Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

SYLLABUS FOR BACHELOR OF TECHNOLOGY IN MECHANICAL ENGINEERING

(Effective from academic session 2018-19)

Semester-VI

Third Year Sixth Semester							
Sl. No.	**Category**	**Subject Code**	**Subject Name**	**Total Number of contact hours**			**Credits**
				L	**T**	**P**	
Theory							
1	Professional Core courses	PC-ME601	Manufacturing Technology	4	0	0	4
2	Professional Core courses	PC-ME602	Design of Machine Elements	3	1	0	4
3	Professional Elective courses	PE-ME601	Elective-I	3	0	0	3
4	Professional Elective courses	PE-ME602	Elective-II	3	0	0	3
5	Humanities and Social Sciences including Management courses	HM-HU601	Humanities II (Operations Research)	3	0	0	3
6	Mandatory courses	MC601	Constitution of India	-	2	-	0
	Total Theory			**16**	**3**	**0**	**17**
Practical/ Sessional							
1	Professional Core courses	PC-ME691	Mechanical Engineering Laboratory (Design) II	0	0	3	1.5
2	Project (or Summer internship)	PW-ME681	Project-II (90 hrs. Total)	0	0	4	2
	Total Practical			**0**	**0**	**7**	**3.5**
	Total of Sixth Semester			**16**	**3**	**7**	**20.5**

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List of Professional Electives in Semester VI for (Elective-I) PE-ME601 and (Elective-II) PE-ME602

Subject Code	Subject name
Thermo-Fluid Group	
A	Internal Combustion Engines and Gas Turbines
B	Refrigeration and Air Conditioning
C	Turbo Machinery
D	Fluid Power Control
E	Advanced Fluid Mechanics
Design Group	
F	Composite Materials
G	Mechatronics
Manufacturing Group	
H	Robotics
I	Material Handling
J	Principles and Practices of Management

Note: If a student chooses the paper, **Turbo Machinery (Code: C)** as a **Professional Elective-**I in **Semester VI**, its paper code will be **PE-ME601C**.

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Subject Code : PC-ME601	**Category:** Professional Core Courses
Subject Name : Manufacturing Technology	**Semester**: Sixth
L-T-P: **4-0-0**	**Credit: 4**
Pre-Requisites: Primary Manufacturing Processes	

Course Objectives:

To impart knowledge to make students able to demonstrate the tooling needed for manufacturing, the dimensional accuracy and tolerances of products, assembly of different components. Also students will be able to understand the principles of working of NC, CNC machine tools and rapid prototyping.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Tooling for conventional and non-conventional machining processes: Mould and die design, Press tools, Cutting tools; Holding tools: Jigs and fixtures, principles, applications and design; Press tools: Configuration, design of die and punch; principles of forging die design.	12
2	Metrology: Metrology in tool wear and part quality including surface integrity, alignment and testing methods; tolerance analysis in manufacturing and assembly. Process metrology for emerging machining processes such as micro-scale machining, Inspection and workpiece quality.	8
3	Assembly practices: Manufacturing and assembly, process planning, selective assembly, Material handling and devices.	6
4	**NC/CNC Machine Tools and Systems** Types of automation: Fixed (or hard) and programmable (or flexible); need, advantages and applications of flexible automation over fixed automation. **Components and Their Functions in NC/CNC Machines** MCU, DPU and CLU, Feed drives using stepper/ servo motors and recirculating ball screw-nut system, Automatic Tool Changers- Tool Turret and Tool Magazine, Automatic pallet Changer. **Basic systems of NC and CNC machines** Coordinate system, Control– open loop and closed loop, Dimensioning– absolute and incremental, Point–to–point and contour motion, Linear and circular Interpolation. **CNC Machine Tools and Integrated Automation** Structure and working principle of CNC lathe, milling machine,	8

	Examples and use of CNC machines, Machining Centre (Vertical and Horizontal), Integrated Automation systems (DNC- Direct and Distributed or BTR and Dedicated system, FMS- FFMS, FMC and FMM)– characteristics and applications.	
5	**Part Programming for CNC machines** Manual Part Programming using ISO G and M Codes in CNC lathe and milling machine for simple jobs, Canned cycle. Computer Aided Part Programming using MACRO statements in APT for simple jobs in CNC lathe and milling machine.	8
6	**Rapid Prototyping** Overview of Rapid Prototyping, Basic Process- CAD Model Creation, Conversion to STL format, Slicing the STL File, Layer by layer construction. Use of CMM and 3-D Camera for making virtual model. Principles, systems, relative advantages and applications of the common RP methods, such as Stereo lithography (SLG), Selective laser sintering (SLS), Fused deposition modelling (FDM), Laminated objects manufacturing (LOM), 3-D Printing**.**	6

Course Outcomes:

1. To describe machines and related tools for manufacturing various components.
2. To understand the relationship between process and system in manufacturing domain.
3. To experiment on CNC machine tools.
4. To demonstrate rapid prototyping methods.

Learning Resources:

1. S. Kalpakjian and S.R. Schmid, Manufacturing Processes for Engineering Materials, 5th Edition, Pearson India, 2014.
2. R.K. Jain, Engineering Metrology, 21st Edition, Khanna Publication, New Delhi, 1984.
3. P.N. Rao, N.K. Tewari and T.K. Kundra, Computer Aided Manufacturing, McGraw Hill, 2017.
4. Y. Koren, Computer Control of Manufacturing Systems, McGraw Hill, 1986.
5. M.P. Grover, Fundamentals of Modern Manufacturing, 3rd Edition, Wiley.
6. M.P. Groover, Automation, Production Systems and CIM, Prentice Hall.
7. A. Ghosh & A.K. Mullick, Manufacturing Science, EW Press.
8. A. Ghosh, Rapid Prototyping, EW Press.

