processing of AM parts: Support material removal	
37.	Post processing of AM parts: surface finishimprovement	
38.	Post processing of AM parts: accuracyimprovement	
39.	Cost model, Build time model	
40.	Rapid tooling (RT), Differences between Conventional and RT	
41.	Classification of RT: Direct Tooling methods	
42.	Classification of RT: Indirect Tooling methods	
43.	Applications of RT and case studies	
44.	Scanning and Reverse Engineering (RE): Introduction	
45.	Measuring devices	
46.	Computer aided design (CAD) model construction from point Cloud	
47.	Data handling and reduction methods	
48.	Applications of RE and case studies	

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester: VII	Year: IV
Name of Course		Advanced Production Engineering		
Course Code		ME24459		
Core / Elective / Other		Elective		
Prerequisite if any:				
1.	Manufacturing Processes-1			
2.	Manufacturing Processes-2			
Course Outcomes:				
1.	Able to understand the metal cutting theory and principles and apply for the evaluation of machinability and economics of machining.			
2.	Ability to design the machine tools, tool for CNC machines, guide ways and slide ways, Jig and fixtures for various machining operations.			
3.	To acquire the knowledge of various unconventional machining operations and CNC machines.			
Description of Contents in brief:				
Unit-1	Metal Cutting Theory: Geometry of cutting tools, metal machining, chip formation, types of chips, force analysis, velocity relationship, stress and strain analysis, power and energy relationships, thermal aspects, dynamometers for turning and drilling. Evaluation of machinability, tool wear and tool life, cutting forces, surface finish, economies of metal machining and cutting fluids.			
Unit-2	Machine Tools System: Design analysis of machine tools, elements, structure, slideways and guides, spindle unit drives in machine tools, layout of gear box, stepped regulators, step less regulators, and hydraulic regulators.			
Unit-3	Tool Design of CNC machines Tooling principles and tool layouts for turrets, automates, Design of single point cutting tools, rigidity, design of chip breakers, dynamic chip breaking.			
Unit-4	Usefulness of jigs and fixtures, principles of design, locating and clamping, diamond pin locator, jig bushes, drill jigs, milling, turning, boring and broaching fixtures, assembly fixtures, welding fixtures, indexing devices, materials for jigs and fixtures, economics of jigs and fixtures.			
Unit-5	Unconventional Machining Processes: Mechanical Processes: Ultrasonic Machining, Elements of USM, Acoustic Head and Design etc., Abrasive Jet Machining, Variables effecting AJM, Water Jet Machining, Equipment and process details, Electrochemical Machining Processes: elements of process, electrolytes & their properties, chemistry of process, metal removal rate. Thermal aspect, temperature rise & pressure-flow rate, tool design, accuracy & surface finish, advantages, application & limitations of the process, Thermal processes: Electrical discharge machining, mechanism of metal removal, accuracy and surface finish, application & future trends,			
Unit-6	Plasma Arc Machining, mechanism of metal removal, accuracy and surface finish, economics and application of plasma jets, Electron/Laser Beam Machining: Electron beam machining: generation and control of electron beam, process capability and			

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	limitations. Laser beam machining: Principles of working, thermal aspect, material removal, cutting speed and accuracy, advantages & limitations.	
List of Text Books:		
1.	Production Engineering & Science by P. C. Pandey & C. K. Singh; Standard Publishers Distributors; 7 th Edition; 2006	
2.	Tool Design by C. Donaldson and <u>V. C. Goold</u> ; Tata McGrawhill; 3 rd Edition; 1976	
3.	Manufacturing Science by Ghosh & Mallik; Affiliated East-West Press; 2010	
4.	A text book of Production Engineering by P. C. Sharma; S. Chand Publications; 1999	
List of Reference Books:		
1.	Metal Cutting Principles by Bhattacharya; New Central Book Agency; 2012	
2.	Production Technology by R. K. Jain ; Khanna Publishers; 2001	
3.	Manufacturing Processes by Ghosh Amitabh; 2012	
URLs:		
2.	https://nptel.ac.in/courses/112/107/112107077/	
3.	https://nptel.ac.in/courses/112/105/112105212/	
Lecture Plan:		
Lecture No.	Topic	Remarks
1.	Metal Cutting Theory, Geometry of cutting tools	
2.	Metal machining, chip formation, types of chips	
3.	Force analysis, velocity relationship	
4.	Stress and strain in chip, power and energy relationships	
5.	Thermal aspects, dynamometers for turning and drilling	
6.	Evaluation of machinability	
7.	Tool wear and tool life	
8.	Cutting forces, surface finish and Cutting fluids	
9.	Economies of metal machining	
10.	Machine Tools System: Design analysis of machine tools elements and Structure	
11.	Slideways and guides	
12.	Spindle unit drives in machine tools	
13.	Layout of gear box, stepped regulators	
14.	Step less regulators, and hydraulic regulators	
15.	Tool Design of CNC machines	
16.	Tooling principles and tool layouts for turrets and automates	
17.	Design of single point cutting tools	
18.	Rigidity, design of chip breakers, dynamic chip breaking	
19.	Usefulness of jigs and fixtures, principles of design	
20.	principles of locating and clamping, diamond pin locator	
21.	Jig bushes, drill jigs	
22.	Milling and turning fixtures	
23.	Boring and broaching fixtures	
24.	Assembly fixtures, welding fixtures, indexing devices	

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25.	Materials for jigs and fixtures, economics of jigs and fixtures	
26.	Unconventional Machining Processes: Mechanical Processes	
27.	Ultrasonic Machining, Elements of USM Acoustic Head and Design	
28.	Abrasive Jet Machining, Variables effecting AJM	
29.	Water Jet Machining, Equipment and process details	
30.	Electrochemical Machining Processes: elements of process, electrolytes & their properties	
31.	Chemistry of process, metal removal rate. Thermal aspect, temperature rise & pressure-flow rate	
32.	Tool design, accuracy & surface finish, advantages, application & limitations of the process	
33.	Thermal processes: Electrical discharge machining, mechanism of metal removal	
34.	Accuracy and surface finish, application & future trends	
35.	Plasma Arc Machining, mechanism of metal removal, accuracy and surface finish	
36.	Economics and application of plasma jets	
37.	Electron beam machining: generation and control of electron beam	
38.	Process capability and limitations of EBM	
39.	Laser beam machining: Principles of working	
40.	Thermal aspect of laser beam machining	
41.	Material removal in laser beam machining	
42.	Cutting speed and accuracy, advantages & limitations	

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

**MAULANA AZAD NATIONAL INSTITUTE OF
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Name of Program		B.Tech (Mechanical Engg.)	Semester: VII	Year: IV
Name of Course		Nano manufacturing		
Course Code		ME24460		
Core / Elective / Other		Elective		
Prerequisite if any:				
1.	Nil			
Course Outcomes:				
1.	Able to understand the concept and principles of Nanotechnology and methods of Nano-manufacturing.			
2.	Able to learn the various characterization techniques at micro and nano level			
3.	Able to learn various fabrication techniques like Nanolithography, MEMS, NEMS and CVD.			
Description of Contents in brief:				
Unit 1.	Introduction to Nano-manufacturing and Nanotechnology, Advantages, disadvantages and applications of Nanotechnology and Nano-manufacturing, Top-down and Bottom-up techniques, self-assembly, self-assembled monolayer.			
Unit 2.	Characterization Techniques: Scanning Electron Microscope, Transmission Electron Microscope, Atomic force microscopy (AFM), Scanning Probe Microscope (SPM), Scanning Tunneling Microscope (STM), X-ray Diffraction (XRD).			
Unit 3.	Nano-lithography: Photolithography: UV Photolithography, X-ray Lithography, Electron Beam Lithography, Particle Beam Lithography's, Probe lithography's. Micro and Nano machining, Focused Ion beam machining.			
Unit 4.	Chemical methods in Nano-manufacturing, Si processing methods: Cleaning /etching, Epitaxy, Molecular-beam epitaxy, chemical beam epitaxy, CVD, Metal-organic CVD (MOCVD), Plasma enhanced CVD (PE-CVD), Sol-gel Technique			
Unit 5.	Properties and application of Nano Materials: Fullerene Structure, Carbon nano tubes, Nano Particles, Processing of Nanocomposites			
Unit 6	Micro & Nano Electromechanical Systems (MEMS & NEMS).			
List of Text Books:				
1.	Introduction to nanotechnology by Charles P. Poole Jr. & Frank J. Owens Publisher: John Wiley & Sons (Asia) Pvt. Ltd.; 2004			
2.	Nanotechnology: Introduction to Nanostructuring Technoques by Michael Kohler, Publisher: John Wiley & Sons (Asia) Pvt. Ltd.; 2 nd Ed., 2007			
3.	Principles of Nanotechnology by Phani Kumar, SCITECH Publications; 2 nd Edition, 2010			
4.	Nanotechnology: A Future Technology with Vision, Appin Labs, BPB Publications; 2007.			
List of Reference Books:				
1.	Micro-engineering, MEMS and Interfacing: A practical Guide by Danny Banks, Publisher: Taylor & Francis; 2006			
2.	Magnetic Microscopy of Nanostructures by H. Hopster & H. P. Oepen, Publisher: Springer; 2003			
3.	Nanomaterials Chemistry Recent Developments and New Directions by C. N. R. Rao, Publisher: John Wiley & Sons (Asia) Pvt. Ltd.; 2007			

