SANDIP UNIVERSITY

School of Engineering and Technology

Department of Mechanical Engineering

Year: BE B.Tech **Semester: VII**

Course: CAD/CAM/CAE **Course Code: 17YME701**

Teaching Scheme (Hrs/Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	T	P	C	CIA-1	CIA-2	CIA-3	CIA-4	Lab	Theory	Lab	
3	0	2	4	10	20	10	10	-	50	50	150
Max. Time, End Semester Exam (Theory) – 3 Hrs									End Semester Exam (Lab) – 2 Hrs.		

Prerequisite	**1. knowledge of software and computer** **2. knowledge of basic programs** **3. able to identify the boundary conditions** **4. Basic concepts of Mathematics**

Course Objectives	
1	To provide an overview of how computers are being used in design for analytical and synthetic curves.
2	To understand the basics of modelling techniques for surfaces and solids.
3	To create CNC programs for appropriate manufacturing techniques viz. turning and milling
4	To identify the applications of computer in any real life applications.
5	To infer the tools for complex engineering components.

Course Content			
Unit No.	Module No.	Content	Hours
1	I	**Computer Graphics:** Two dimensional computer graphics, Transformations-Introduction, Formulation and it's types,Homogeneous coordinates, Perspective projection, Inverse Transformations, Three dimensional Computer graphics, viewing transformation,Mapping and Projections of Geometric Models.	6
	II	**Geometric Modelling**: Concept of parametric and non-parametric representation of curves, Analytic Curves, Synthetic Curves - cubic spline, Bezier curve, and B-spline curve.	4
2	I	**Surface Modelling**: Introduction, Surface Representation, Cylindrical surface, ruled surface, Surface of revolution Spherical surface, Composite surface, Bezier surface. B-spline surface, Regenerative surface and pathological conditions.	4
	II	**Solid Modelling**: Introduction, Geometry and Topology, Sweep representation, Constructive solid geometry, Boundary representations.	4
3	I	**CNC Machine Tools**: Numerical control, Elements of NC system,	9

		NC part programming: Methods of NC part programming, manual part programming, Computer assisted part programming, Post Processor. CNC part programming, Steps in developing CNC part program.CNC part programming for LatheMachine, Milling Machine Pocketing, contouring & drilling and subroutine using canned cycle.	
4	I	**Computer Aided Manufacturing (CAM)**: Computer assisted process planning: Difficulties in traditional process planning, Computer aided production management system Materialsrequirement planning, inputs to MRP, MRP output records, Benefits of MRP, Computer assisted production scheduling, computer monitoring and control system.	9
5	I	**Flexible Manufacturing System**: FMS equipment, FMS layouts, Analysis methods for FMS benefits of FMS. Computer aided quality control: Automated inspection- Off-line, On-line, contact, Noncontact; Coordinate measuring machines, Machine vision. Computer Integrated Manufacturing: CIM system, Benefits of CIM,CIM Hardware and CIM Software.	9
		Total No. of Hrs	45

Course Outcome	
Students should able to	
CO1	Analyse geometric transformation techniques in CAD
CO2	Develop mathematical models to represent surfaces and model engineering components using solid modelling techniques.
CO3	Develop programs for CNC to manufacture industrial components.
CO4	Interpret the application of computers in various aspects of Manufacturing viz., Design, Proper planning, Manufacturing cost, Layout & Material Handling system.
CO5	Selectproper manufacturing method using FMS and CIM.

List of Experiments	
Sr. No.	**Description**
1	Developing CAD model of mechanical sub assembly consisting 8-10 components
2	Developing component/ assembly using CAD features of Hybrid Modelling, Feature BasedModelling, Parametric Modelling and Constraint Based Modelling.
3	Stress and Deflection Analysis of 2D truss.
4	Stress and Deflection Analysis of Beam.
5	Stress and deflection analysis of plate 2D/3D. [Mechanical Component]
6	Tool path generation for Turning – Grooving and Threading.
7	Tool path generation for Milling – Facing, Pocketing, Contouring and Drilling.
8	Tool path generation of Turn Mill.
9	Developing CAD model of mechanical sub assembly consisting 8-10 components

RecommendedResources	
Text Books	1. Ibrahim Zeid and R. Sivasubramanian - CAD/CAM - Theory and Practice Tata McGraw Hill Publishing Co. 2009 2. Chandrupatla T. R. and Belegunda A. D. -Introduction to Finite Elements in Engineering - Prentice Hall India. 3. Nitin S. Gokhale, Practical Finite Element Analysis, Finite To Infinite; First Edition edition, ISBN-10: 8190619500 ISBN-13: 978-8190619509. 4. S. K. Sinha, CNC Programming using Fanuc Custom Macro B, McGraw-Hill Professional 5. S. R. Deb, Robotics Technology and Flexible Automation, Tata McGraw Hill.
Reference Books	1. IbraimZeid, Mastering CAD/CAM – Tata McGraw Hill Publishing Co. 2000 2. Segerling L. J. - Applied Finite Elements Analysis, John Wiley and Sons 3. Seshu P. Text book of Finite Element Analysis, PHI Learning Private Ltd. New Delhi, 2010 4. Rao P. N., Introduction to CAD/CAM Tata McGraw Hill Publishing Co. 5. B. S. Pabla, M. Adithan, CNC Machines, New Age International, 1994 6. Ian Gibson, David W. Rosen, Brent Stucker, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer 7. Geoffrey Boothroyd, Peter Dewhurst, Winston A. Knight, Product Design for Manufacture and Assembly, Third Edition,CRC Press 8. Antti Saaksvuori, AnselmiImmonen, Product Life Cycle Management - Springer, 1st Edition, 2003