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SYLLABUS FOR BACHELOR OF TECHNOLOGY IN MECHANICAL ENGINEERING

(Effective from academic session 2018-19)

Subject Code : PC-ME602	**Category:** Professional Core Courses
Subject Name : Design of Machine Elements	**Semester** : Sixth
L-T-P : 3-1-0	**Credit: 4**
Pre-Requisites: Strength of materials, Machine Drawing	

Course Objectives:

This course seeks to provide an introduction to the design of machine elements commonly encountered in mechanical engineering practice, through

1. a strong background in mechanics of materials based failure criteria underpinning the safety-critical design of machine components
2. an understanding of the origins, nature and applicability of empirical design principles, based on safety considerations
3. an overview of codes, standards and design guidelines for different elements
4. an appreciation of parameter optimization and design iteration
5. an appreciation of the relationships between component level design and overall machine system design and performance

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Objective and scope of Mechanical Engineering Design; Design considerations; Review and selection of materials and manufacturing processes; codes and standards;	4
2	Modes of failure; Design/allowable stress; Factor of safety (FoS); Theories of failure – maximum normal stress theory, maximum shear stress theory, Distortion energy theory. Choice of Failure criteria; Design for stability : buckling analysis – Johnson and Euler columns	4
3	Fatigue in metals; S-N curve; Endurance limit and fatigue strength; Stress concentration factors – effect of discontinuity, fillets and notches; Effect of size, surface finish, stress concentration and degree of reliability on endurance limit; Design for finite and infinite life; Goodman, modified Goodman and Soderberg diagrams with respect to fatigue failure under variable stresses; Cumulative fatigue damage – Miner's equation.	5
4	Design of (i) Cotter joint; (ii) Knuckle joint and (iii) Fillet Welded joint of brackets under different types of loading.	6
5	Bolted joints : Metric thread, standard sizes, use of lock nuts and washers; Applications in structures including brackets, turn buckle; Pre-stressed bolts; Riveted joints : Unwin's formula; Brief discussion on single, double and triple row lap joints, butt joints with single or double strap / cover plate; simple strength design; joint efficiencies.	6

6	Design of : (i) Solid and hollow shafts, strength design of shafts, design based on torsional rigidity; (ii) Shaft coupling-rigid, pin-bush and geared flexible type, alignment of coupling; **(iii)** Belt drives-geometrical relations, derivation of torque and power transmission by flat and V-belt drives, selection of belt from manufacturers' catalogues, **pulley** (iv) **Chain drives – roller chains, polygonal effect, power rating, sprocket wheel, silent chain**	10
7	Design of: (i) Transmission screw, Screw jack, (ii) Helical compression spring - stress and deflection equations, stiffness, curvature effect : Wahl's factor, springs in parallel and series; **(iii) Multi-leaf springs : load-stress and load-deflection equations, Nipping**	8
8	Analysis and design of sliding and rolling contact bearings, Design of transmission elements: spur, helical, bevel and worm gears; Analysis of clutches and brakes	5

Course Outcomes:
Upon completion of this course, students will get an overview of the design methodologies employed for the design of various machine components.

Learning Resources:
1. J.E. Shigley and C.R. Mischke, Mechanical Engineering Design, 5th Edition, McGraw Hill International, 1989.
2. D. Deutschman, W.J. Michels and C.E. Wilson, Machine Design Theory and Practice, Macmillan, 1992.
3. R.C. Juvinal, Fundamentals of Machine Component Design, John Wiley, 1994.
4. M.F. Spottes, Design of Machine elements, Prentice-Hall India, 1994.
5. R. L. Norton, Mechanical Design– An Integrated Approach, Prentice Hall, 1998.
6. V. B. Bhandari, Design of Machine Elements by, McGraw Hill Publishing Co. Ltd., 2007.
7. P. Kannaiah, Machine Design, 2nd Edition, Scitech Publications.
8. Sadhu Singh, Machine Design, Khanna Book Publishing Co.

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SYLLABUS FOR BACHELOR OF TECHNOLOGY IN MECHANICAL ENGINEERING

(Effective from academic session 2018-19)

Subject Code: HM-HU601	**Category:** Humanities and Social Sciences including Management Courses
Subject Name: Humanities II (Operations Research)	**Semester**: Sixth
L-T-P: **3-0-0**	**Credit: 3**
Pre-Requisites:	

Course Objectives:

1. To study the various Operations Research tools,
2. To study to apply an appropriate model to the given situation.
3. To formulate the problem.
4. To solve and analyze the problems on Operations Research.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Introduction to Operations Research:** Introduction, Historical Background, Scope of Operations Research, Features of Operations Research, Phases of Operations Research, Types of Operations Research Models, Operations Research Methodology, Operations Research Techniques and Tools, Structure of the Mathematical Model, Limitations of Operations Research	2
2	**Linear Programming:** Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Case Studies of LPP, Graphical Methods to Solve Linear Programming Problems, Applications, Advantages, Limitations. Graphical Analysis of Linear Programming Problems: Introduction, Graphical Analysis, Some Basic Definitions, Graphical Methods to Solve LPP, Some Exceptional Cases, Important Geometric Properties of LPP. Simplex Method: Introduction, Standard Form of LPP, Fundamental theorem of LPP, Solution of LPP - Simplex Method, The Simplex Algorithm, Penalty Cost Method or Big M-method, Two Phase Method, Solved Problems on Minimisation. Duality in Linear Programming Problem: Introduction, Importance of Duality Concepts, Formulation of Dual Problem, Economic	8

	Interpretation of Duality, Sensitivity Analysis.	
3	**Transportation Problem:** Introduction, Formulation of Transportation Problem (TP), Transportation Algorithm (MODI Method), the Initial Basic Feasible Solution, Moving Towards Optimality.	3
4	**Assignment Problem:** Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Travelling Salesman Problem	3
5	**Project Management Using CPM-PERT:** Project Scheduling and PERT-CPM: Introduction, Basic Difference between PERT and CPM, PERT/CPM Network Components and Precedence Relationship, Project Management – PERT, Float calculation and its importance. Cost reduction by Crashing of activity	5
6	**Queuing Theory:** Basis of Queuing theory, elements of queuing theory, Operating characteristics of a queuing system, Queue discipline, Service Mechanism, Classification of Queuing models, [M/M/1]:{//FCFS} Queue System, numerical	3
7	**Inventory Management:** Inventory classification, Different costs associated to Inventory, Inventory models with deterministic demands (EOQ, EPQ and price discount models), inventory classification systems	4
8	**Job Sequencing:** Introduction to sequencing and scheduling models: n job two machines problem, n job 3 machines problem	2
9	**Decision Theory:** Introduction, Decision under certainty, Decision under risk, Decision under uncertainty: Laplace criterion, MaxiMin criterion, MiniMax criterion, savage MiniMax regret criterion, Hurwicz criterion, Decision tree	3
10	**Replacement Theory:** Introduction, Replacement of capital equipment which depreciated with time, replacement by alternative equipment, Group and individual replacement policy.	3

Course Outcome:
At the end of this course students will be able to

1. Apply forecasting methods for predicting demands.
2. Make decisions under certainty, uncertainty and conflicting situations.
3. Apply linear programming tools for optimal utilization of resources in various types of industries.
4. Solve transportation problems to minimize cost and understand the principles of assignment

of jobs and recruitment polices.
5. Understand the basic elements of a Queuing model
6. Apply PERT/CPM for project scheduling and resource allocation in an optimal way.
7. Manage inventory with cost effectiveness.