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4.	Nanophysics and Nanotechnology by Edward L. Wolf,Publisher: John Wiley & Sons (Asia) Pvt. Ltd.; 2008	
5.	Nanostructures: Tsakalakos, Ovidko & Vasudevan, Springer Science & Business Media; 2012	
URLs:		
1.	https://link.springer.com/chapter/10.1007/978-1-4419-6016-0_8	
2.	https://link.springer.com/chapter/10.1007/978-3-662-54357-3_1	
Lecture Plan (about 40-50 Lectures):		
Lecture No.	Topic	Remarks
1.	Introduction to Nano-manufacturing and Nanotechnology	
2.	Different Top-down and Bottom-up techniques, History of Nanotechnology	
3.	Nano materials, Nano Composites	
4.	Concept of Positional Assembly and Massive parallelism, self-assembly, self-assembled monolayer	
5.	Applications of Nanotechnology and Nanomanufacturing	
6.	Advantages and drawbacks of Nanotechnology and nanomanufacturing, Social, ethical and environmental impacts of Nanotechnology	
7.	Characterization Techniques: Scanning Electron Microscope Part-1	
8.	Scanning Electron Microscope part-2	
9.	Transmission Electron Microscope	
10.	Scanning Probe Microscope (SPM)	
11.	Atomic force microscopy (AFM)	
12.	Magnetic Force Microscope	
13.	Scanning Tunneling Microscope (STM)	
14.	X-ray diffraction technique (XRD)	
15.	Nano-lithography: Photolithography	
16.	UV Photolithography, X-ray Lithography	
17.	Electron Beam Lithography	
18.	Particle Beam Lithography's	
19.	Probe lithography's	
20.	Micro and Nano machining	
21.	Focused Ion beam machining	
22.	Chemical methods in Nano-manufacturing	
23.	Si processing methods	
24.	Cleaning /etching	
25.	Epitaxy, Molecular-beam epitaxy	
26.	chemical beam epitaxy	
27.	CVD, Metal-organic CVD (MOCVD)	
28.	Plasma enhanced CVD (PE-CVD)	
29.	Sol-gel Technique	
30.	Properties of Nano Materials	
31.	Application of Nano Materials	
32.	Fullerene Structure	

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33.	Carbon nano tubes and its advantags	
34.	Applications of CNTs	
35.	Nano Particles	
36.	Processing of Nanocomposites part-1	
37.	Processing of Nanocomposites part-2	
38.	Applications of Nano composites	
39.	Micro Electromechanical Systems (MEMS)	
40.	Nano Electromechanical Systems (NEMS)	

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

**MAULANA AZAD NATIONAL INSTITUTE OF
TECHNOLOGY, BHOPAL -**

Name of Program		B.Tech (Mechanical Engg.)	Semester: VII	Year: IV
Name of Course		Lean Manufacturing		
Course Code		ME24461		
Core / Elective / Other		Elective		
Prerequisite if any:				
1.	Engineering Management			
2.	Industrial Engineering and Operations Research			
Course Outcomes:				
1.	Students shall understand the distinction between Mass Production and Lean Manufacturing in industries.			
2.	Students shall be able to describe the value adding, non value adding activities/elements and types of waste with their elimination from production processes/ manufacturing systems			
3.	Students shall be able to identify and implement lean tools or techniques like continuous flow, pull systems, 5S, Visual Control, Kanban, TPM, JIT etc.			
Description of Contents in brief:				
Unit 1	Review of manufacturing paradigm, Objectives of lean manufacturing, Main Lean Principles and Wastes, traditional versus lean manufacturing characteristics, Value creation and waste elimination-major kinds of manufacturing waste, Toyota/Lean production system.			
Unit 2	Fundamentals of Kaizen, Just In Time (JIT) production system; Pull/flow production, cell layout, takt time, Jidoka, 5S (Five S) Japanese approach.			
Unit 3	Standardized work, Visual control, Level production, Kanban and replenishment strategies.			
Unit 4	Concept of Poka Yoke, Cross functional team & Total Productive Maintenance.			
Unit 5	Concept of Single-Minute Exchange of Die (SMED), Value stream mapping (VSM).			
Unit 6	Various case studies of implementation of lean manufacturing tools in the industries.			
List of Reference Books:				

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1.	E book: Lean Manufacturing Tools, Techniques; William M. Feld, The CRC press series on resource management, 2000.
2.	Ebook:Justin Time Factory Implementation ThroughLean Manufacturing Tools, Springer International Publishing AG, Susana GarridoAzevedo, KannanGovindan 2018
3.	E book: Value Stream Management for the Lean Office, Don Tapping and Tom Shuker ,CRC Press Taylor & Francis Group

URLs:

1.	http://microsoft.com/dynamics/ax (Lean Manufacturing: Kanban and Pull Based Manufacturing)
2.	http://www.qad.com , (Training Guide Lean Manufacturing)

Lecture Plan (about 40-50 Lectures):

Lecture No.	Topic
1	Craft Production, Mass Production/Ford System
2	Birth of Lean Production/The Toyota Production System
3	The Ultimate Goal and Benefits of Lean Manufacturing
4	Components of Lean Philosophy; waste elimination, simplicity, continuous improvement, visibility,flexibility
5	Culture of continuous improvement; Kaizen advantages
6	Kaizen and Deming Cycle for Continuous improvement
7	Basic image of Lean production , Customer Focus; PQCDSM
8	Lean Thinking Principals; Value & Waste Definition, Flow, Pull , Perfection
9	Muda explanation
10	Mura, and Muri explanation
11	Lean activities/ house of lean/lean tools-techniques
12	4M Stabilization for improvements at Gemba using visual management, 5S system, Standardized work and Total Productive Maintenance(TPM)
13	Visual Management systems-I (Cont.)
14	Visual Management systems-II
15	Standard Work: Documenting the Interaction between People and Their Environment
16	Elements of Standardized Work; Takt time and Cycle Time, Work sequence, In-process stock
17	Charts Used to Define Standardized Work; Production capacity chart, Standardized work combination table, Standardized work analysischart
18	5S System-I (Cont.)
19	5S System-II (Cont.)
20	5S System-III (Cont.)
21	Spaghetti plots & Layouts ; Fixed-position, Process , Product & Cellular or combination layout
22	Just-in-Time Production
23	Pull System of Manufacturing
24	One-Piece Flow and Cellular Manufacturing
25	Production leveling or heijunka
26	Multifunctional Workers

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27	Kanban a visual tool to achieve JIT production; Benefits; Forms/types
28	Kanban Rules
29	Design of kanban-I (Cont.)
30	Design of kanban-II (Cont.)
31	Total Productive Maintenance
32	Six Big Losses
33	Overall equipment effectiveness-I (Cont.)
34	Overall equipment effectiveness-II
35	Concept of ZishuHozen
36	Concept of Jidoka, Poka-Yoke & Andon
37	SMED based Case studies
38	Value Stream Mapping
39	Value Stream Mapping based Case study –I
40	Value Stream Mapping based Case study-II

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

**MAULANA AZAD NATIONAL INSTITUTE OF
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Name of Program		B.Tech (Mechanical Engg.)	Semester: VII	Year: IV
Name of Course		Composite Materials		
Course Code		ME24462		
Core / Elective / Other		Elective		
Prerequisite if any:				
1.	Basics of material science			
Course Outcomes:				
1.	Students will be able to apply knowledge of Metals, Composites their science and engineering involved, different fabrication methods available for the fabrication composite materials.			
2.	Students will be able to analysis the mechanical and tribological behavior of the composite Materials			
3.	One will be able to develop the varies components made of MMCs, PMCs,CMCs. For different applications.			
Description of Contents in brief:				
Unit 1.	Introduction, definition and classification of composite materials, Types of reinforcements, Criteria for the selection of the matrices and reinforcements Its Properties, Types of Matrix, Interfaces, Wettability Its importance and application.			
Unit 2.	Polymers and Polymer Matrix Composites and Metals and Metal Matrix Composites: Its Type like Lamina, Laminates, Sandwich concept of Isotropy, Anisotropy and Orthotropy in composites.			
Unit 3.	Processing of Composites: Primary and Secondary Manufacturing Process of metal matrix composites like star casting, ultrasonic assisted star casting, centrifugal casting, concept of bottom pouring, top pouring their advantages and limitations, Powder metallurgy technique, Iso-static Compaction method. Fabrication method of polymer matrix composites like Hand Lay-Up technique, Compression Molding technique and Autoclave technique. Its mechanical and Tribological properties characterization.			
Unit 4.	Introduction of Ceramics and ceramic matrix composites, Types of Ceramic matrix composites, Ceramic-metal systems, Ceramic glass system, Ceramic-ceramic systems and Fabrication of ceramic matrix composites, Its mechanical and Tribological properties characterization.			
Unit 5.	Concept of Macro-Mechanism and Micro-Mechanics of composites, Prediction of Density and Elastic Modulus of composites. Problems based on density and elastic modulus of composites. Economics of Composites and Reinforcements, Design of Composite Materials.			
Unit 6.	Applications of Composites in different Sectors like Automobile, Aerospace and Food Packaging Industries etc. Concept of Nano-Materials and Nano-Composites. Micro-electromechanical Systems [MEMS],Nano-electromechanical Systems [NEMS]			
List of Text Books:				
1.	An introduction to composite materials by D. Hull and T.W. Clyne, Cambridge, 2012			