Year: B.Tech. **Semester:VII**
Course : Mechanical Vibrations **Course Code: 17YME702**

Teaching Scheme (Hrs/Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	T	P	C	CIA-1	CIA-2	CIA-3	CIA-4	Lab	Theory	Lab	
3	-	2	3	10	20	10	10	-	50	50	150
Max. Time, End Semester Exam (Theory) – 3 Hrs									End Semester Exam (Lab):2Hrs		

Prerequisite	**1. Engineering Mechanics** **2.Theory of Machines & Mechanisms**

Course Objectives	
1	To understand the concepts of balancing problems of machines.
2	To develop analytical competency in solving vibration problems.
3	To make the student conversant with natural frequencies of forced vibration.
4	To make students familiar with critical speeds in machines.
5	To make the student conversant with fundamentals of vibration, noise & its control.

Course Content			
Unit No.	Module No.	Content	Hours
1	I	**Balancing** Balancing of rotating masses in one and several planes, balancing of reciprocating masses in single and multi cylinder engines: in-line, radial and V-type, primary and secondarybalancing analysis, concept of direct and reverse cranks method, static and dynamic balancingmachines.	9
2	I	**Fundamentals of Vibration** Elements of a vibratory system, S.H.M., degrees of freedom,modeling of a system, concept of linear and non-linear systems, equivalent spring, linear and torsional systems.	9
	II	**Single DOF System : Free Undamped & Damped Vibration** Natural frequency by equilibrium and energy methods for longitudinaland torsional vibrations. Different types of damping, equivalent viscous damping, freevibrations with viscous damping - over damped, critically damped and under dampedsystems, initial conditions, logarithmic decrement, dry friction or coulomb damping -frequency and rate of decay of oscillations.	
3	I	**Single DOF Systems : Forced Vibration**	9

		Forced vibrations of longitudinal and torsional systems, Frequency Response Functions - Simple harmonic excitation, excitation due to reciprocating and rotating unbalance, base excitation, magnification factor, resonance phenomenon and phase difference, Quality Factor, Vibration Isolation, Force and Motion transmissibility.	
4	I	**Two DOF System : Undamped Vibration** Free vibration of spring coupled systems – longitudinal and torsional, natural frequency and mode shapes, Free vibration of mass coupled systems, geared systems, Critical speed of shaft having single rotor of undamped systems.	9
5	I	**Noise Measurement** Fundamentals of noise Sound concepts, Decibel Level, , white noise, weighted sound pressure level, Logarithmic addition, subtraction and averaging, sound intensity, noise measurement, sound fields, octave band, sound reflection, absorption and transmission, pass-by-noise, Reverberation chamber, Anechoic Chamber, Human Exposure to Noise and Noise standards.	9
	II	**Noise Control –** Basics of noise and vibration, Control of natural frequency, Vibration isolators, andAbsorbers, Noise source control, path control, enclosures, absorbers, noise control at receiver (Nonumerical treatment)	
		Total No. of Hrs	**45Hrs**

Beyond the Syllabus
1.

Course Outcome	
Students should able to	
CO1	Students should able to find solutions on balancing problems of machines.
CO2	Ability to develop analytical competency in solving vibration problems.
CO3	Ability to calculate natural frequencies in forced vibration.
CO4	Students should able to find critical speed in rotary machines.
CO5	Ability to understand the fundamentals, measurement and control of vibration and noise.

List of Experiments	
Sr. No.	**Description**
1	Experimental verification of dynamic balancing of rotating masses.
2	To determine the natural frequency of damped vibration of single degree freedom systemand to find it's damping coefficient.
3	To verify natural frequency of torsional vibration of two rotor system and position of node.

4	To determine resonance frequency of transverse vibration of beam.
5	To determine the frequency response curve under different damping conditions for singledegree freedom system of vibration.
6	Measurement of vibration parameters like frequency, amplitude, velocity, acceleration ofany vibrating system by using vibration measuring instruments.
7	Noise measurement and analysis using appropriate instrument
8	To determine critical speed of single rotor system.
9	To study shock absorbers and to plot transmissibility curve.
10	Analysis of machine vibration, signature, using any analysis software package.

RecommendedResources	
Text Books	1. Rao S. S. —Mechanical Vibrations, Pearson Education Inc. New Delhi. 2. Grover G. K. —Mechanical Vibrations, New Chand and Bros.,Roorkee 3. Wiiliam J Palm III, —Mechanical Vibration,Wiley India Pvt. Ltd, New Delhi 4. UickerJ.John, Jr, Pennock Gordon R, Shigley Joseph E.—Theory of Machines and Mechanisms‖ International Version, OXFORD University Press, New Delhi. 5. M L Munjal, — Noise and Vibration Control,Cambridge University Press India
Reference Books	1. Weaver, — Vibration Problems in engineering‖ 5th Edition Wiley India Pvt. Ltd, New Delhi. 2. Bell, L. H. and Bell, D. H., —Industrial Noise Control – Fundamentals and Applications‖, Marcel Dekker Inc. 3. Alok Sinha — Vibration of Mechanical System‖, Cambridge university Press , India 4. Dr Debabrata Nag, — Mechanical Vibrations‖, Wiley India Pvt. Ltd, New Delhi. 4. . Shrikant Bhave, Mechanical Vibrations Theory and Practice, Pearson, NewDelhi.
E-Resources	1. https://nptel.ac.in/courses/112103112/