Learning Resources

1. F.S. Hillier, G.J. Lieberman, B. Nag and P. Basu, Introduction to Operation Research, 10th Edition, McGraw Hill, 2017.
2. C. Mohan and K. Deep, Optimization Techniques, New Age, 2009.
3. N.D. Vohra, Quantitative Techniques in Management, 5th Edition, McGraw-Hill.
4. K.V. Mittal and C. Mohan, Optimization Methods in Operations Research and Systems Analysis, New Age, 2003.
5. H.A. Taha, Operations Research - An Introduction, 7th Edition, Prentice Hall, 2002.
6. A. Ravindran, D.T. Phillips and J.J. Solberg, Operations Research: Principles and Practice, 2nd Edition, John Willey and Sons, 2009.
7. K. Bedi, Production and Operations Management, Oxford University Press, 2004.
8. S.J. Chandra and A. Mehra, Numerical Optimization with Applications, Narosa, 2009.
9. J.K. Sharma, Operation Research: Theory and Applications, 5th Edition, Macmillan Pub., 2013.
10. L.W. Wayne, Operations Research Applications and Algorithms, 4th Edition, Brooks/Cole, USA.

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SYLLABUS FOR BACHELOR OF TECHNOLOGY IN MECHANICAL ENGINEERING

(Effective from academic session 2018-19)

Subject Code : MC601	**Category:** Mandatory Courses
Subject Name : Constitution of India	**Semester** : Sixth
L-T-P : 0-2-0	**Credit: 0**
Pre-Requisites:	

Course Objectives:

The objectives of this course help the students to

1. To provide basic information about Indian constitution.
2. To identify individual role and ethical responsibility towards society.
3. To understand human rights and its implications.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Introduction to the Constitution of India, The Making of the Constitution and Salient features of the Constitution. Preamble to the Indian Constitution Fundamental Rights & its limitations.	4
2	Directive Principles of State Policy & Relevance of Directive Principles State Policy Fundamental Duties. Union Executives – President, Prime Minister Parliament Supreme Court of India.	5
3	State Executives – Governor, Chief Minister, State Legislature High Court of State. Electoral Process in India, Amendment Procedures, 42nd, 44th, 74th, 76th, 86th & 91st Amendments.	5
4	Special Provision for SC & ST Special Provision for Women, Children & Backward Classes Emergency Provisions. Human Rights –Meaning and Definitions, Legislation Specific Themes in Human Rights- Working of National Human Rights Commission in India Powers and functions of Municipalities, Panchyats and Co - Operative Societies.	5
5	Special Provision for SC & ST Special Provision for Women, Children & Backward Classes Emergency Provisions. Human Rights –Meaning and Definitions, Legislation Specific Themes in Human Rights- Working of National Human Rights Commission in India Powers and functions of Municipalities, Panchyats and Co - Operative Societies.	5

Course Outcomes:

On completion of the course student will

1. Have general knowledge and legal literacy and thereby to take up competitive examinations.
2. Understand state and central policies, fundamental duties.
3. Understand Electoral Process, special provisions.
4. Understand powers and functions of Municipalities, Panchayats and Co-operative Societies,

5. Understand Engineering ethics and responsibilities of Engineers
6. Understand Engineering Integrity & Reliability

Learning Resources:

1. D.D. Basu, Introduction to the Constitution on India, 19th/ 20th Students Edition, Prentice Hall EEE, 2001.
2. C.E. Haries, M.S. Pritchard and M.J. Robins, Engineering Ethics, Thompson Asia, 2003.
3. M.V. Pylee, An Introduction to Constitution of India, Vikas Publishing, 2002.
4. M. Govindarajan, S. Natarajan and V.S. Senthilkumar, Engineering Ethics, Prentice Hall of India Pvt. Ltd., New Delhi, 2004.
5. B.K. Sharma, Introduction to the Constitution of India, PHI Learning, New Delhi, 2011.
6. Latest Publications, Indian Institute of Human Rights, New Delhi.

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SYLLABUS FOR BACHELOR OF TECHNOLOGY IN MECHANICAL ENGINEERING

(Effective from academic session 2018-19)

Subject Code : PC-ME691	**Category:** Professional Core Courses
Subject Name : Mechanical Engineering Laboratory (Design) II	**Semester** : Sixth
L-T-P : 0-0-3	**Credit: 1.5**
Pre-Requisites:	

Course Objectives:

To understand the measurement of mechanical properties of materials
To understand the deformation behaviour of materials
To understand the kinematic and dynamic characteristics of mechanical devices

Course Contents (12 experiments/ problems/ studies are to perform):

1. Uniaxial tension test on mild steel rod
2. Torsion test on mild steel rod
3. Impact test on a metallic specimen
4. Brinnell/ Vickers and Rockwell hardness tests on metallic specimens
5. Bending deflection test on beams
6. Strain measurement using Rosette strain gauge, or like.
7. Microscopic examination of heat-treated and untreated metallic samples
8. Determination of velocity ratios of simple, compound, epicyclic and differential gear trains
9. Studying kinematics of four bar, slider crank, crank rocker, double crank, double rocker and oscillating cylinder mechanisms
10. Studying kinematics of typical mechanisms like pantograph, some straight line motion mechanisms, wiper, drafter, etc.
11. Motion studies of different cams & followers
12. Single degree of freedom Spring-mass-damper system: determination of natural frequency and damping coefficient
13. Determination of torsional natural frequency of single and double rotor systems- undamped and damped natural frequencies
14. Studying machine vibration using sensor
15. Solving simple balancing problems experimentally

Course Outcomes:

Students who have undergone the course will be able to understand the measurement of mechanical properties of materials and will be able to characterize the dynamic behavior of mechanical system.

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Subject Code : PW-ME681	**Category:** Project (Summer Internship)
Subject Name : Project-II	**Semester** : Sixth
L-T-P : 0-0-4	**Credit: 2**
Pre-Requisites:	

Course Objectives:

This course is aimed to provide more weightage for project work. The project work could be done in the form of a summer project or internship in the industry or even a minor practical project in the college. Participation in any technical event/ competition to fabricate and demonstrate an innovative machine or product could be encouraged under this course.

Course Outcomes:

Students will be able to understand the procedure to carry out practical projects related to any technical event/ competition to fabricate and demonstrate an innovative machine or product, etc.