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2.	Engineering mechanics of composite materials by Issac M. Daniel Ori Ishai, Oxford press, 2005	
3.	Composite Manufacturing: Materials, Product & Process Engineering by Sanjay K. Mazumdar, CRC press, 2002	
List of Reference Books:		
1.	Composite Materials by Lawrence J. Broutman, Academic press, 1974	
2.	Composite Materials by R.M. Jones, CRC press, 1998	
3.	Composite Materials: Science and Engineering by Krishnan K. Chawla, Springer, 1987	
URLs:		
1.	https://onlinelibrary.wiley.com/doi/epdf/10.1002/pol.1969.160071214	
2.	www.nptel.ac.in	
3.	https://www.springer.com/gp/book/9781493950157	
Lecture Plan (about 40-50 Lectures):		
*Lecture No.	Topic	Remarks
1.	Introduction, definition and classification of composite materials	
2.	Types of reinforcements	
3	Criteria for the selection of the matrices and reinforcements	
4	Its Properties, Types of Matrix and Reinforcements	
5	Role of Interfaces	
6	Wettability: Its importance and application, polymers	
7	Different types of Matrix and Reinforcements used	
8	Polymer Matrix Composites	
9	Metals and Metal Matrix Composites	
10	Type like Particulate, Lamina, Laminates, Sandwich	
11	Concept of Isotropy, Anisotropy and Orthotropy in Composites	
12	Processing of Composites: Primary and Secondary Manufacturing Process of metal matrix composites like stir casting, ultrasonic assisted stir casting	
13	Centrifugal casting, concept of bottom pouring, top pouring their advantages and limitations	
14	Powder metallurgy technique	
15	Iso-static compaction method	
16	Fabrication method of polymer matrix composites like Hand Lay-Up technique	
17	Compression Molding technique, Autoclave technique	
18	Mechanical and Tribological properties characterization	
19	Introduction of Ceramics, Ceramic matrix composites	
20	Types of Ceramic matrix and reinforcements	
21	Ceramic-Metal, Ceramic glass, Ceramic-Ceramic systems	
22	Fabrication of ceramic matrix composites	
23	Mechanical and Tribological properties characterization.	
24	Experimental demonstration of MMCs in the class	
25	Experimental demonstration of PMCs in the class	

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26	Experimental demonstration of CMCs in the class	
27	Concept of Macro-Mechanism in the composites	
28	Concept of Micro-Mechanics of composites	
29	Prediction of Density and Elastic Modulus of composites.	
30	Numerical problems	
31	Economics of Composites and Reinforcements	
32	Design of Composite Materials	
33	Applications of Composites in different Sectors like Automobile, Aerospace and Food Packaging Industries etc.	
34	Survey of different parts manufactured by Metal Matrix Composites, their fabrication and analysis	
35	Survey of different parts manufactured by Polymer Matrix Composites, their fabrication and analysis	
36	Survey of different parts manufactured by Ceramic Matrix Composites, their fabrication and analysis	
37	Concepts of Nano-Materials	
38	Applications of Nano-Materials	
39	Nano-Composites: Fabrication Techniques and Properties.	
40	Mechanical Properties of the Nano-composites	
41	Micro-Electro-Mechanical Systems [MEMS],	
42	Nano-Electro-Mechanical Systems [NEMS]	

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

**MAULANA AZAD NATIONAL INSTITUTE OF
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Name of Program	B.Tech (Mechanical Engg.)	Semester: VII	Year: IV
Name of Course	Smart Materials		
Course Code	ME24463		
Core / Elective / Other	Elective		
Prerequisite if any:			
1.	Materials Science and Engineering		
2.	Mechanics of Materials		
Course Outcomes:			
1.	Identify and classify smart material systems and recognize various characteristics and Applications		
2.	Select and design various smart material as actuator and sensor		
3.	Design smart material composites for various applications and explain their manufacturing processes		
4.	Explain previously developed models for various smart material systems and predict the behavior		
5.	Identify the applications of smart material systems in energy harvesting and self-healing systems		
Description of Contents in brief:			
Unit 1.	Overview and need of smart materials, Active and passive smartness, Traditional vs smart systems, Smart material actuators and sensors		
Unit 2.	Piezoelectric materials: Piezoelectric property, Constitutive relationships, Direct and converse piezoelectric effect, piezoelectric polymers, ceramics and composites, Bimorphs and Piezostacks, Piezoelectric coefficients, Active strain expression, Euler Bernoulli model, Uniform strain model, Piezo actuators and sensors.		
Unit 3.	Magnetostrictive materials: Magnetostriction, Magnetostrictive smart materials and transducers, Magnetostrictive effects in actuation and sensing, Constitutive equations. Induced strain actuation modelling of magnetostrictive actuators.		
Unit 4.	Shape memory materials: Shape memory effect (SME), Metallic alloys and polymers exhibiting SME, One-way shape memory effect, Pseudoelasticity, Two-way shape memory effect, Application of SM alloys in actuators, Forward and reverse transformation, R phase transformations, Constitutive models, Brinson Model		
Unit 5.	Composite Materials: Introduction to smart composites, critical issues in smart composites, Classification of composites and their manufacturing techniques, Laminated and sandwich composites, Micro and micromechanics of composites, ABD matrices.		
Unit 6	Smart Actuators and self-healing materials: Multilayered piezoelectric materials, Role in energy harvesting, Concept, strategies and design of self-healing.		
List of Text Books			
1.	I. Chopra and J. Sirohi, Smart structures theory, Cambridge University Press, 1 st Edition, 2013.		

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2.	V.K. Vardan, K.J. Vinoy, S. Gopalakrishnan, Smart Materials systems and MEMS: Design and development methodologies, John Wiley and Sons,1 st Edition, 2006.	
3.	J.L. Pons, Emerging Actuator Technologies, John Wiley and Sons, 1 st Edition, 2005.	
List of Reference Books:		
1.	J. Yang, An introduction to the theory of piezoelectricity, Springer, 1 st Edition, 2005	
2.	M.H. Elahinia, Shape memory alloy actuators, Wiley, 1 st Edition, 2016	
3.	K K Chawla, Composite Materials: Science and Engineering, Springer,3 rd Edition, 2012	
URLs:		
1.	https://nptel.ac.in/courses/112/104/112104251/	
Lecture Plan (about 40-50 Lectures):		
*Lecture No.	Topic	Remarks
1.	Introduction to the course, Overview and applications of smart Materials	L
2.	Features of smart materials, active and passive smartness, Traditional vs smart system, smart sensors and actuators	L
3.	History of piezoelectricity, Piezoelectric materials, piezoelectric actuator fabrication,	L
4.	Constitutive relationships, Piezoelectric polymers and ceramics processing	L
5.	Fundamental equations of Piezoelectricity, Piezoelectric Coefficients	L
6.	Different piezoelectric materials and properties, piezo-patch	L
7.	Active strain expression, Euler Bernoulli Model	L
8.	Uniform strain model of induced strain actuation, piezo actuators and sensors,	L
9.	Case study on piezoelectric sensors and actuators	L
10.	Examples and history of Magnetostriction, Effects of magnetostriction in actuation and sensing	L
11.	Constitutive equation for magnetostrictive materials, some Applications	L
12.	Induced strain actuation modelling of magnetostrictive Materials	L
13.	Blocking force for magnetostrictive mini actuator	L
14.	AFC and MFC	L
15.	Case studies on magnetostrictive sensors and actuators	L
16.	Shape memory effect, metallic alloys exhibiting SMA	L
17.	One way and two way SMA, Pseudoelasticity, Application of SMA	L
18.	Forward and reverse transformations, R phase transformations	L
19.	Constitutive models,	L
20.	Brinson model	L
21.	Applications of SMA	L
22.	Case studies on SMA sensors and actuators	L

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23.	Introduction to composites, smart composites, Classification of composites, examples and applications	L
24.	Fibres and their types, advantages of smart composites	L
25.	Composite manufacturing techniques for fibre reinforced composites, polymer matrix composites, metal matrix Composites	L
26.	Fabrication techniques for Ceramic matrix composites, carbon-carbon composites and structural composites	L
27.	Case studies on metal and polymer matrix composites	L
28.	Evaluation of volume, density, weight, longitudinal and transverse modulus of composite	L
29.	Halpin Tsai model	L
30.	Deformation stages of fiber reinforced composites, computation of strength of composite,	L
31.	Plane stress and plane strain conditions, Stress strain relationship in a Lamina	L
32.	Coordinate transformation of stress and strain	L
33.	Strain displacement relations in laminated composites and stress in a lamina	L
34.	Laminate stiffness and compliance, Introduction to ABD Matrices	L
35.	Case study on smart composites	L
36.	Multilayered piezo electric materials, Self-healing systems	L
37.	Energy harvesting, Design of piezoelectric energy harvester, concept of a basic energy harvester system	L

Evaluation Criteria:

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

**MAULANA AZAD NATIONAL INSTITUTE OF
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Name of Program		B.Tech (Mechanical Engg.)	Semester: VII	Year: IV
Name of Course		Sustainable Supply Chain Management		
Course Code		ME24464		
Core / Elective / Other		Elective		
Prerequisite: None				
Course Outcomes:				
1.	To learn about supply chain and logistics from different perspective & understand the impact of logistics and supply chain on the environment.			
2.	To understand why the traditional logistic and supply chain needs to be responsible for the product throughout its life cycle.			
3.	To identify the scope of reuse and recycling to make the manufacturing process environmentally sustainable.			
Description of Contents in brief:				
1.	Introduction of Supply Chain, Decision Phases in Supply chain,Green issues in Inbound & Outbound Logistics.			
2.	Network Design & Reverse Logistics,Traditional Network Design,Sustainable Network Design, Closed Loop Supply Chain, Circular economy.			
3.	Sustainability in supply chain and environmental legislations, Sustainable Development Goals, Triple bottom line, Carbon foot print, Lifecycle Analysis,			
4.	Sustainable Transportation, Environmental effects of freight transport mode, Greener transportation modes, Optimization of routing of vehicles, Increase the Fuel Efficiency of Road Freight			
5.	Sustainable Design and manufacturing,Eco Design,Sustainable packagig,Sustainable disposal Sustainable warehousing,Sustainable manufacturing,			
6.	Sustainable multi-tier supplier management,Sustainable multi-tier supplier management,Sustainable Procurement,Sustainable supplier development,Sustainable performance measurement			
7.	Role of government in promoting green logistics,Role of government in promoting green logistics Sustainable policies,Environmental standards & Green CSR activities, Sustainable Incentives			