SANDIP UNIVERSITY

School of Engineering and Technology

Department of Mechanical Engineering

Year: B.Tech **Semester: VII**

Course :Design of Mechanical Systems **Course Code: 17YME703**

Teaching Scheme (Hrs/Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	T	P	C	CIA-1	CIA-2	CIA-3	CIA-4	Lab	Theory	Lab	
3	-	-	3	10	20	10	10	-	50	-	100
Max. Time,End Semester Exam (Theory) – 3 Hrs									End Semester Exam (Lab) - NA		

Prerequisite	**1. Manufacturing Process, Machine design.** **2.Engineering Mathematics, Theory of machines, IC Engines.**

Course Objectives	
1	To enable student to design cylinders and pressure vessels and to use IS code.
2	To enable student select materials and to design I.C. engine components.
3	Ability to apply the statistical considerations in design and analyze the defects and failure modes in Components.
4	To enable student to design machine tool gearbox.
5	To enable student to design material handling systems.

Course Content			
Unit No.	Module No.	Content	Hours
1	I	**Design of Belt conveyer system for material handling** System concept, basic principles, objectives of material handling system, unit load and containerization. Belt conveyors, Flat belt and troughed belt conveyors, capacity of conveyor, rubber covered and fabric ply belts, belt tensions, conveyor pulleys, belt idlers, tension take-up systems, power requirement of horizontal belt conveyors for frictional resistance of idler and pulleys.	9
2	I	**Design of I. C. Engine components** Introduction to selection of material for I. C. engine components, Design of cylinder and cylinder head, construction of cylinder liners, design of piston and piston-pins, piston rings, design of connecting rod, design of crank-shaft and crank-pin.	9
3	I	**Statistical considerations in design** Frequency distribution - Histogram and frequency Polygon, normal distribution - units of measurement of central tendency and dispersion - standard deviation - population	6

		combinations - design for natural tolerances, statistical analysis of tolerances, mechanical reliability and factor of safety.	
	II	**Design for manufacture, assembly and safety** General principles of design for manufacture and assembly (DFM and DMFA), principles of design of castings and forgings, design for machining, design for safety.	3
4	I	**Design of Machine Tool Gearbox** Introduction to machine tool gearboxes, design and its applications, basic considerations in design of drives, determination of variable speed range, graphical representation of speed and structure diagram, ray diagram, selection of optimum ray diagram, deviation diagram, difference between numbers of teeth of successive gears in a change gear box.	9
5	I	**Optimum Design** Objectives of optimum design, adequate and optimum design, Johnson's Method of optimum design, primary design equations, subsidiary design equations and limit equations, optimum design with normal specifications of simple machine elements: Tension bar, Transmission shaft and Pressure vessel, Introduction to redundant specifications.	9
		Total No. of Hrs	**45Hrs**

Beyond the Syllabus
1. Introduction to Optimization in design

Course Outcome	
Students should able to	
CO1	The student will understand the difference between component level design and system level design.
CO2	Ability to design various mechanical systems like pressure vessels, machine tool gear boxes, material handling systems, etc. for the specifications stated.
CO3	Ability to to handle system level projects from concept to product.
CO4	The student will understand to design various elements of gearbox.
CO5	Ability to design various material handling equipments.

RecommendedResources	
Text Books	1. Bhandari V.B. ―Design of Machine Elements‖, Tata McGraw Hill Pub. Co. Ltd. 2. Juvinal R.C, Fundamentals of Machine Components Design, Wiley, India
Reference Books	1. Shigley J. E. and Mischke C.R., ―Mechanical Engineering Design‖, McGraw Hill Pub. Co 2. M. F. Spotts, ―Mechanical Design Analysis‖, Prentice Hall Inc. 3. Black P.H. and O. Eugene Adams, ―Machine Design‖ McGraw Hill Book Co. Inc.

4. Johnson R.C., ―Mechanical Design Synthesis with Optimization Applications‖, Von Nostrand Reynold Pub.
5. S.K. Basu and D. K. Pal, ―Design of Machine Tools,,, Oxford and IBH Pub Co.
6. Rudenko,‖Material Handling Equipment‖, M.I.R. publishers, Moscow
7. P. Kannaiah ,‖Design of Transmission systems‖, SCIETCH Publications Pvt Ltd.
8. Pandy, N. C. and Shah, C. S., ―Elements of Machine Design―, Charotar Publishing House.
9. Mulani, I. G., ―Belt Conveyors‖
10. Singiresu S. Rao, Engineering Optimization: Theory and Practice, , John Wiley & Sons.
11. M.V. Joshi, Process Equipment Design, Mc-Millan.
12. Design Data―, P.S.G. College of Technology, Coimbatore.
13. Bhandari, V. B. Machine Design data book, Tata McGraw Hill Publication Co. Ltd.
14. I.S. 2825: Code for unfired pressure vessels.