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SYLLABUS FOR BACHELOR OF TECHNOLOGY IN MECHANICAL ENGINEERING

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Subject Code: A	**Category:** Professional Elective Courses
Subject Name: Internal Combustion Engines and Gas Turbines	**Semester**: Sixth
L-T-P: **3-0-0**	**Credit: 3**
Pre-Requisites: Thermodynamics, Heat Transfer	

Course Objectives:

To acquire knowledge about the IC engine cycles, classification, working Principles and to measure performance parameters along with heat balance sheet.
To explain different alternate fuels, gas turbines and about jet propulsion

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Introduction:** Basic Engine components and Nomenclature, Classification of Engines, The working principle of Engines, Comparison of 2-Stroke and 4-Stroke Engines; CI, and SI Engines, Ideal and Actual Working Cycles and their analysis, Valve timing Diagram. **Fuels:** Fossil fuels, Chemical structure of Petroleum, Properties of SI and CI Engine Fuels, Fuel Ratings; Octane Number, Cetane Number.	6
2	**Carburetors & Fuel Injection:** Air Fuel Mixture Requirements, Construction and Working of Simple Carburetor, Calculation of Air-Fuel Ratio, Parts of Carburetor. Requirement of Injection Systems, Classification of Injection Systems, Fuel Feed pump, Injection Pumps, Working principles of Governors, Nozzles and Fuel Injector, Injection in SI and CI Engines. **Combustion and Ignition Systems in SI and CI Engines:** Normal and Abnormal Combustion in SI and CI Engines, Stages of Combustion, Detonation and Knocking.	7
3	**Performance parameters for IC Engines:** Engine Power, Engine Efficiencies, Performance Characteristics, Variables Effecting Performance Characteristics, Methods of Improving Engine Performance, Heat Balance. **Modern Automotive Engines:** Changes in Fuel injection Methods in S.I and C.I engines, Common Rail Direct Injection System, Gasoline Direct Injection, Variable Valve Technology, A brief review of Design changes to achieve high efficiency.	7
5	**Alternate Fuels For IC Engines:** Need for use of alternate fuels. Use of alcohol fuels. Biodiesel.	3

	Biogas and Hydrogen in engines.	
6	**Gas Turbine:** Introduction to Gas Turbines, Development, Classification and Application of Gas Turbines, Ideal and Actual Cycles; Effect of Inter cooling, Reheating, Regeneration, Combined cycle and Cogeneration.	6
7	**Gas Turbine Cycles for Aircraft Propulsion:** Criteria of performance, Intake, and propelling nozzle efficiencies, Simple Turbojet Cycle, The turboprop engine, Thrust augmentation, Gas turbine combustion systems, Combustion chamber designs, Gas Turbine Emissions.	7

Course Outcomes:

1. Explained basic concepts of actual cycles with analysis and to describe the fundamental concepts of IC engines along with its working principles.
2. Described the combustion phenomenon in SI and CI engines.
3. Evaluated the performance of IC engines and the importance of alternate fuels.
4. Classified the essential components of gas turbine along with its performance improving methods.
5. Illustrated the working principle of different types of Jet propulsive engines and Rockets.

Learning Resources:

1. V. Ganesan, I.C. Engines, McGraw Hill, 2017.
2. V. Ganesan, Gas Turbines, McGraw Hill, 2004.
3. C.R. Ferguson and A.T. Kirkpatrick, Internal Combustion Engines, Wiley, 2015.
4. H.N. Gupta, Fundamentals of Internal Combustion Engines, PHI, 2012.
5. H. Cohen, H.I.H. Saravanamuttoo, G.F.C. Rogers, P. Straznicky and A.C. Nix, Gas Turbine Theory, Pearson, 2019.
6. J.B. Heywood, Internal Combustion Engine Fundamentals, McGraw Hill Co., 1988.
7. W.W. Pulkrabek, Engineering Fundamentals of IC Engine, PHI Pvt. Ltd., 2002.

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SYLLABUS FOR BACHELOR OF TECHNOLOGY IN MECHANICAL ENGINEERING

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Subject Code: B	**Category:** Professional Elective Courses
Subject Name: Refrigeration & Air Conditioning	**Semester**: Sixth
L-T-P: **3-0-0**	**Credit: 3**
Pre-Requisites: Thermodynamics, Heat Transfer	

Course Objective:

1. To know about the basics of refrigeration and air-conditioning system.
2. To learn about different types of Refrigeration, Air-Conditioning and ventilation systems.
3. To know about designing a Refrigeration and Air-Conditioning system.

Course Content:

Module No.	Description of Topic	Contact Hrs.
1	Introduction: Concepts of Refrigeration and Air-Conditioning. Unit of refrigeration, Refrigerants– Desirable Properties, Nomenclature	02
2	Simple Vapour Compression Refrigeration System (Simple VCRS): Vapour compression cycle on p-h and T-s diagrams. Cycles with subcooling and superheating, their effects; Effect of changes in evaporator pressure and condenser pressure on the performance of a simple VCRS; dry compression and wet compression of refrigerant; actual Vapour Compression Cycle.	05
3	Air Refrigeration System (ARS): Bell-Coleman refrigerator. COP determination, actual air-refrigeration cycle.	03
4	Vapour Absorption Refrigeration System (VARS): Advantages of VARS over VCRS. Working principle of simple VARS, practical VARS. Limitations of VARS, maximum COP of a VARS, Lithium bromide-water System; Aqua-ammonia systems.	04
5	Equipment and Control: Major Refrigeration Equipment-Compressors: Types; reciprocating, rotary & centrifugal, volumetric efficiency, Condensers: types used in refrigeration systems; Evaporators: expansion devices: capillary tubes and thermostatic expansion valves.	06
6	Ventilation– Definition & Requirement, Natural & Mechanical Ventilation, Ventilation Load Calculation.	03
7	Basic definitions and principles related to Psychometry; Psychometric Charts & Their Uses; Heating, Cooling, Heating & Humidification & Cooling & Dehumidification processes. Adiabatic Saturation, Cooling Coils, By-pass Factor.	05
8	Sensible Heat Factors. Heat Load estimation: Simple cases of Cooling and Dehumidification. Duct Sizing & Design. Air-conditioning equipment: Air handling units, Cooling Towers.	8

Course Outcomes:

After completing this course, the students will

1. know about the systems of Refrigeration, Air-Conditioning and Ventilation.
2. learn about different components of these systems.
3. know about designing a Refrigeration and Air-Conditioning system.