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List of Text Books:	
1.	McKinnon, A. Browne, M. Whiteing, A. (2015). Green Logistics: improving the environmental sustainability of logistics. (3rd edn). London: Kogan Page.
2.	Chopra and Mandle, "Supply chain management" Pearson publication
List of Reference Books:	
1.	Womack, James and Jones, Daniel. "Lean Thinking: Banish Waste and Create Wealth in Your Corporation, Revised and Updated". Free Press (a division of Simon & Schuster), 2003.
2.	Palevich, Robert. "The Lean Sustainable Supply Chain: How to Create a Green Infrastructure with Lean Technologies". FT Press, 2012

Lecture Plan

Lecture Number	Description of Topic
1.	Introduction of Supply Chain
2.	Introduction of Supply Chain
3.	Decision Phases in Supply chain
4.	Decision Phases in Supply chain
5.	Closed Loop Supply Chain
6.	Green issues in Inbound & Outbound Logistics
7.	Green issues in Inbound & Outbound Logistics
8.	Network Design & Reverse Logistics
9.	Network Design & Reverse Logistics
10.	Traditional Network Design
11.	Traditional Network Design
12.	Sustainable Network Design
13.	Sustainable Network Design
14.	Sustainable Network Design
15.	Closed Loop Supply Chain network design
16.	Circular economy
17.	Circular economy
18.	Sustainability in supply chain and environmental legislations
19.	Sustainable Development Goals
20.	Triple bottom line
21.	Carbon foot print
22.	Lifecycle Analysis
23.	Sustainable Transportation
24.	Environmental effects of freight transport mode
25.	Greener transportation modes
26.	Optimization of routing of vehicles
27.	Increase the Fuel Efficiency of Road Freight
28.	Sustainable Design and manufacturing
29.	Eco Design,
30.	Sustainable packaging
31.	Sustainable disposal
32.	Sustainable warehousing
33.	Sustainable manufacturing
34.	Sustainable multi-tier supplier management
35.	Sustainable multi-tier supplier management

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36.	Sustainable Procurement
37.	Sustainable supplier development
38.	Sustainable performance measurement
39.	Role of government in promoting green logistics
40.	Role of government in promoting green logistics Sustainable policies
41.	Interpretation and Analysis of Financial Statements
42.	Environmental standards & Green CSR activities
43.	Sustainable Incentives
44.	Revision of course

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester: VII	Year: IV
Name of Course		Accounts and Financial Planning		
Course Code		ME24465		
Core / Elective / Other		Elective		
Prerequisite if any:				
1.	None			
Course Outcomes:				
1.	The students will learn the basic fundamentals and overview of Financial Management.			
2.	The students shall be able to read and interpret various financial documents/reports.			
3.	The students shall be able to learn the fundamentals of accounting.			
Description of Contents in brief:				
Unit 1.	Financial management-an overview, Financial decisions in the firms, the fundamental principles of finance, goals of financial management, building blocks of modern finance.Risk-return trade off, Organization of finance functions, Emerging role of financial managers' in India, Over view of financial statements – Income statement, Balance Sheet, Cash flow statement, Analysis of financial statements			
Unit 2.	Financial Planning & forecasting, Tools & techniques of Financial Planning & Forecasting, Sources of finance.Time Value of Money, Future value of a single amount, Present value of a single amount, Future value of Annuity, Present value of Annuity & Perpetuity			
Unit 3.	Capital Budgeting –Concept and overview, Capital budgeting process, Project classification, Techniques of capital budgeting, Investment criteria Net present value, internal rate of return, Modified Internal rate of return, Benefit cost ratio, Payback period method			
Unit 4.	Introduction and Scope of Accounting ,Financial Statements,Profit and Loss Account,Depreciation,Inventory Valuation			
Unit 5.	Cash Flow Statement,Corporate Governance, Corporate Governance: Global Models,Accounting Standards and Principles ,Evolution of Accounting			
Unit 6.	Recording of Financial Transactions,Interpretation and Analysis of Financial Statements,Ratio Analysis and Interpretation			
List of Text Books:				
1.	Financial management for Managers Prof. Anil K.Sharma			
2.	Financial Accounting Professor V. Bapat			
List of Reference Books:				
1.	Financial management: Theory and practices by Prasanna Chandra : McGraw hills.			
2.	Financial management: Text, Problem and cases M.Y Khan, P.K. Jain : McGraw hills.			
URLs:				
1.	https://nptel.ac.in/courses/110106135			
2.	https://nptel.ac.in/courses/110101131			
3.	https://nptel.ac.in/courses/110107144			

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Lecture Plan

Lecture Number	Description of Topic
1.	Fundamentals of Financial Management
2.	Fundamentals of Financial Management
3.	Financial Planning and Forecasting
4.	Time Value of Money
5.	Time Value of Money
6.	Capital Budgeting
7.	Capital Budgeting
8.	Estimation of Project Cash Flows
9.	Estimation of Project Cash Flows
10.	Risk Analysis in Capital Budgeting
11.	Cost of Capital
12.	Cost of Capital
13.	Capital Structure
14.	Capital Structure
15.	Dividend Decisions
16.	Dividend Decisions
17.	Revision FM
18.	Revision FM
19.	Introduction and Scope of Accounting
20.	Introduction and Scope of Accounting
21.	Introduction and Scope of Accounting
22.	Financial Statements
23.	Financial Statements
24.	Balance Sheet
25.	Balance Sheet
26.	Profit and Loss Account
27.	Profit and Loss Account
28.	Profit and Loss Account
29.	Depreciation
30.	Depreciation
31.	Depreciation
32.	Inventory Valuation
33.	Cash Flow Statement
34.	Corporate Governance
35.	Corporate Governance: Global Models
36.	Corporate Governance: Enron Case
37.	Accounting Standards and Principles
38.	Evolution of Accounting
39.	Recording of Financial Transactions
40.	Interpretation and Analysis of Financial Statements
41.	Ratio Analysis and Interpretation 1
42.	Financial Statement Analysis
43.	Revision of Accounting Course

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Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester: VII	Year: IV
Name of Course		Organisational Behaviour		
Course Code		ME24466		
Core / Elective / Other		Elective		
Prerequisite if any:				
1.	B.Tech Mechanical VI Semester			
Course Outcomes:				
CO1	Enables to understand Foundations of Organizational Behavior			
CO2	Enables to understand Work Motivation			
CO3	Enables to understand Management			
CO4	Enables to understand planning			
CO5	Enables to understand organizing			
CO6	Enables to understand controlling			
CO7	Enables to understand Group Behavior			
CO8	Enables to understand Leadership			
CO9	Enables to understand Organization culture and Organizational Change			
Description of Contents in brief:				
Unit 1.	Management: Nature, purpose and scope of management, Skills and roles of a Manager, Functions, Development of Management Theories (Classical, Neo-Classical and Modern).			
Unit 2.	Planning: Types of plans, Levels of planning, planning process, Management by objectives, Strategic Management, premising and forecasting; Decision-Making process, barriers, styles of decision making.			
Unit 3.	Organizing: Organizational design and structure, Coordination, centralization and de-centralization, Delegation, Authority & power – concept & distinction, Line and staff organizations.			
Unit 4.	Controlling: Concept, planning-control relationship, process of control, Types of Control, Control Techniques, Staffing: Human Resource Management and Selection.			
Unit 5.	Foundations of Organisational Behaviour: The nature and determinants of organisational behaviour, need for knowledge of OB, contributing disciplines to the field, OB Model.			
Unit 6.	Individual differences, Learning, Values, attitudes, Personality (MBTI, Big Five Model), Emotions, Affective events theory, Emotional Intelligence, Perception, Attribution theory.			
Unit 7.	Group Behaviour: Types of Groups, Stages of Group Development, Group Decision Making, Understanding Teamwork: Types of Teams, Creating Effective teams, Communication: significance, types, barriers, overcoming barriers. Leadership: Basic Approaches & Contemporary Issues in Leadership. Conflict: levels of conflict, resolving conflicts; power and politics: sources of power, use of			

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	power.	
List of Text Books:		
S.No	Title of Book	Author, publication year and publisher
24.	Organisation Behavior	Ashwathappa K
25.	Organisational Behaviour	Luthans F
26.	Organisational Behaviour	Robbins S P, Timothy A. Judge
27.	Organisational Behavior	Aquinas PG
List of Reference Books:		
S.No	Title of Book	Author, publication year and publisher
1.	Organizational Behavior: Human Behavior at Work	John W. Newstrom
2.	The Human Side of Enterprise	Douglas McGregor
URLs:		
1.	https://nptel.ac.in	
2.	www.citehr.com	
3.	https://www.slideshare.net/rajasshrie1/chapter-1-ob-38248150	
Lecture Plan (about 40-50 Lectures):		
*Lecture No.	Topic	Remarks
1	Management: Nature, purpose and scope of management	
2	Skills and roles of a Manager	
3	Functions, Development of Management Theories (Classical, Neo-Classical and Modern)	
4	Planning: Types of plans	
5	Levels of planning, planning process	
6	Management by objectives	
7	Strategic Management, premising and forecasting	
8	Decision-Making process, barriers, styles of decision making	
9	Organizing: Organizational design and structure	
10	Coordination, centralization and de-centralization	
11	Delegation, Authority & power – concept & distinction	
12	Line and staff organizations	
13	Controlling: Concept, planning-control relationship	
14	process of control, Types of Control	
15	Control Techniques	
16	Staffing: Human Resource Management and Selection	
17	Foundations of Organisational Behaviour	
18	The nature and determinants of organisational behaviour	
19	need for knowledge of OB	
20	contributing disciplines to the field	
21	OB Model	