SANDIP UNIVERSITY

School of Engineering and Technology
Department of Mechanical Engineering

Year: Final B.Tech | **Semester: VII**

Course : Process Equipment Design | **Course Code: 17YMEE--01**

Teaching Scheme (Hrs/Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	**T**	**P**	**C**	**CIA-1**	**CIA-2**	**CIA-3**	**CIA-4**	**Lab**	**Theory**	**Lab**	
3	0	0	**3**	10	20	10	10	-	50	-	100
Max. Time, End Semester Exam (Theory) -100									**End Semester Exam (Lab) - NA**		

Prerequisite	1. Design of Machine Elements **2.** Mechanics of Material

Course Objectives	
1	To understand the mechanical and process design methods for various process equipment.
2	To understand the designing for pressure vessels.
3	To understand the designing for heat exchangers.
4	To study the designing for distillation and absorption columns.

Course Content			
Unit No.	Module No.	Content	Hours
1	I	**INTRODUCTION:** Introduction to Chemical Engineering Design, Process design, Mechanical aspects of process equipment design, General design procedure, Equipment classifications, Design codes and standards (IS, ASTM and BS) **CRITERIA IN VESSEL DESIGN**: Properties of materials, Material of construction for various equipments and services, Material specifications, Fabrication techniques.	9 Hr
2	II	**DESIGN OF PRESSURE VESSELS:** Design of pressure vessels under internal pressure, Construction features, Pressure vessel code, Design of shell, various types of heads, nozzles, flanges for pressure vessel, Design and construction features of thick-walled pressure vessels, Various types of jackets and coils for reactors, Auxiliary process vessels	9 Hr
3	III	**SUPPORTS FOR VESSELS:** Design consideration for supports for process equipments, Design of brackets support, leg support skirt, support, saddle support. **DESIGN OF STORAGE VESSEL:** Storage of non-volatile and volatile liquids and gases, Codes for storage vessel design, Bottom,	9 Hr

		Roof and Shell designs.	
4	IV	**DESIGN OF VESSELS UNDER EXTERNAL PRESSURE:** Design criteria for external design pressure, vessels operated under vacuum, Use of stiffeners, Design of covers, pipes and tubes. **DESIGN OF HEAT EXCHANGERS:** Types of heat exchangers, Selection criteria, Design of heat exchangers- shell, tube, baffles, closures, channels, tube sheets etc.	9 Hr
5	V	**DESIGN OF DISTILLATION AND ABSORPTION COLUMNS** Basic features of tall vertical equipments/ towers, Towers/Column Internal, Design of tower shell and internals, supports etc. **PROCESS HAZARDS & SAFETY, MEASURES IN EQUIPMENT DESIGN:** Equipment testing, Analysis of hazards, Pressure relief devices. Safety measures in process equipment design	9 Hr
		Total No. of Hrs.	**45Hrs**

Course Outcome	
Students should able to	
CO1	Determine the parameters of equipment design and important steps involved in design.
CO2	Design pressure vessels.
CO3	Design heat exchangers.
CO4	Design of distillation and absorption columns.

RecommendedResources	
Text Books	1. Joshi's Process Equipment Design by V.V. Mahajani (Author), S.B. Umarji (Author). 2. Process Equipment Design by Brownell (Author), Young (Author)
Reference Books	1. Soares C., "Process Engineering Equipment Handbook", McGraw-Hill, New York, 2002. 2. Cheremisinoff N.P., "Handbook of Chemical Processing Equipment", Butterworth Heinemann, Oxford, 2000.
E-Resources	1. http://www.msubbu.in/ln/design/ 2. https://www.scribd.com/document/326216766/Process-Equipment-Design-by-Joshi

SANDIP UNIVERSITY

School of Engineering and Technology
Department of Mechanical Engineering

Year: BE B Tech **Semester: VII**
Course : Power Plant Engineering **Course Code:** 17YMEE--02

Teaching Scheme (Hrs/Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	**T**	**P**	**C**	**CIA-1**	**CIA-2**	**CIA-3**	**CIA-4**	**Lab**	**Theory**	**Lab**	
3	-	0	3	10	20	10	10	-	50	-	100
Max. Time, End Semester Exam (Theory) – 3 Hrs									**End Semester Exam (Lab) - NA**		

Prerequisite
1. **Fundamentals of Engineering Thermodynamics.**
2. **The usage of Property Tables and steam table.**

Course Objectives	
1	To acquire knowledge of economics of power plant and general information.
2	To study the steam power plant and various operations regarding it.
3	To have knowledge of steam turbines and its various parameters.
4	To get acquainted with Gas Turbine and its performance
5	To study the Hydro, nuclear and diesel power plants and environmental impact of the power plants.

Course Content			
Unit No.	Module No.	Content	Hours
1	I	**Introduction of Power Plants & Economics of Power Plants:** A) Global energy Scenario, Present status of power generation in India, in Maharashtra, Basic layouts of Steam, hydro, gas turbine, nuclear and diesel plants.	4
	II	B) Economics of Power Generation: Introduction, Cost of electric energy, Fixed and operating cost (with numerical treatment), Load curves, Load duration curves, Connected load, Maximum load, Peak load, base load, Load factor, Plant capacity factor, Plant use factor, Demand factor, Diversity factor (Simple numerical treatment),Selection and Type of generation, Tariff for electric energy.	5
2	I	**Steam Power Plant:** A.Introduction: General layout of modern power plant with different circuits, working and importance of each circuit, Site selection, comparison with other plants. B. Study of Rankine cycle with reheat and regeneration,	6