Learning Resources:

1. W.F. Stocker and J.W. Jones, Refrigeration and Air Conditioning, McGraw Hill, 2014.
2. C.P. Arora, Refrigeration and Air Conditioning, McGraw Hill India, 2017.
3. P.L. Ballaney, Refrigeration and Air Conditioning, Khanna Publication, New Delhi, 1972.
4. R.C. Arora, Refrigeration and Air Conditioning, PHI, 2010.
5. S.C. Arora and S. Domkundwar, Refrigeration and Air Conditioning, Dhanpat Rai Publication, 2018.
6. Sadhu Singh, Refrigeration and Air Conditioning, Khanna Publishing House, 2018.

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SYLLABUS FOR BACHELOR OF TECHNOLOGY IN MECHANICAL ENGINEERING

(Effective from academic session 2018-19)

Subject Code: C	**Category:** Professional Elective Courses
Subject Name: Turbo Machinery	**Semester**: Sixth
L-T-P: **3-0-0**	**Credit: 3**
Pre-Requisites: Fluid Mechanics and Fluid Machinery	

Course Objective:

To know about the basic characteristics of compressible and incompressible flow machines.
To learn about deriving dimensionless numbers through dimensional analysis.
To know about system of testing and performance analysis of turbo machines.

Course Content:

Module No.	Description of Topic	Contact Hours
1	**Introduction:** Classification: Incompressible and compressible flow machines; Radial, axial and mixed flow machines; Turbines vs pumps, fans and compressors. Applications: Water supply, ventilation, power generation, propulsion.	2
2	**Incompressible- Flow Machines:** i) Hydraulic Turbines: Headrace, penstock, nozzle, runner, draft tube and tail race; Gross head and net head; Velocity diagrams for impulse and reaction turbines; Discharge, head, power and efficiencies.	8
3	ii) Pumps: Reservoir, foot valve, suction line, pump, delivery line and overhead tank; Static head and losses; Velocity diagrams; Discharge, head, power and efficiencies.	8
4	**Compressible-Flow Machines:** Static and stagnation states; Isentropic and adiabatic expansion and compression processes; Nozzle, diffuser and rows of stationary and moving blades; Efficiencies.	8
5	**Dimensional Analysis:** Similarity laws, volume-flow, mass-flow head and power coefficients, pressure ratio, enthalpy ratio, Reynolds number, Mach number; Specific speed and machine selection.	4
6	**Testing and Performance Analysis:** Measurement devices; affinity laws and unit quantities. Set up and operating characteristics of pumps, turbines; fans and turbo-compressors. Cavitation– cause of cavitation and definition of Thoma's cavitation parameter, surge and choking.	6

Course Outcomes:

After completing this course, the students will

1. know basic characteristics of compressible and incompressible flow machines.
2. learn how to derive dimensionless numbers using dimensional analysis.
3. know about the method of testing and performance analysis of turbo machines.

Learning Resources:

1. S.M. Yahya, Turbine, Compressors and Fans, 4th Edition, McGraw Hill Education, 2017.
2. J. Lal, Hydraulic Machines, Metropolitan Book Co., New Delhi, 6th Edition, 2016.
3. S.K. Som, G. Biswas and S. Chakraborty, Introduction to Fluid Mechanics & Fluid Machines, McGraw Hill, 2017.
4. M.M. Das, Fluid Mechanics & Turbo Machines, PHI, 2010.
5. R.K. Bansal, Fluid Mechanics & Machinery, Laxmi Publications, 2018.
6. C. Ratnam, A.V. Kothapalli, Fluid Mechanics & Machinery, I.K. International Publishing House Ltd, 2010.
7. C.S.P. Ojha, R. Berndtsson and P.N. Chandramouli, Fluid Mechanics & Machinery, Oxford University Press, 2008.
8. S.C. Gupta, Fluid Mechanics and Hydraulic Machines, Pearson Publication, 2006.
9. A.T. Sayers, Hydraulic and Compressible Flow Turbomachines, McGraw-Hill, 1990.
10. R.K. Bansal, Fluid Mechanics and Hydraulic Machines, Laxmi Publications, 2018.
11. S.S. Rattan, Fluid Mechanics and Hydraulic Machines, Khanna Book Publications, 2016.
12. I.J. Karassic, J.P. Messina, P. Cooper and C.C. Heald, Pump Handbook, McGraw-Hill,New York, 2001.
13. V.M. Cherkassky, Pumps, Fans and Compressors, MIR Publication, Moscow, 1985.

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SYLLABUS FOR BACHELOR OF TECHNOLOGY IN MECHANICAL ENGINEERING

(Effective from academic session 2018-19)

Subject Code: D	**Category:** Professional Elective Courses
Subject Name : Fluid Power Control	**Semester**: Sixth
L-T-P: **3-0-0**	**Credit: 3**
Pre-Requisites: Fluid Mechanics and Fluid Machinery	

Course Objective:

1. To know the basics of different types of fluid power control systems and their applications.
2. understand working principles of different components of a pneumatic or hydraulic system.

Course Content:

Module No.	Description of Topic	Contact Hrs.
1	Fluid power; Applications and advantages; Components of a hydraulic and pneumatic system. Desired properties of a hydraulic fluid; advantage of mineral oil over water; definition of terms like pressure, head, force, density, specific gravity, kinematic and absolute viscosity, compressibility and incompressibility. Pascal's law; analysis of simple hydraulic jack, Mechanical advantage; continuity equation; hydraulic power of a cylinder.	5
2	Hydraulic Pumps: positive displacement pumps; constructional features, working principle and volumetric capacity of external gear pump, vane pump, axial piston pump and radial piston pump.	6
3	Hydraulic Actuators : Constructional features of single acting and double acting hydraulic cylinders; mounting of cylinders, cushioning of cylinder; different application of cylinder through mechanical linkages; force, velocity and power from a cylinder. Hydraulic motors; torque, power and flow rate in a hydraulic motor.	4
4	Hydraulic Valves: Direction control valves – operation and graphical symbol of 3 way and 4 way valves; different modes of activation of valves. Operation and graphical symbols of check valves, pressure relief valve pressure reducing valve, unloading valve and flow control valve.	4
5	Representation of hydraulic components through ANSI symbols. Analysis of hydraulic circuits for single and double acting cylinder control, regenerative circuit, pump unloading circuit, double pump hydraulic system, cylinder synchronization circuit, speed control of a hydraulic motor, circuit to lift and hold heavy load, automatic sequencing of two cylinders.	7

6	Advantages & disadvantages of pneumatic system compared to hydraulic system; constructional details and operation of a reciprocating compressor; working principle and use of filter, pressure regulator, lubricator and silencer; symbols of different pneumatic components; compressed air distribution system in a plant; drawing pneumatic circuits for different operations.	6
7	Use of electrical devices for controlling fluid circuits; function of electrical devices like push-button switches, limit switches, pressure switches, solenoids, relays and timers and their symbols; concept of ladder diagram; study of circuits using electrical control devices such as control of a solenoid actuated cylinder using one limit switch, reciprocation of a cylinder using pressure or limit switches, and two cylinder sequencing circuit using two limit switches.	4

Course Outcomes:
After completing this course, the students will
1. know about different types of fluid power control systems and their applications.
2. learn working principles of different components of a pneumatic and hydraulic system.
3. learn about drawing fluid power control circuits to suit an application.