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22	Individual differences, Learning, Values, attitudes	
23	Emotional Intelligence, Perception	
24	Personality (MBTI, Big Five Model)	
25	Emotions, Affective events theory	
26	Attribution theory	
27	Application of Motivation Theories & workers participation Management	
28	Case Studies	
29	Group Behaviour: Types of Groups	
30	Stages of Group Development	
31	Group Decision Making	
32	Understanding Teamwork: Types of Teams	
33	Creating Effective teams	
34	Communication: significance, types, barriers, overcoming barriers.	
35	Leadership: Basic Approaches (Trait Theories, Behavioural Theories & Contingency Theories)	
36	Contemporary Issues in Leadership	
37	Conflict: levels of conflict, resolving conflicts; power and politics: sources of power, use of power	
38	Organisation culture and Organisational Change	
39	Effects of culture	
40	changing Organisational culture forces of change	
41	Resistance to change, the change process.	
42	Case studies	

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program	B.Tech (Mechanical Engg.)	Semester: VII	Year: IV
Name of Course	Total Quality Management		
Course Code	ME24467		
Core / Elective / Other	Elective		
Prerequisite if any:			
1.			
2.			
Course Outcomes:			
1.	Prioritize quality goals based on customer expectations and competition.		
2.	Identify improvement areas based on cost of poor quality.		
3.	Organize for quality and development of quality culture through small group activities.		
Description of Contents in brief:			
Unit 1.	UNIT -I INTRODUCTION Introduction, Need for quality, Evolution of quality, Definitions of quality, Dimensions of product and service quality, Basic concepts of TQM, TQM Framework, Contributions of Deming, Juran and Crosby, Customer focus, Customer orientation, Customer satisfaction, Customer complaints, Customer retention, Costs of quality.		
Unit 2.	UNIT- II TQM PRINCIPLES Leadership, Strategic quality planning, Quality Councils, Employee involvement, Motivation, Empowerment, Team and Teamwork, Quality circles Recognition and Reward, Performance appraisal, Continuous process improvement, PDCA cycle, 5S, Kaizen.		
Unit 3.	UNIT- III TQM TOOLS AND TECHNIQUES I The seven traditional tools of quality, New management tools, Methodology, applications to manufacturing and service sector including IT, Bench marking, Reason to bench mark, Bench marking process, FMEA and FTA.		
Unit 4.	UNIT- IV TQM TOOLS AND TECHNIQUES II Control Charts, Process Capability, Concepts of Six Sigma, Quality Function Development (QFD), Taguchi quality loss function, TPM Concepts, Performance measures.		
Unit 5.	UNIT- V QUALITY MANAGEMENT SYSTEMS Need for ISO 9000, ISO 9001-2008 Quality System, Elements, Documentation, Quality Auditing, QS 9000, ISO 14000, Concepts, Requirements and Benefits, TQM Implementation in manufacturing and service sectors.		
List of Text Books:			
1.	Total Quality Management by Dale H. Besterfield		

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2.	Total Quality Management by John S. Oakland, Butterworth - Heinemann	
3.	Total Quality Management by Suganthi L. , Anand Samuel	
List of Reference Books:		
1.	Total Quality Management by Janakiraman B. R.K. Gopal	
2.	Total Quality Management by Girish Pathak	
3.	Total Quality Management by P.N. Mukherjee	
URLs:		
1.	www.swayam.gov.in	
2.	www.nptel.ac.in	
Lecture Plan (about 40-50 Lectures):		
*Lecture No.	Topic	Remarks
1.	Introduction of TQM	
2.	Introduction of TQM	
3.	Need for quality	
4.	Need for quality and various definition of quality	
5.	Evolution of quality,	
6.	Dimensions of product and service quality	
7.	Basic concepts of TQM	
8	TQM Framework	
9.	Contributions of Deming, Juran and Crosby	
10.	Contributions of Deming, Juran and Crosby	
11.	Customer focus	
12.	Customer orientation	
13.	Customer satisfaction	
14.	Customer complaints, Customer retention, Costs of quality.	
15.	Leadership	
16.	Strategic quality planning	
17.	Quality Councils	
18.	Quality circles Recognition and Reward,	
19.	Employee involvement	
20.	Motivation, Empowerment, Team and Teamwork	
21.	Performance appraisal, Continuous process improvement, PDCA cycle, 5S, Kaizen.	
22.	The seven traditional tools of quality	
23.	New management tools, Methodology	
24.	Applications to manufacturing and service sector including IT	
25.	Bench marking	
26.	Reason to bench mark, Bench marking process	
27.	FMEA and FTA	
28.	FMEA and FTA	
29.	Control Charts	

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30.	Process Capability	
31.	Concepts of Six Sigma	
32.	Quality Function Development (QFD)	
33.	Taguchi quality loss function, TPM Concepts, Performance Measures	
34.	Taguchi quality loss function, TPM Concepts, Performance Measures	
35.	Need for ISO 9000	
36.	ISO 9001-2008 Quality System	
37.	Elements, Documentation, Quality Auditing	
38.	QS 9000, ISO 14000	
39.	Concepts, Requirements and Benefits	
40.	TQM Implementation in manufacturing and service sectors	
41.	TQM Implementation in manufacturing and service sectors	
42.	TQM Implementation in manufacturing and service sectors	

***Min 48 (for four credit course)**

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
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Name of Program		B.Tech (Mechanical Engg.)	Semester: VII	Year: IV
Name of Course		Marketing Management		
Course Code		ME24468		
Core / Elective / Other		Elective		
Prerequisite if any:				
1.	B.Tech Mechanical VI Semester			
Course Outcomes:				
CO1	Enables to understand Marketing Scope and Concepts, marketing			
CO2	Enables to understanding the market place and consumers.			
CO3	Enables to understand Consumer markets and consumer buyer Behaviour			
CO4	Enables to understand Integrated Marketing Communication			
CO5	Enables to understand Sustainable marketing			
Description of Contents in brief:				
Unit 1.	Introduction of Marketing management, Scope and Concepts, marketing: creating and capturing customer value, partnering to build customer relationship. Understanding the market place and consumers: analysing the marketing environment, managing marketing information to gain customer insight			
Unit 2.	Consumer markets and consumer buyer Behaviour, business markets and business buyer Behaviour. Designing a customer driven strategy, creating value for target customer, products.			
Unit 3.	Services and brands, building customer value, new product development and product life. Managing Marketing Channels, Logistics and Supply Chain Management, Retailing and Wholesaling			
Unit 4.	Integrated Marketing Communication, Sales Promotions, Advertising and Public Relations, Sales Management, Personal Selling, Direct and online Marketing. Sustainable marketing, Social Responsibility and Ethics.			
Unit 5.	Marketing Evaluation and Control, Marketing of services. Recent concepts in Marketing, Global Marketing Strategies for Indian Firms, Digital marketing.			
List of Text Books:				
S.No	Title of Book	Author, publication year and publisher		
1.	Marketing Management	Philip kotler		
2.	Marketing Management	Rajan Saxena		
3.	Marketing Management	SHH Kazmi		
4.	StrategicMarketingManagement	AlexanderChernev		
5.	PrinciplesofMarketing	GaryArmstrongandPhilipKotler		
List of Reference Books:				
S.No	Title of Book	Author, publication year and publisher		
1.	Marketing Management	Ramasamy & Namakumari		
2.	Marketing Management	S. Jayachandran		
URLs:				

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1.	https://nptel.ac.in	
2.	http://www.netmba.com/marketing/concept/	
3.	http://www.jimnovo.com/Relationship-Marketing-more.htm	
4.	http://www.realinnovation.com/content/c081103a.asp	
Lecture Plan (about 40-50 Lectures):		
*Lecture No.	Topic	Remarks
1.	Introduction of Marketing management	
2.	Scope and Concepts, marketing	
3.	Scope and Concepts, marketing	
4.	creating and capturing customer value	
5.	partnering to build customer relationship	
6.	Understanding the market place	
7.	Understanding the consumers	
8.	analysing the marketing environment	
9.	managing marketing information to gain customer insight	
10.	managing marketing information to gain customer insight	
11.	Consumer markets	
12.	consumer buyer Behaviour	
13.	business markets	
14.	business buyer Behaviour	
15.	Designing a customer driven strategy and mix	
16.	creating value for target customer, products,	
17.	services and brands, building customer values	
18.	new product development	
19.	product life cycle strategies	
20.	Services and brands	
21.	building customer value	
22.	new product development	
23.	product life	
24.	Managing Marketing Channels	
25.	Logistics and Supply Chain Management	
26.	Retailing and Wholesaling	
27.	Integrated Marketing Communication	
28.	Sales Promotions	
29.	Advertising and Public Relations	
30.	Sales Management	
31.	Personal Selling	
32.	Direct and online Marketing	
33.	Sustainable marketing	
34.	Social Responsibility and Ethics	
35.	Marketing Evaluation and Control	
36.	Marketing of services	

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37.	Recent concepts in Marketing	
38.	Global Marketing Strategies for Indian Firms	
39.	Digital marketing	
40.	Digital marketing	
41.	Digital marketing	