		Cogeneration power plant (simple numerical treatment-Cogeneration)	
	II	Steam Condenser: Necessity of steam condenser, Classification, Cooling water requirements, Condenser efficiency, Vacuum efficiency(Numerical Treatment), Cooling towers, Air Leakage, Effects of Air Leakage on condenser performance,	3
3	I	**Steam Turbines:**Classification, Description of common turbines, Impulse and reaction turbines- Introduction, single stage impulse turbine, compounding of turbines, velocity triangles, work output, Blade and stage efficiencies.	6
	II	Reaction turbines (no numerical treatment on reaction turbines)Comparison between impulse and reaction turbines. Governing of the steam turbines. Losses in turbines.	3
4	I	**Gas Turbine power plant:** Simple open cycle gas turbine power plant, Brayton cycle, Thermal Efficiency, Cycle air rate, work ratio (numerical treatment) Means of improving the efficiency and specific output. Closed cycle gas turbines,	6
	II	Classifications of the gas turbine power plants and gas turbines, arrangements of gas turbine power plants. Site selection, comparison with other plants.	3
5	I	**Hydro-electric power plant (HEPP), Nuclear power plant and Diesel Power Plant:** A) Hydroelectric Power Plant: Introduction, Site Selection, Advantages and Disadvantages of HEPP, Hydrograph, Flow duration curve, Mass Curve, Classification of HEPP with layout. B) Nuclear Power Plants: Elements of NPP, Nuclear reactor & its types (PWR, BWR, CANDU, Breeder, Gas cooled, Liquid metal cooled), fuels moderators, coolants, control rod, N-waste disposal C) Diesel Power Plant: Construction, working, selection parameters. D) Environmental impact due to power plants.	9
		Total No. of Hrs	**45Hrs**

Beyond the Syllabus
1. Introduction to nonconventional power plants.

Course Outcome	
Students should able to	
CO1	To understand the various economical terms and calculate various performance parameters.
CO2	To learn and calculate the performance parameters in steam power plant.

CO3	To know the fundamentals of steam turbines and its applications.
CO4	To estimate the performance of gas turbines and know it's applications.
CO5	To get acquainted with basic information of various power plants and environmental impact of power plants.

RecommendedResources	
Text Books	1. P.K.Nag, ―Power Plant Engineering‖, McGraw Hill Publications New Delhi. 2. R.K.Rajput, ―Power Plant Engineering‖, Laxmi Publications New Delhi. 3. R.Yadav , ―Steam and Gas Turbines‖ ,Central Publishing House, Allahabad.
Reference Books	1. K K Ramalingam ,‖ Power Plant Engineering, SCITECH Publications Pvt Ltd. 2. Domkundwar& Arora, ―Power Plant Engineering‖, Dhanpat Rai & Sons, New 3. D.K.Chavan&G.K.Phatak, ―Power Plant Engineering‖ , Standard Book House, New Delhi.
E-Resources	

Year: BE BTech **Semester: VII**
Course : Additive Manufacturing **Course Code: 17YMEE--03**

Teaching Scheme (Hrs/Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	**T**	**P**	**C**	**CIA-1**	**CIA-2**	**CIA-3**	**CIA-4**	**Lab**	**Theory**	**Lab**	
3	-	-	3	10	20	10	10	-	50	-	100
Max. Time, End Semester Exam (Theory) - NA									**End Semester Exam (Lab) - NA**		

Course Objectives	
1	Additive Manufacturing (AM) is an economically viable alternative to conventional manufacturing technologies for producing highly complex parts.
2	Course is to acquaint students with the concept of AM, various AM technologies.
3	Selection of materials for AM, modeling of AM processes, and their applications in various fields.
4	Course will also cover AM process plan including building strategies and post-processing.
5	To understand the concept of digiproneurship.

Course Content			
Unit No.	Module No.	Content	Hours
1	I	**Introduction to Additive Manufacturing (AM):** Introduction to AM, AM evolution, Distinctionbetween AM & CNC machining, Advantages of AM.	4
	II	**AM process chain:** Conceptualization, CAD, conversion to STL, Transfer to AM, STL filemanipulation, Machine setup, build , removal and clean up, post processing.	4
2	I	**Classification of AM processes:** Liquid polymer system, discrete particle system, moltenmaterial systems, and solid sheet system.	4
	II	**Design for AM:** Motivation, DFMA concepts and objectives, AM unique capabilities, Exploringdesign freedoms, Design tools for AM, Part Orientation, Removal of Supports, Hollowing outparts, Inclusion of Undercuts and Other Manufacturing Constraining Features, InterlockingFeatures, Reduction of Part Count in an Assembly, Identification of markings/ numbers etc.	5
3	I	**Guidelines for process selection:** Introduction, selection methods for a part, challenges ofselection, example system for preliminary selection, production planning and control	4
	II	**AM Applications:** Functional models, Pattern for investment and	5

		vacuum casting, Medicalmodels, art models, Engineering analysis models, Rapid tooling, new materials development, Bi-metallic parts, Re-manufacturing. Application examples for Aerospace, defense, automobile,Bio-medical and general engineering industries	
4	I	**Post processing of AM parts:** Support material removal, surface texture improvement,accuracy improvement, aesthetic improvement, preparation for use as a pattern, propertyenhancements using non-thermal and thermal techniques.	5
5	I	**Future Directions of AM:** Introduction, new types of products and employment anddigiproneurship.	5
		Total No. of Hrs	**36 Hrs**