Learning Resources:
1. S. Ilango and V. Soundararajan, Introduction to Hydraulics and Pneumatics, PHI, 2011.
2. A. Esposito, Fluid Power with Applications, Pearson, 2003.
3. S.R. Majumdar, Pneumatic Systems: Principles and Maintenance, McGraw Hill, 1999.
4. E.C. Fitch Jr., Fluid Power and Control Systems, McGraw Hill, New York,1966.
5. D.S. Banks and D.D. Banks, Industrial Hydraulics, Prentice Hall, 1988.

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SYLLABUS FOR BACHELOR OF TECHNOLOGY IN MECHANICAL ENGINEERING

(Effective from academic session 2018-19)

Subject Code : E	**Category:** Professional Elective Courses
Subject Name: Advanced Fluid Mechanics	**Semester :** Sixth
L-T-P : 3-0-0	**Credit:** 3
Pre-Requisites: Fluid Mechanics	

Course Objective:

1. To know about compressible fluid flow.
2. To learn about ideal fluid flow.
3. To know about free surface flow.
4. To know about unsteady flow.

Course Content:

Module No.	Description of Topic	Contact Hrs.
1	Compressible Flow: review of thermodynamic principles for perfect gases, adiabatic and isentropic relations; steady flow energy equation; speed of propagation of a small disturbance through a compressible fluid, sonic velocity, Mach number, mach cone and Mach wave; isentropic flow, stagnation properties of a compressible flow, isentropic pressure, temperature and density ratios; compressibility correction factor in the measurement of air speed; area– velocity relationship for compressible flow through a variable area duct, mass flow rate through a duct, critical condition and choking; flow through convergent-divergent nozzle, over expansion and under expansion, performance of propulsive nozzles; normal shock, normal shock relations, wave drag.	12
2	Ideal Fluid Flow: rotation of a fluid particle, vorticity, rotational and irrotational motion; velocity potential function, circulation, stream function, flownet; governing equation for two dimensional irrotational motion, simple two dimensional irrotational flows like uniform flow, plane source, plane sink etc; superimposition of simple irrotational flows, combination of a source and a sink, combination of uniform flow and a source (Rankine half body), combination of a uniform flow and a source-sink pair (Rankine oval), doublet and its strength, superimposition of an uniform flow and a doublet (flow past a stationary cylinder); vortex motion– free and forced vortex, strength of a vortex; combination of a uniform flow, a doublet and a free vortex (flow over a rotating cylinder), Magnus effect, Kutta-Joukowski's theorem.	12
3	Free Surface Flow: flow in open channel, Chezy's equation, Manning's equation, economical cross section, specific energy,	8

	hydraulic jump.	
4	Unsteady flow– water hammer.	4

Course Outcomes:
After completing this course, the students will
1. know about compressible fluid flow.
2. learn about ideal fluid flow.
3. know about free surface flow.
4. know about unsteady flow.

Learning Resources:
1. Sadhu Singh, Fluid Mechanics and Hydraulic Machines, Khanna Book Publishing, New Delhi, 2018.
2. R.K. Bansal, A Textbook of Fluid Mechanics and Hydraulic Machines, Laxmi Publication, New Delhi, 2010.
3. S.K. Som, G. Biswas and S. Chakraborty, Introduction to Fluid Mechanics and Fluid Machines, McGraw-Hill, 2012.

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SYLLABUS FOR BACHELOR OF TECHNOLOGY IN MECHANICAL ENGINEERING

(Effective from academic session 2018-19)

Subject Code: F	**Category:** Professional Elective Courses
Subject Name: Composite Materials	**Semester**: Sixth
L-T-P: **3-0-0**	**Credit: 3**
Pre-Requisites: Materials Engineering	

Course Objectives:

To understand the mechanical behaviour of composite materials.

To get an overview of the methods of manufacturing composite materials.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Definition and applications of composite materials, Fibres- glass, carbon, ceramic and aramid fibres; Matrices- polymer, graphite, ceramic and metal matrices; characteristics of fibres and matrices. Lamina- assumptions, macroscopic viewpoint, generalized Hooke's law, reduction of homogeneous orthotropic lamina, isotropic limit case, orthotropic stiffness matrix, commercial material properties, rule of mixtures, transformation matrix, transformed stiffness.	12
2	Manufacturing of composite materials, bag moulding, compression moulding, pultrusion, filament welding, other manufacturing processes	8
3	Basic assumptions of laminated anisotropic plates, symmetric laminates, angle ply laminates, cross ply laminates, laminate structural moduli, evaluation of lamina properties, determination of lamina stresses, maximum stress and strain criteria, von Mises Yield criterion for isotropic materials, generalized Hill's criterion for anisotropic materials, Tsai-Hill's criterion for composites, prediction of laminate failure, thermal analysis of composite laminates.	8
4	Analysis of laminated plates- equilibrium equations of motion, energy formulation, static bending analysis, buckling analysis, free vibrations, natural frequencies.	8

Course Outcomes:

Upon completion of this course, the students will have an overview of the mechanical behaviour and application of composite materials

Learning Resources:

1. R.F. Gibson, Principles of Composite Material Mechanics, 2nd Edition, McGraw Hill, 1994.
2. M.W. Hyer, Stress Analysis of Fiber-Reinforced Composite Materials, McGraw Hill, 1998.
3. K.K. Chawla, Composite Materials- Science and Engineering, Springer International Publishing, 2019.
4. M. Mukhopadhyay, Mechanics of Composite Materials and Structures, University Press, 2013.