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program	B.Tech (Mechanical Engg.)	Semester: VII	Year: IV
Name of Course	CAD/CAM		
Course Code	ME24469		
Core / Elective / Other	Elective		
Prerequisite if any: NIL			
Course Outcomes:			
1.	Understand the basic concepts of CAD/CAM and apply geometric transformations in CAD		
2.	Develop mathematical models to represent curves and surfaces		
3.	Model typical components using solid modelling techniques for design		
4.	Develop part programs for typical components		
5.	Understand the elements of the CAM environment		
Description of Contents in brief:			
Unit 1.	The design process, Product life cycle, Overview of computer aided design and manufacturing (CAD/CAM), Hardware and software requirements in CAD/CAM, Introduction to geometric representation- Implicit, explicit and parametric equations, Transformations in 2D and 3D		
Unit 2.	Wire Frame entities, Representation of curves: Non parametric and parametric. Synthetic curves: Hermite cubic spline, Bezier curves and B-Spline curves, Surface modeling: Plane surface, Ruled surface, Surface of revolution, Tabulated cylinder, Hermite Bi-cubic surface, Bezier surface, B-spline surface		
Unit 3.	Representation of solids: Topology of surfaces, Euler and modified form of equations, Representations: Quadtree, Octree, Halfspace, Boundary representation (B-Rep), Constructive solid geometry (CSG), Boolean operations in 2D- set membership classification, Union, Difference and Intersection		
Unit 4.	An Overview, classification and components of CNC Machines, Part programming fundamentals, Process planning, Axes selection, Tool selection, Steps involved in development of part program, Job and tool set up planning, Machining path planning, Manual part programming methods, Preparatory functions: G- Codes, Miscellaneous Functions: M Codes, Tool length and cutter radius compensations, Writing part programs for typical components: Milling, Turning, etc., Canned cycles, Automatically programmed tool (APT), Geometry statements, Motion statements, Post processor statements, Auxiliary statements, Writing complete part programs for typical components with APT		
Unit 5.	Introduction to group technology, Part classification & coding systems: OPITZ coding, Production flow analysis. Computer aided process planning (CAPP): Introduction to CAPP, Variant & generative methods of CAPP, Flexible manufacturing system (FMS): Components of FMS, FMS equipment & control, FMS case studies, Terminology in quality control (QC), the computer in QC, Contact inspection methods, Non-contact inspection methods, computer aided (CA) testing, Integration of CAQC with CAD/CAM		
List of Text Books:			
1.	D. F. Rogers and J. A. Adams, Mathematical Elements for Computer Graphics,		

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	McGraw Hill, 2002.
2.	Grover M. P. and Zimmers E.W. "CAD/CAM: Computer Aided Design and Manufacturing", Prentice Hall of India, 2010.
3.	I. Zeid, CAD/CAM Theory and Practice, Tata McGraw Hill, 2006

List of Reference Books:

1.	T.C. Chang, R.A. Wysk, H.P. Wang "Computer Aided Manufacturing", 3rd Edition, Pearson Prentice Hall, 2006.
2.	M. E. Mortenson, Geometric Modeling, John Wiley & Sons, 1985.
3.	P.N. Rao, "CAD/CAM Principles and Applications", 3rd Edition, Tata McGraw Hill, New Delhi, 2010.

URLs:

1.	https://nptel.ac.in/courses/112/102/112102101/
2.	https://nptel.ac.in/courses/112/102/112102103/
3.	https://nptel.ac.in/courses/112/104/112104031/

Lecture Plan (about 40-50 Lectures):

*Lecture No.	Topic	Remarks
1.	The Design Process	
2.	Product Life Cycle	
3.	Overview of CAD/CAM, Hardware and software requirements in CAD/CAM	
4.	Introduction to geometric representation- Implicit, explicit	
5.	Introduction to geometric representation- Parametric equations	
6.	Transformations in 2D	
7.	Transformations in 3D	
8.	Wire Frame entities, Representation of Curves: Non parametric and parametric	
9.	Synthetic Curves: Hermite Cubic spline	
10.	Bezier Curves	
11.	B-Spline Curves	
12.	Surface Modeling: Plane Surface, Ruled Surface	
13.	Surface of Revolution, Tabulated Cylinder	
14.	Hermite Bi-cubic Surface	
15.	Bezier Surface	
16.	B- Spline Surface	
17.	Representation of solids: Topology of surfaces, Euler and modified form of equations	
18.	Representations: Quadtree, Octree, Halfspace	
19.	Boundary Representation (B-Rep), Constructive Solid Geometry (CSG)	
20.	Boolean operations in 2D- set membership classification, Union, Difference and Intersection	
21.	An Overview, classification and components of CNC machines	
22.	CNC Programming: Part programming fundamentals	
23.	Process planning, Axes selection, Tool selection	
24.	Steps involved in Development of Part Program	

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25.	Job and Tool Set up Planning, Machining path planning	
26.	Manual Part Programming: Manual part programming Methods	
27.	Preparatory functions: G- Codes, Miscellaneous Functions: M Codes	
28.	Tool length and Cutter radius compensation	
29.	Writing Part programs for typical components: Milling,	
30.	Writing Part programs for typical components: Turning, etc.	
31.	Canned cycles	
32.	Automatically Programmed Tool (APT)	
33.	Geometry statements	
34.	Motion statements	
35.	Post processor statements, Auxiliary statements	
36.	Writing complete Part programs for typical components with APT	
37.	Group Technology: Introduction to Group technology	
38.	Part classification & coding systems	
39.	OPITZ coding	
40.	Production flow analysis	
41.	Computer Aided Process Planning (CAPP): Introduction to CAPP	
42.	Variant & Generative methods of CAPP	
43.	Flexible Manufacturing System (FMS) : Components of FMS	
44.	FMS equipment & control	
45.	FMS case studies	
46.	Terminology in quality control (QC)	
47.	contact inspection methods	
48.	Non-contact inspection methods	
49.	computer aided (CA) testing	
50.	integration of CAQC with CAD/CAM	

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program	B.Tech (Mechanical Engg.)	Semester: VII	Year: IV
Name of Course	Advanced Operations Research		
Course Code	ME24470		
Core / Elective / Other	Elective		
Prerequisite if any:			
1.	Operations Research		
Course Outcomes:			
1.	Analyse and synthesis the linear programming problem and non linear Problems		
2.	Simulate the optimization problems and Develop decision making skills		
3.	Understanding goal programming and dynamic programming methods		
Description of Contents in brief:			
Unit 1.	Introduction of LP, Simplex Problem, Duality in Linear Programming, Dual Simplex Method, Revised Simplex Method, Sensitivity analysis,		
Unit 2.	Special Cases of Assignment Problem, Transportation Problem and Optimality Test, Transshipment Problem,		
Unit 3.	Integer Linear Programming, Branch and Bound Method, Goal Programming,		
Unit 4.	Decision Analysis: Decision Trees, Sequencing Problem		
Unit 5.	Simulation, Monte-Carlo Method, Dynamic Programming,		
Unit 6	Non-Linear Programming, Game Theory, Multi Criteria Decision Making Tools		
List of Text Books:			
1.	Introduction to Operations Research, by Frederick S. Hillier and Gerald J. Lieberman, Tata McGraw Hill, New York.		
2.	Operations Research: An Introduction, by Hamdy A. Taha, Prentice-Hall, New York.		
3.	Operations Research by Heera & Gupta, S Chand Publications		
List of Reference Books:			
1.	Operations Research: Applications and Algorithms, Winston, W. L.Duxbury Press, Belmont		
2.	Operations Research by Ravindran and Phillip; Wiley publication		
3.	Quantitative Techniques in Management by N D Vohra; McGraw Hill Education		
URLs:			
1.	https://nptel.ac.in/courses/112/106/112106134/		
2.	https://freevideolectures.com/course/2365/fundamentals-of-operations-research		
3.	http://www.nptelvideos.in/2012/12/fundamentals-of-operations-research.html		

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Lecture Plan (about 40-50 Lectures):		
*Lecture No.	Topic	Remarks
1.	Introduction of advanced OR	
2.	Scope of LP	
3	Limitation of LP	
4	Simplex Problem,	
5	Simplex Problem	
6	Simplex Problem	
7	Duality in Linear Programming, ,	
8	Dual Simplex Method,	
9	Revised Simplex Method,	
10	Revised Simplex Method,	
11	Sensitivity analysis	
12	Sensitivity analysis	
13	Special Cases of Assignment Problem	
14	Special Cases of Assignment Problem,	
15	Transportation Problem	
16	Transportation Problem	
17	Optimality Test,	
18	Optimality Test,	
19	Transshipment Problem	
20	Transshipment Problem	
21	Integer Linear Programming,	
22	Branch and Bound Method,	
23	Goal Programming	
24	Goal Programming	
25	Goal Programming	
26	Decision Analysis	
27	Decision Analysis	
28	Decision Trees	
29	Decision Trees	
30	Sequencing problem	
31	Sequencing problem	
32	Simulation,	
33	Monte-Carlo Method,	
34	Dynamic Programming	
35	Dynamic Programming	
36	Dynamic Programming	
37	Non-Linear Programming,	
38	Non-Linear Programming,	
39	Game Theory	
40	Game Theory	
41	Multi Criteria Decision Making Tools	
42	Multi Criteria Decision Making Tools	

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Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester: VII	Year: IV
Name of Course		Industrial Tribology		
Course Code		ME24471		
Core / Elective / Other		Elective		
Prerequisite if any:				
1.	Nil			
Course Outcomes:				
1.	To enable students to understand wear characteristics of tribological joints			
2.	To enable students to design and analyze tribological systems			
3.	To enable students to understand lubrication properties at different temperatures			
Description of Contents in brief:				
Unit 1.	Introduction: Surface interactions, science of rubbing surface, wear rate, modelling and solution of simple problems. Material properties influencing interactions:			
Unit 2.	Introduction, elastic properties, plastic deformation properties, relation between the strength and other properties of solids, chemical reactivity of surfaces, absorbed surface layer, surface energy, relation between surface energy and hardness, surface interfacial energies of solids under engineering condition.			
Unit 3.	Surface Interaction: Size of real contact area and effect of surface energy, size of junction, rheological properties. Wear in tribological joints - classification, calculation methods with allowance for stiffness, wear limits, reliability of joints, simple examples			
Unit 4.	Friction: Introduction, laws, function, properties of uncontaminated metals in air, outgassed metal surface, calculation of flash temperature using surface energy, stick-slip and its prevention.			
Unit 5.	Quantitative expression for abrasive wear, of hardness and particle size on abrasive wear rate, surface fatigue wear, brittle fracture wear, corrosive wear with types.			
Unit 6	Lubrication: Solid film lubrication, boundary lubrication with single and multiple penetration model, properties of lubricants, effectiveness of lubrication-intermediate temperature, behaviour of a solid lubrication below melting point effect of speed, load on lubrication			
List of Text Books:				
1.	A. Cameron, "Basic Lubrication Theory", John Wiley and Sons, 1981			
2.	E. Rabinwicz, "Friction and wear of Materials", Wiley, 1995			
3.	L. Higgens , "Maintenance Engg. Hand Book", McGraw Hill, 2001			
List of Reference Books:				
1.	Theomang, "Industrial Lubrication", Wiley, 2010.			
2.	Gegner, J, Tribology Fundamentals and Advancements, INTECH, 2014.			
URLs:				
1.	https://nptel.ac.in/courses/112/102/112102015/			
Lecture Plan (about 40-50 Lectures):				
*Lecture No.	Topic			Remarks
1.	Overview of Tribology and relevance to industry			