Course Outcome
Students should able to
CO1
CO2
CO3
CO4

RecommendedResources	
Text Book(s):	1. C.K. Chua, K.F. Leong and C.S. Lim, Rapid prototyping: Principles and applications, 3 rd Edition, World Scientific, 2010. 2. Ian Gibson, David W. Rosen and Brent Stucker, Additive manufacturing technologies: rapid prototyping to direct digital manufacturing, Springer, 2010.
Reference Books	1. Chua Chee Kai, Leong Kah Fai, “Rapid Prototyping: Principles & Applications”, World Scientific, 2003. 2. Ian Gibson, David W Rosen, Brent Stucker., “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing”, Springer, 2010 3. Ali K. Kamrani, EmandAbouel Nasr, “Rapid Prototyping: Theory & Practice”, Springer, 2006. 4. D.T. Pham, S.S. Dimov, Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer 2001

SANDIP UNIVERSITY

School of Engineering and Technology

Department of Mechanical Engineering

Year: BE BTech **Semester: VII**

Course : Technology and Financial Management **Course Code: 17YMEE--04**

Teaching Scheme (Hrs/Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	**T**	**P**	**C**	**CIA-1**	**CIA-2**	**CIA-3**	**CIA-4**	**Lab**	**Theory**	**Lab**	
3	-	-	3	10	20	10	10	-	50	-	100
Max. Time, End Semester Exam (Theory) - 3Hrs									**End Semester Exam (Lab) -** NA		

Prerequisite	1. **Basic concepts of costing.** 2.**Applications of Quality tools.**

Course Objectives	
1	To understand the basics of finance and costing.
2	Identify economical route with supply and demand in market.
3	Develop and operate quality management tools.

Course Content			
Unit No.	Module No.	Content	Hours
1	I	**Finance and Costing:** **Finance-** Functions, Source of finance, National & International finance, Benefits & Limitations, Budgets & Budgeting Control. **Costing-**Significance of engineers, Traditional absorption costing, Marginal costing, Contract costing, Activity based costing, Process costing.	10
2	I	**Engineering Economic Analysis:** Basic concepts & price theory, Supply & Demand, Consumer behaviour, Law of reducing returns, Competition- types, equilibrium, Inflation & unemployment, Foreign trade, Balance of payment.	9
3	I	**Quality Management:** Fundamentals of TQM, Deming, Juran, Kaizen, JIT, ISO 9000, ISO 14000.	9
4	I	**Project Management:** Project life cycle, CPM, PERT, BOT, Public Private Participation	8
5	I	**HR Management:** Difference between personnel management & HR management,	9

		Role of HR Manager, Manpower planning, Merit rating, Training & Development, Retirement & Separation, Organizational Development & Behaviour, Management by objectives.	
		Total No. of Hrs	**45 Hrs**

Beyond the Syllabus
1. Development of knowledge based product and project. 2. Concept of Inventory models

Course Outcome	
Students should able to	
CO1	Develop a new project by effective finance and costing management.
CO2	Analyze supply and demand through engineering economics.
CO3	Implement Quality management tools.
CO4	Develop a project life cycle technique.

RecommendedResources	
Text Books	1. Lecture notes and reading material will be provided during the class.
Reference Books	1. S C Kuchal, Indian Economics 2. Prasad N K, Cost Accounting, Book Syndicate Pvt. Ltd., Kolkata 700 009 3. Collin Drury, Management & Cost Accounting, English Language Book 4. Series, Chapman & Hall, London [ISBN 0412 341204] 5. E Dessler, Human Resource Management 6. R S Dwivedi, Managing Human Resporces 7. Chase Operations Management for Competitive Advantage 8. B S Sahay, World Class Manufacturing 9. Juran, Quality Control Handbook 10. K Ishikawa, Guide to Quality Control 11. Fred Luthans, McGraw Hill Publications, Organizational Behaviour 12. Robbins S P, Prentice Hall Publications, Organizational Behaviour
E-Resources	1. https://nptel.ac.in/courses/105103023/39 2. https://nptel.ac.in/noc/individual_course.php?id=noc19-mg05

SANDIP UNIVERSITY

School of Engineering and Technology

Department of Mechanical Engineering

Year: B Tech **Semester: VII**

Course : Energy Audit & Management **Course Code: 17YMEO-08**

Teaching Scheme (Hrs/Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	**T**	**P**	**C**	**CIA-1**	**CIA-2**	**CIA-3**	**CIA-4**	**Lab**	**Theory**	**Lab**	
3	-	3	3	10	20	10	10	-	50	-	100
Max. Time, End Semester Exam (Theory) – 3 Hrs									**End Semester Exam (Lab) – NA**		

Prerequisite

1. **Fundamentals of Thermal Science.**
2. **Fundamentals of Sciences.**

Course Objectives	
1	To provide understand on the structure and functioning of energy management systems.
2	To train students on the auditing of management systems in general and energy management systems in particular.
3	To determine various methods to reduce consumption of energy and save cost.
4	To provide the knowledge to improve energy efficiency of overall system.
5	To provide adequate knowledge about electrical energy management and lightning system.