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SYLLABUS FOR BACHELOR OF TECHNOLOGY IN MECHANICAL ENGINEERING

(Effective from academic session 2018-19)

Subject Code: G	**Category:** Professional Elective Courses
Subject Name: Mechatronics	**Semester**: Sixth
L-T-P: **3-0-0**	**Credit: 3**
Pre-Requisites: Fluid Mechanics and Fluid Machinery, Kinematics and Theory of Machines, Basic Electrical Engineering, Basic Electronics Engineering	

Course Objectives:

To provide knowledge on electrical circuits, signal conditioning.
To make familiar about control system and power electronics in designing mechatronic system

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Introduction to Mechatronics: Definition, Mechatronics in design and manufacturing, Comparison between Traditional and Mechatronic approach; Concurrent engineering	3
2	Review of fundamentals of electronics: Logic gates and their operations, Signal processing devices, Data conversion devices, Input and output devices. Sensors and Transducers, Actuators, Limit switches, Relays	6
3	Control Systems: Open loop and closed loop control, block diagrams, transfer functions, Laplace transforms.	3
4	Electrical Drives: Stepper motors, servo drives.	2
5	Mechanical Drives: Different mechanisms, Ball screws, Linear motion bearings, Transfer systems.	3
6	Pneumatic and Hydraulic Drives: Elements of pneumatic and hydraulic drives, comparison between them. Design of pneumatic and hydraulic circuits, symbolic representations of such circuits indicating different valves, actuators, etc.	4
7	Basics of 8085 microprocessor, programmable register architecture, buses, memory mapping, clock pulse and data transfer operations, and simple assembly and mnemonic programming on 8085 microprocessor.	5
8	Use of On-Off, PI and PID controllers to control different drives, Programming in PLC controller using Ladder diagram.	4
9	Mathematical modeling of physical systems, such as spring-mass vibration system, linear and rotory motion and its Laplace Transform.	2
10	Basics of time domain analysis, Introduction to discrete-time systems and Z-transform.	2
11	Introduction to Mechatronic systems, such as automatic brake, door closing and opening, robot, CNC machine, AGV, etc.	2

Course Outcomes:

At the end of the course, the student will be able to

1. Model and analyze mechatronic systems for an engineering application
2. Identify sensors, transducers and actuators to monitor and control the behavior of process or product.
3. Develop PLC programs for an engineering application.
4. Evaluate the performance of mechatronic systems.

Books:

1. W. Bolton, Mechatronics, 5th Edition, Addison Wesley Longman Ltd., 2010.
2. D. Shetty and R. Kolk, Mechatronics System Design, 3rd Edition, PWS Publishing, 2009.
3. D.G. Alciatore & M.B. Histand, Introduction to Mechatronics and Measurement systems, 4th Edition, McGraw Hill, 2006.
4. A. Smaili and F. Arnold, Applied Mechatronics, Oxford University Press, Indian Edition, 2007.
5. M.D. Singh and J.G. Joshi, Mechatronics, Prentice Hall of India, 2006.
6. K.K. Appu Kuttan, Introduction to Mechatronics, Oxford University Press, New Delhi, 2007.
7. HMT Ltd., Mechatronics, McGraw Hill Publication, 2017.
8. F.H. Raven, Automatic Control Engineering, McGraw Hill India, 2013.
9. K. Ogata, Modern Control Engineering, Prentice Hall, 2010.
10. B.C. Kuo, Automatic Control Systems, Prentice Hall, 1975.
11. A. Ambikapthy, Control Systems, Khanna Publishing House, 2015.

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SYLLABUS FOR BACHELOR OF TECHNOLOGY IN MECHANICAL ENGINEERING

(Effective from academic session 2018-19)

Subject Code: H	**Category:** Professional Elective Courses
Subject Name: Robotics	**Semester:** Sixth
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: Manufacturing Technology	

Course Objective:

To impart knowledge about the engineering aspects of Robots and their application

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Introduction: Basic concepts- Robot anatomy- Manipulators- kinematics: Forward and inverse kinematics- Precision movement, robot specifications and Work volume, Types of Robot drives- Basic robot motions- Point to point control, continuous path contour.	8
2	End Effectors: End effectors- classification- mechanical, magnetic, vacuum and adhesive gripper- gripper force analysis and design. Robot control- Unit control system concept- servo and non-servo control of robot joints, adaptive and optimal control.	7
3	Sensors: Sensor devices, Types of sensors- contact, position and displacement sensors, Force and torque sensors- Proximity and range sensors- acoustic sensors- Robot vision systems- Sensing and digitizing- Image processing and analysis.	6
4	Robot Programming: Robot language classification- programming methods- off and on line programming- Lead through method- Teach pendent method- VAL systems and language, simple program.	8
5	Industrial Application: Application of robots- Material handling- Machine loading and unloading, Assembly, Inspection, Welding, Spray painting, Mobile robot, Microbots- Recent developments in robotics- safety consideration.	7

Course Outcome:

1. To familiarize the Basics of robots Control system.
2. To familiarize the end effectors, Sensor technology and Industrial application of robot.

Learning Resources:

1. S.R. Deb, Robotics technology and flexible automation, McGraw Hill publishing company limited, New Delhi, 1994.

2. M.P. Groover. Industrial Robotics Technology Programming and Applications, McGraw Hill Book Co, Singapore, 1987.
3. S.K. Saha, Introduction to Robotics, McGraw-Hill Publication, 2014.
4. Y. Koren, Robotics for Engineers, McGraw Hill, New York, 1985.
5. P.G. Ranky and C.Y. Ho, Robots Modelling Control and Applications with Software, Springer Verlag, 1985.
6. J.J. Craig, Introduction to Robotics, Addison-Wesley, 2009.
7. R.J. Schilling, Fundamentals of Robotics Analysis and Control, Prentice Hall of India, 1996.
8. T. Yoshikawa, Foundations of Robotics Analysis and Control, Prentice Hall of India, 2010.
9. K.S. Fu, R.C. Gonzales and C.S.G. Lee, Robotics: Control, Sensing, Vision and Intelligence, McGraw Hill, 1997.
10. W. Stadler, Analytical Robotics and Mechatronics, McGraw Hill Book Co., 1995.

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SYLLABUS FOR BACHELOR OF TECHNOLOGY IN MECHANICAL ENGINEERING

(Effective from academic session 2018-19)

Subject Code: I	**Category:** Professional Elective Courses
Subject Name: Material Handling	**Semester**: Sixth
L-T-P : **3-0-0**	**Credit: 3**
Pre-Requisites: Kinematics and Theory of Machines	

Course Objective:

1. To know about the material handling systems used in industry.
2. To learn about basic designing principles of some material handling systems.
3. To know about modern handling system using a robot.