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2.	Surface interactions, science of rubbing surface	
3	wear rate, modelling and solution of simple problems	
4	wear rate, modelling and solution of simple problems	
5	Material properties influencing interactions	
6	Material properties influencing interactions	
7	elastic properties, plastic deformation properties	
8	relation between the strength and other properties of solids	
9	chemical reactivity of surfaces	
10	absorbed surface layer, surface energy	
11	relation between surface energy and hardness	
12	surface interfacial energies of solids under engineering condition	
13	MINI TEST	
14	Surface Interaction: Size of real contact area and effect of surface energy	
15	size of junction, rheological properties	
16	Wear in tribological joints – classification	
17	calculation methods with allowance for stiffness	
18	wear limits, reliability of joints, simple examples	
19	wear limits, reliability of joints, simple examples	
20	Friction: Introduction, laws	
21	function, properties of uncontaminated metals in air	
22	outgassed metal surface	
23	calculation of flash temperature using surface energy	
24	stic-slip and its prevention	
26	stic-slip and its prevention	
27	Quantitative expression for abrasive wear, of hardness and particle size on abrasive wear rate	
28		
29		
30	surface fatigue wear, brittle fracture wear, corrosive wear with types.	
31		
32	Lubrication: Solid film lubrication	
33	boundary lubrication with single and multiple penetration model	
34	properties of lubricants	
35	effectiveness of lubrication-intermediate temperature	
36	behaviour of a solid lubrication below melting point	
37	effect of speed, load on lubrication	
38	Calculations and models for the above	

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Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program	B.Tech (Mechanical Engg.)	Semester: VII	Year: IV
Name of Course	Mechanics of Composite Materials		
Course Code	ME24472		
Core / Elective / Other	Elective		
Prerequisite if any:			
1.			
Course Outcomes:			
1.	Students will be able to predict the elastic properties of both long and short fiber composites based on the constituent properties.		
2.	Students will be able to predict the failure strength of a laminated composite plate.		
3.	Students will be able to analyze a laminated plate in bending, including finding laminate properties from lamina properties and find residual stresses from curing and moisture.		
Description of Contents in brief:			
Unit 1.	Definition of composite material, fiber, matrix, types of fibers and raw fiber properties, types of matrix, prepegs, fillers and other additives, advantages and applications, composite materials and structures, applications and use of composite materials in present world		
Unit 2.	Basics of composites, mechanical behavior, lamina, laminate, the basic building block of a composite material		
Unit 3.	Micromechanical analysis of composite strength and stiffness, properties and typical composite materials, volume and weight fractions, longitudinal strength and stiffness, traverse modulus, in-plane shear modulus, poisson ratio.		
Unit 4.	Elastic properties of unidirectional lamina, stress-strain relationships, engineering constants, stress strain relations of a thin lamina, examples.		
Unit 5.	Analysis of laminated composites, laminates, basic assumptions, strain displacement relationship, stress-strain relationships, equilibrium, equations, laminate stiffness, determination of lamina stresses and strains, types of laminate configuration, balanced laminate, anti-symmetric laminate, examples, multi channel integration, look at the big picture wireless applications		
Unit 6.	Failure theories: micromechanics of failure of unidirectional lamina, anisotropic strength and failure theories, importance of shear strength, choice of failure criteria, examples.		
List of Text Books:			
1.	Madhujit Mukhopadhyay , Mechanics of Composite Materials and Structures , Orient Blackswan, 2010		
2.	R M Jones , Mechanics of Composite Materials , CRC Press, 2015		
3.	Agarwal, B.D., and Broutman, L.J., “Analysis and Performance of Fibre Composites”, John Wiley and sons. Inc., New York, 1995		
List of Reference Books:			

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1.	Autar K. Kaw , Mechanics of Composite Materials, 2nd ed., CRC Press, 2006	
2.	I. M. Daniel, O. Ishai, Mechanics of Composite Materials, Oxford University Press,2006	
3.		
URLs:		
1.	https://nptel.ac.in/courses/112/104/112104161/	
2.	https://nptel.ac.in/courses/112/104/112104249/	
3.		
Lecture Plan (about 40-50 Lectures):		
*Lecture No.	Topic	Remarks
1.	Over view of the subject, relevance to industry, Definition of composite material	
2	fiber, matrix, types of fibers and raw fiber properties	
3	types of matrix, prepegs, fillers and other additives	
4	advantages and applications	
5	composite materials and structures	
6	applications and use of composite materials in present world	
7	Basics of composites	
8	mechanical behavior, lamina, laminate	
9	mechanical behavior, lamina, laminate	
10	the basic building block of a composite material	
11	the basic building block of a composite material	
12	Micromechanical analysis of composite strength and stiffness	
13	Micromechanical analysis of composite strength and stiffness	
14	MINI TEST	
15	properties and typical composite materials	
16	volume and weight fractions	
17	longitudinal strength and stiffness	
18	transverse modulus	
19	in-plane shear modulus	
20	poisson ratio	
21	Elastic properties of unidirectional lamina	
22	Elastic properties of unidirectional lamina	
23	stress-strain relationships	
24	stress-strain relationships	
25	Engineering constants, stress strain relations of a thin lamina, examples.	
26	Engineering constants, stress strain relations of a thin lamina, examples.	
27	Analysis of laminated composites	
28	laminates, basic assumptions	
29	strain displacement relationship, stress-strain relationships	
30	equilibrium, equations, laminate stiffness	

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31	determination of lamina stresses and strains,	
32	types of laminate configuration, balanced laminate,	
33	anti-symmetric laminate, examples,	
34	multi channel integration, look at the big picture wireless applications	
35	micromechanics of failure of unidirectional lamina	
36	anisotropic strength and failure theories	
37	importance of shear strength,.	
38	choice of failure criteria, examples	

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program	B.Tech (Mechanical Engg.)	Semester: VII	Year: IV
Name of Course	Computational Methods		
Course Code	ME24473		
Core / Elective / Other	Elective		
Prerequisite if any:			
1.			
Course Outcomes:			
At the end of the course, the student shall be able to:			
1.	Understand of the fundamental theory of the finite element methods.		
2.	Generate the governing FE equations for systems governed by partial differential equations.		
3.	Understand the use of the basic finite elements for structural applications using truss, beam, frame, and plane elements.		
4.	Demonstrate the ability to evaluate and interpret FEA analysis results for design and evaluation purposes.		
5.	Ability to create models for trusses, frames, plate structures, machine parts, and components using ANSYS general-purpose software.		
Description of Contents in brief:			
Unit 1.	Introduction: Historical background, basic concept of the finite element method, comparison with finite difference method.		
Unit 2.	Variational methods: calculus of variation, the Rayleigh-Ritz and Galerkin methods; Finite element analysis of 1-D problems: formulation by different approaches (direct, potential energy and Galerkin); Derivation of elemental equations and their assembly, solution and its post-processing. Applications in heat transfer, fluid mechanics and solid mechanics. Bending of beams, analysis of truss and frame.		
Unit 3.	Finite element analysis of 2-D problems: finite element modelling of single variable problems, triangular and rectangular elements; Applications in heat transfer, fluid mechanics and solid mechanics		
Unit 4.	Numerical considerations: numerical integration, error analysis, mesh refinement. Plane stress and plane strain problems; Bending of plates; Eigen value and time dependent problems.		
Unit 5.	Discussion about preprocessors, postprocessors and finite element packages <i>namely</i> ANSYS, ABAQUS, LS Dyna, Simufact to name a few.		
List of Text Books:			
1.	U.S. Dixit, Finite element methods for engineer, Cengage Learning, 2009.		
2.	K.J. Bathe, Finite element procedures, Second Edition, Prentice Hall, 1996.		
3.	J. N. Reddy, An introduction to the finite element method, 3rd edition, McGraw-Hill, 2006.		