Course Content		
Unit No.	Module No.	Content
1	I	**GeneralAspectsofEnergyManagement:** Currentenergyscenario– IndiaandWorld,Currentenergyconsumptionpattern in globalandIndianindustry,PrinciplesofEnergymanagement,Energypolicy,Energy actionplanning,Energy securityandreliability,Energyandenvironment,Needof Renewableandenergyefficiency.
	II	Energy conservationopportunities in Boiler and steam system, Furnace, DG sets,HVACsystem,pumpingsystem,CoolingtowerandCompressedairsystem.
2	I	EnergyAuditing : NeedofEnergyAudit,Typesofenergyaudit,Componentsofenergyaudit
	II	Energyaudit methodology, Instruments, equipment used in energy audit, Analysis and recommendationsofenergyaudit– examplesfordifferentapplications,Energyaudit reporting, Energyauditsoftware.
	II	
3	I	EnergyEconomics : CostingofUtilities-

		Determinationofcostofsteam,naturalgas,compressedairand electricity.
	II	FinancialAnalysisTechniques– Simplepayback,Timevalueofmoney,NetPresentValue (NPV),ReturnonInvestment(ROI),InternalRateofReturn(IRR),RiskandSensitivityanalysis.
4	I	EnergyEfficiencyinThermalUtilities: Energy performanceassessmentandefficiency improvement of Boilers, Furnaces,Heatexchangers,Fansandblowers,pumps,CompressorsandHVACsystems. Steamdistribution,Assessmentofsteamdistributionlosses
5	I	ElectricalEnergyManagementandLighting: Electricitybilling,Electricalloadmanagementandmaximumdemandcontrol,Power factor improvementanditsbenefit,Selectionandlocationofcapacitors,Distribution and transformerlosses. Electrical motors- types, efficiency and selection. Speed control,Energyefficientmotors.ElectricityAct2003.
	II	Lighting -Lamp types and their features, recommended illumination levels, Lighting system energy efficiency.
		Total No. of Hrs

Beyond the Syllabus
1. Study of ISO 19011 and ISO 17021

Course Outcome	
Students should able to	
CO1	Carry out development, implementation and maintenance of ISO based Energy Management System.
CO2	Utilize the techniques and skills of Energy Management System Auditing.
CO3	Determine and apply financial techniques to various sectors.
CO4	Assess the energy performance of various mechanical systems and components
CO5	Carry out electrical tariff calculation and accurately predict the electricity bill required for the installation.

RecommendedResources	
Text Books	1. ISO 19011: 2011 - Guidelines for auditing management systems. 2. ISO 17021: 2011 - Conformity assessment — Requirements for bodies providing audit and certification of management systems. 3. ISO 50001: 2011 - Energy management systems — Requirements with guidance for use. 4. Bureau of energy efficiency, New Delhi, India: Guide Book - National certificate examination for energy management and energy audit, 2nd ed.2005 (Book I - General aspect of energy management and energy audit; Book II - Energy efficiency in thermal utilities; Book III - Energy efficiency in electrical utilities; and Book IV - Energy performance assessment for equipment & utility systems).
Reference Books	1. Wayne C. Turner, Steve Doty, "Energy Management Hand book", The Fairmont Press, 6th Edition, 2007. 2. Amit K. Tyagi, "Handbook on Energy Audits and Management", Tata Energy Research Institute, 2nd reprint, 2003. 3. Albert Thumann P.E. CEM, William J. Younger CEM, "Handbook of Energy Audit", The Fairmont Press Inc., 7th Edition. 4. L.C. Witte, P.S. Schmidt, D.R. Brown, "Industrial Energy Management and Utilization", Hemisphere Publication, Washington 5. Robert L.Loftness, "Energy Hand book", Second edition, Von Nostrand Reinhold Company
E-Resources	1. www.enrgymanagertraining.com 2. http://www.bee-india.nic.in

SANDIP UNIVERSITY

School of Engineering and Technology
Department of Mechanical Engineering

Year: B.Tech **Semester:VII**
Course :Entrepreneurship Development **Course Code: 17YMEA07**

Teaching Scheme (Hrs/Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	T	P	C	CIA-1	CIA-2	CIA-3	CIA-4	Lab	Theory	Lab	
-	-	-	2					-	-	50	50
Max. Time, End Semester Exam (Theory) - NA									End Semester Exam (Lab) – 2Hrs.		

Prerequisite **1. N/A**

Course Objectives	
1	Know what creativity is and master some techniques to accentuate it.
2	Know what Innovation is and understand why it is required.
3	Execute an innovative project in the area of your passion to learn the complete innovation life cycle.
4	Understand team dynamics in idea generation, development, and diffusion phases.
5	Innovation as a bridge to entrepreneurship.

Course Content			
Unit No.	Module No.	Content	Hours
1	I	**Fundamentals of Innovation** a) What is Innovation? b) Presentation tips c) A few case studies. d) How it is different from Invention e) Why it is required? f) The course structure & expectations g) Funding sources	5
2	II	**Getting Ready to Innovate** a) Discover your passion and challenge b) Decide innovation project c) Learn and use challenge analysis and innovation frameworks	5
3	III	**Accentuating Creativity** a) Learning techniques like 5 why, brainstorming, TRIZ b) Assessments of your creativity and improving it.	5
4	IV	**Idea Screening and Development** a) System Thinking b) Design Thinking c) Integration of both	5

		d) Idea screening methods e) Handling screening results f) Idea development g) Team dynamics	
5	V	**Idea Diffusion** a) Challenges b) Frameworks and their performance c) Simulation exercise	5
6	VI	**Entrepreneurial Plan** a) Assessment of individuals b) Development plans of individuals c) Identifying market, competitive advantages, and entry barriers d) Developing entrepreneurial plan	5
			30Hr

Beyond the Syllabus
1. Introduction to the concept of startups

Course Outcome	
Students should able to	
CO1	Know what creativity is and master some techniques to accentuate it.
CO2	Know what Innovation is and understand why it is required.
CO3	Execute an innovative project in the area of your passion to learn the complete innovation life cycle.
CO4	Understand team dynamics in idea generation, development, and diffusion phases.
CO5	Innovation as a bridge to entrepreneurship.