Course Content:

Module No.	Description of Topic	Contact Hrs.
1	**Introduction:** Definition, importance and scope of material handling (MH); classification of materials; codification of bulk materials ; utility of following principles of MH– (i) materials flow, (ii) simplification, (iii) gravity, (iv) space utilization, (v) unit size, (vi) safety, (vii) standardization, (viii) dead-weight, (ix) idle time, (x) motion.	4
2	**Unit load**: Definition; advantages & disadvantages of unitization; unitization by use of platform, container, rack, sheet, bag and self contained unit load; descriptive specification and use of pallets, skids, containers, boxes, crates and cartons; shrink and stretch wrapping. **Classification of MH Equipment**: Types of equipment– (i) industrial trucks & vehicles, (ii) conveyors, (iii) hoisting equipment, (iv) robotic handling system and (v) auxiliary equipment; Independent equipment wise sub classification of each of above type of equipment.	6
3	**Industrial trucks & vehicles**: Constructional features and use of the following equipment – (i) wheeled hand truck, (ii) hand pallet truck, (iii) fork lift truck; Major specifications, capacity rating and attachments of fork lift truck.	5
4	**Conveyors:** Use and characteristics of belt conveyor, constructional features of flat and troughed belt conveyor; Use and constructional features of chain conveyors– (i) apron, car and trolley type; Construction of link-plate chains; Dynamic phenomena in chain drive; Use and constructional features of roller conveyors; Gravity and powered roller conveyor; Pneumatic conveyor-use and advantages; Positive, negative and combination system of pneumatic conveyors; constructional feature, application and conveying capacity of screw conveyor.	8

5	**Hoisting Equipment**: Advantage of using steel wire rope over chain; constructional features of wire ropes; Rope drum design; Pulley system-simple vs. multiple pulley; Load handling attachments : hooks, grabs, tongs, grab bucket; Arrangement of hook suspension with cross piece and pulleys (sheaves); Use and constructional features of (i) hand operated trolley hoist , (ii) winch; (iii) bucket elevator, (iv) Jib crane, (v) overhead traveling crane and (vi) wharf crane; Level luffing system of a wharf crane; Utility of truck mounted and crawler crane.	8
6	**Robotic handling**: Materials handling at workplace; Major components of a robot; Applications of robotic handling.	2
7	**Auxiliary Equipment:** Descriptive specification and use of (i) Slide and trough gates, (ii) belt, screw and vibratory feeders, (iii) Chutes, (iv) positioners like elevating platform, ramps, universal vice; (v) ball table.	3

Course Outcomes:
After completing this course, the students will
1. know about constructional features, working principle and specific applications of each of the material handling system.
2. learn about unit load calculation and selecting specification of some material handling system.

Learning Resources:
1. S. Ray, Introduction to Materials Handling, New Age International Pub., 2017.
2. T.K. Ray, Mechanical Handling of Materials, Asian Books Pvt. Ltd., 2005.
3. T.H. Allegri, Materials Handling: Principles and Practices, CBS Publishers and Distributors, 2018.
4. J.M. Apple, Material Handling System Design, John Wiley & Sons, 1972.

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SYLLABUS FOR BACHELOR OF TECHNOLOGY IN MECHANICAL ENGINEERING

(Effective from academic session 2018-19)

Subject Code: J	**Category:** Professional Elective Courses
Subject Name: Principles & Practices of Management	**Semester:** Sixth
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: Basic Engineering Concept	

Course Objectives:

To provide knowledge on different aspects of management applied in an industry.
To make familiar about some management decision making systems and motivational aspects usually practiced in an industry.

Module No.	Description of Topic	Contact Hrs.
1	**Management:** Definition, nature, importance, evolution of management thoughts– pre & post scientific era, contributions made by Taylor, Fayol, Gilbreth, Elton Mayo, McGregor, Maslow– Covering Time & Motion Study, Hawthrone Experiments; Is management a science or art? Functions of manager, ethics in managing and social responsibility of managers.	5
2	**Planning & Control:** Why Management process starts with planning, steps in planning, planning premises, types of planning, barriers to effective planning, operational plan, strategic planning, Mckinsey's 7's Approach, SWOT analysis, Controlling- concept, Planning- control relationship, process of control, human response to control, dimensions of control, MBO.	5
3	**Decision Making & Organizing:** Nature, process of decision making, decision making under Certainty and Uncertainty, decision-tree, group-aided decision, brain-storming; Organizing – concept, nature and process of organizing, authority and responsibility, delegation and empowerment, centralization and decentralization, concept of departmentation.	6
4	**Staffing & Motivation:** Concept, Manpower planning, Job design, recruitment & selection, training anddevelopment, performance appraisal, motivation, motivators and satisfaction, motivating towards organizing objectives, morale building.	5
5	**Leadership & Communication:** Defining leadership and its role, should managers lead, leadership style, leadership development, Leadership behavior. Communication- Process, Bridging gap-using tools of communication, electronic media in Communication.	5
6	**Financial Management:** Financial functions of management, Financial Planning, Management of Working Capital, Sources of	5

	Finance.	
7	**Marketing Management:** Functions of Marketing, Product Planning & Development, Marketing Organization, Sales Organization, Sales Promotion, Consumer Behaviour, Marketing Research and Information.	5

Course Outcomes: At the end of the course, the student will be able to:

1. Understand the evolutionary development of management thought and general principles of management.
2. Understand the management functions in an organization

Learning Resources:

1. S. Robbins and M. Culter, Management, Pearson, 2016.
2. J.R. Schermerhorn, Introduction to Management, Wiley India Edition, 2011.
3. C.J. O'Donnel and H. Koontz, Principles of Management, McGrew Hill, 1995.
4. R.L. Daft, New Era of Management, Cengage Learning, 2008.
5. J.A.F. Stoner, R. Freeman and D.R. Gilbert. Jr., Management, Prentice Hall of India, 1985.
6. H. Koontz and H. Weihrich, Essentials of Management, McGrew Hill, 2007.
7. D.C. Bose, Principles of Management and Administration, Prentice Hall of India, 2012.
8. K. Nerkar, V. Chopde and Kogent Learning Solutions Inc, Principles and Practices of Management, Dreamtech Press, 2011.
9. P. Diwan, Management Principles and Practices, Excel Books, New Delhi, 2002.
10. R.L. Daft, Principles of Management, Cengage Learning, 2012.
11. Premvir Kapoor, Principles of Management, Khanna Publishing House, 2019.