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4.	R.D. Cook, D. S. Malkus and M. E. Plesha, Concepts and Applications of Finite Element Analysis, 4th edition, John Wiley, 2007	
List of Reference Books:		
1.	O. C. Zienkiewicz and R. L. Taylor, The Finite Element Method, 7th edition, Butterworth-Heinemann, 2013.	
2.	T. J. R. Hughes, The Finite Element Method, Prentice-Hall, 1986.	
URLs:		
1.	https://nptel.ac.in/courses/112/104/112104116/	
2.	https://nptel.ac.in/courses/112/104/112104115/	
3.	https://nptel.ac.in/courses/112/106/112106135/	
4.	https://nptel.ac.in/courses/112/106/112106130/	
5.	https://nptel.ac.in/courses/105/108/105108141/	
Lecture Plan (about 40-50 Lectures):		
*Lecture No.	Topic	Remarks
1.	Finite element method: a quick introduction	
2.	Direct FEM formulation of axial rod problem	
3.	Direct FEM formulation of beam problem	
4.		
5.	Some classical function approximation methods for solving differential equations: Ritz method, Galerkin method, Least square method, Collactive methods.	
6.		
7.		
8.		
9.	Ritz FEM formulation	
10.		
11.	Galerkin FEM formulation	
12.		
13.	Developing elemental equations by Ritz method	
14.	Developing element equations by Galerkin method	
15.	Some one-dimensional C⁰ continuity FEM formulation: steady-state heat conduction; longitudinal deformation of a rod; fluid flow problem	
16.		
17.	Finite element formulation for bending of beams: Galerkin FEM formulation; weak form; choose suitable approximating shape functions; Hermitian shape function; elemental equation, application of boundary conditions and solution	
18.		
19.		
20.	Finite element formulation for trusses and frames	
21.	Introduction to 2-D and 3-D FEM	
22.	Triangular elements, Tetrahedral element, Rectangular elements, Bricks element	
23.	Governing heat conduction equation for 2D heat conduction Problems	

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24.	Weak form and FEM formulation	
25.	Assembly procedure of 2D problems in FEM	
26.	Poisson equation for 3D FEM	
27.	Torsion of circular and non-circular cross section	
28.		
29.	Numerical integration: One-dimensional integration formula; Two dimensional integration formula	
30.	Integration over square region; Integration over triangular Region	
31.	Natural coordinates and iso-parametric, sub-parametric and super parametric elements	
32.	Four noded quadrilateral elements and serendipity elements	
33.	Eight noded curvilinear elements	
34. -36.	FEM Formulation for Plane Stress and Plane Strain Problems	
35.	Free Vibration Problems: Vibration of A Rod and vibration of a beam	
36.		
37.	Finite Element Formulation of Time Dependent Problems	
38.	FEM formulation of plate problem	
39.		
40.	FEM formulation of 2D flow problem	
41.		
42.	Error analysis in finite element methods: errors measure	
43.	Types of errors, Super convergent patch recovery (SPR) Technique	
44.	Higher order of approximations of primary variables	
45.	Error estimates by recovery	
46.	Miscellaneous topics: Difference between FEM and FDM, Essential and Natural boundary conditions, Solving the problem of fracture mechanics using FEM, Ill condition system, patch test.	
47.		
48.		

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program	B.Tech (Mechanical Engg.)	Semester: VII	Year: IV
Name of Course	Analysis and Design of Mechanical Control System		
Course Code	ME24474		
Core / Elective / Other	Elective		
Prerequisite if any:			
1.			
Course Outcomes:			
1.	Acquire knowledge of automatic control of Mechanical, hydraulic, pneumatic and electrical machines.		
2.	Understand the concept of stability.		
3.	Enables to understand transfer function, signal flow graph representation		
4.	To know the concept of time, frequency response and state-space models.		
Description of Contents in brief:			
Unit 1.	UNIT-I Introduction, fundamental definitions, type of system, Laplace transformation, poles and Zeros, mathematical modeling of Mechanical electrical, pneumatic, hydraulic, thermal systems. Block diagram reduction and signal flow path.		
Unit 2.	UNIT-II Time response analysis, characteristics of first-order, second and higher-order systems static and dynamic error calculations.		
Unit 3.	UNIT-III Stability, stability analysis using Routh-Hurwitz criterion, Root locus plot, Bode plot.		
Unit 4.	UNIT-IV Design of PI, PD, PID controllers log, lead and lag-lead compensator design,		
Unit 5.	UNIT-V State space representation, transfer function, controllability & absorbability.		
List of Text Books:			
1.	Modern control theory, Katsuhiko Ogata, Pearson Education International.		
2.	Control System Engineering, J. Nagrath, M.Gopal, New Age International Publishers.		
List of Reference Books:			
1.	Automatic Control Systems, Farid Golnaraghi, B.C. Kuo, John Wiley & Sons Int..		
2.	Modern Control Systems, R.C. Dorf, H. Bishop, Pearson Education International.		
URLs:			

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1.	www.swayam.gov.in	
2.	www.nptel.ac.in	
Lecture Plan (about 40-50 Lectures):		
*Lecture No.	Topic	Remarks
1.	Introduction to control systems	
2.	Mechanical control systems	
3.	Hydraulic, Pneumatic and Electrical control systems	
4.	Hydraulic, Pneumatic and Electrical control systems	
5.	Fundamental definitions,	
6.	Laplace transformation,	
7.	Laplace transformation, poles and zeros,	
8	Laplace transformation, poles and zeros,	
9.	Mathematical modeling of mechanical, electrical, pneumatic, hydraulic, thermal systems.	
10.	Mathematical modeling of mechanical, electrical, pneumatic, hydraulic, thermal systems.	
11.	Block diagram reduction and signal flow path.	
12.	Block diagram reduction and signal flow path.	
13.	Block diagram reduction and signal flow path.	
14.	Time response analysis	
15.	Time response analysis	
16.	Characteristics of first-order systems	
17.	Characteristics of second-order systems	
18.	Characteristics of higher-order systems	
19.	Static and dynamic error calculations	
20.	Static and dynamic error calculations	
21.	Stability	
22.	Stability analysis using Routh-Hurwitz criterion	
23.	Stability analysis using Routh-Hurwitz criterion	
24.	Stability analysis using Routh-Hurwitz criterion	
25.	Root locus plot,	
26.	Root locus plot	
27.	Bode plot	
28.	Bode plot	
29.	Controllers	
30.	Design of PI controllers	
31.	Design of PD controllers	
32.	Design of PID controllers	
33.	Log, lead and lag-lead compensator design,	
34.	Log, lead and lag-lead compensator design,	
35.	Log, lead and lag-lead compensator design,	

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36.	State space representation	
37.	State space representation	
38.	State space representation	
39.	Transfer function	
40.	Transfer function	
41.	Transfer function	
42.	Controllability	
43.	Controllability	
44.	Absorbability	
45.	Absorbability	
46.	Tutorial	
47.	Tutorial	
48.	Tutorial	

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Attendance/Assignment if any	20	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	

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Name of Program		B.Tech (Mechanical Engg.)	Semester: VII	Year: IV
Name of Course		Advanced Machine Design		
Course Code		ME24475		
Core / Elective / Other		Elective		
Prerequisite if any:				
1.	Machine Design 1			
2.	Machine Design 2			
3.	Manufacturing science			
Course Outcomes:				
1.	Enables to understand the basic concept of contact stresses for various shapes and its application.			
2.	Enables to apply the Lagrange multiplier method for different engineering optimization problems.			
3.	Enables to gain knowledge about economic, human, stiffness, rigidity, impact, fracture and wear consideration in machine design.			
4.	Enables to design of different IC engine components.			
Description of Contents in brief:				
Unit 1.	Residual and Contact Stress:- Residual stresses, its causes, manufacturing process causing thermal gradient, impact etc. Contact stresses and Hertzian stresses			
Unit 2.	Optimization in Design, Economic Consideration, Human Consideration in Design. Product Design, Creativity in Design and Alternative Design. Different modules of Design theory like aesthetics, form, shape and color.			
Unit 3.	Stiffness and Rigidity considerations in Design, Shock and Impact considerations in Design, Design against Fracture, Wear consideration in Design, Tribology, Concept of Friction, Wear and Lubrication, Effect of surface films, Designing for wear life, Erosive and Corrosive Wear.			
Unit 4.	Detailed design and working drawing: Petrol Engine/Diesel Engine. Lathe/Milling/Drilling Machine, Computer Aided Design of one assembly from the above.			
List of Text Books:				
1.	Siraj Ahmed (2014): Mechanical Engineering Design: Principles and concepts, PHI Learning Pvt. Ltd, ISBN-978-81-203-4931-5, New Delhi.			
List of Reference Books:				
1.	Rao and Dukupatti (2006): Mechanism and Machine Theory: New age International Pvt. Ltd., ISBN 81-224-0426-X, New Delhi.			
2.	George Dieter, Linda Schmidt (2009): Engineering Design: McGraw-Hill Education, ISBN 0072837039, The University of Michigan.			
3.	G.M.Maitra and L.V. Prasad (2009): Handbook of Mechanical Design, McGraw-Hill Education, ISBN 978-0-07-460238-6, New Delhi.			
4.	Robert L. Norton (2009): Machine Design:, Pearson Education, ISBN 978-81-317-0533-9, New Delhi.			
Lecture Plan (about 40-50 Lectures):				
*Lecture No.	Topic			Remarks

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1.	Residual and Contact Stress	
2.	Manufacturing process causing thermal gradient	
3.	Contact stresses	
4.	Hertzian stresses	
5.	Tutorial	
6.	Tutorial	
7.	Optimization in Design	
8.	Economic Consideration	
9.	Human Consideration	
10.	Stiffness and rigidity considerations in design	
11.	Shock and impact considerations in design against fracture	
12.	Wear consideration in design	
13.	Tribology	
14.	Concept of friction	
15.	Wear and lubrication	
16.	Effect of surface films	
17.	Designing for wear life	
18.	Erosive and corrosive wear	
19.	Creativity in design and alternative design	
20.	Product design	
21.	Different modules of design theory	
22.	Aesthetics and form	
23.	Shape and color	
24.	Tutorial	
25.	Tutorial	
26.	Tutorial	
27.	Product design	
28.	Different modules of design theory	
29.	Detailed design: diesel/Petrol engine Components	
30.	Detailed design: diesel/Petrol engine Components	
31.	Detailed design: diesel/Petrol engine Components	
32.	Detailed design: Lathe Components	
33.	Detailed design Lathe Components	
34.	Computer aided design of one assembly from the above	
35.	Tutorial	
36.	Tutorial	
37.	Tutorial	
38.	Tutorial	
39.	Tutorial	
40.	Tutorial	

Evaluation Criteria:

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5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	40	
8	Experiments if any (for practical courses)	-	
9	Any other	-	