RecommendedResources	
Text Books	1. Fundamentals of Entrepreneurship Paperback – 2005by Mohanty (Author). 2. Entrepreneurship Development Paperback – 2017by Sharma (Author).
Reference Books	1.Rogers, E. (2003),The Diffusion of Innovation – Fifth Edition. Free Press. New York. 2. Munshi, P. (2009) Making Breakthrough Innovation Happen. India: Harper Collins Publishers 3. Hansen, M.T. and Birkinshaw, J. (2007), 'Innovation value chain', Harvard Business Review, June, pp.121–130. 4. Johansson, F. (2006),The Medici Effect. Boston, Massachusetts: Harvard Business School Press. 5. Dabholkar, Krishnan (2013), "8 steps to innovation", Harper Collins 6. Many more contemporary articles
E-Resources	1. https://www.toppr.com/guides/business-studies/entrepreneurship-development/need-for-entrepreneurship/ 2. https://www.youtube.com/watch?v=vXKoRWAhJVg

3. https://www.youtube.com/watch?v=5m_NDMCeKaE
4. https://www.youtube.com/watch?v=wbkpaA6LH80

SANDIP UNIVERSITY

School of Engineering and Technology

Department of Mechanical Engineering

Year: B.Tech **Semester: VII**

Course : Critical Thinking **Course Code: 17YMEA08**

Teaching Scheme (Hrs/Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	T	P	C	CIA-1	CIA-2	CIA-3	CIA-4	Lab	Theory	Lab	
-	-	-	2						-	50	50
Max. Time, End Semester Exam (Theory) - NA									End Semester Exam (Lab) - 2Hrs.		

Prerequisite **1. N/A**

Course Content			
Unit No.	Module No.	Content	Hours
1	I	**Introduction to Critical Thinking:** • What is Critical Thinking-It's role in problem solving. • The difference between a critical thinker and one who is not. • Barriers that prevent us from thinking critically. **Importance of Being Logical:** Key concepts of "Thinking fast and slow" - Logical fallacies & Mistakes , we make when do not think "statistically"	5
2	I	**Patterns in Deductive Logic** • Hypothetical syllogism - Categorical syllogism (Set theory concepts). • Argument by elimination, based on maths, based on definition. • Evaluating deductive arguments – validity & soundness.	5
3	I	**Argumentation – Foundation of Critical Thinking** • Recognizing arguments and their structural components & indicatorwords • Analysis of arguments • Categorical logic - VENN Diagrams to test logical "validity" • Propositional logic - Complex statements & arguments • Truth Tables – to test validity of complex statements	5
4	I	**Inductive Reasoning** • The importance of inductive reasoning in hypothesis testing, analytics, belief systems. • Evaluating the strength of an inductive argument.	5
5	I	**Basic Probability Concepts** • Probability & frequency distributions	5

		• Important parameters & measures • Bayesian probability	
			30Hr

RecommendedResources	
Text Books	1. Critical Thinking: Conceptual Perspectives and Practical Guidelines 1st Edition, Kindle Editionby Christopher P. Dwyer (Author) 2. The Art of Problem Solving 101: Improve Your Critical Thinking and Decision Making Skills and Learn How to Solve Problems Creatively Paperback – 17 Oct 2016by Michael Sloan (Author)
Reference Books	1. "Thinking Fast and Slow"- Daniel Kahneman – Penguin Books. 2. "Critical Thinking – Students Introduction" - Bassham, Irwin, Nardone, Wallace –McGraw Hill
E-Resources	1. https://www.youtube.com/watch?v=FMt_RIR_JHo 2. https://www.youtube.com/watch?v=kaCIycmx8NA 3. https://www.youtube.com/watch?v=gVhxvvpCglY 4. https://www.youtube.com/watch?v=9PsLktb7HTA

SANDIP UNIVERSITY

School of Engineering and Technology
Department of Mechanical Engineering

Year: B.Tech **Semester:VII**

Course :Introduction to Design of Experiments **Course Code: 17YMEA07**

Teaching Scheme (Hrs/Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	T	P	C	CIA-1	CIA-2	CIA-3	CIA-4	Lab	Theory	Lab	
-	-	-	2	-	-	-	-	-	-	50	50
Max. Time, End Semester Exam (Theory) - NA									End Semester Exam (Lab) - 2Hrs.		

Prerequisite **N/A**

Course Objectives	
1	Understand the issues and principles of Design of Experiments (DOE)
2	Understand experimentation is a process
3	List the guidelines for designing experiments
4	Recognize the key historical figures in DOE
5	Understand the Application Design of Experiments (DOE) through Case Study

Course Content			
Unit No.	Module No.	Content	Hours
1	I	**INTRODUCTION TO DOE:**History of the Design of Experiments (DOE), Basic Principles of DOE,Steps for Planning, Conducting and Analyzing an Experiment.	5
2	I	**REVIEW OF STATISTICS :** Normal Distribution, Distribution of Sample Plan, Confidence Interval, Hypothesis Testing	5
3	I	**FUNDAMENTALS OF EXPERIMENTAL DESIGN:** Experiment Test Strategies, Need for Statistically Designed Experiments, Analysis of Variance, Basic Principles of Design, Terminology used in DOE, Steps in Experimentation, Brainstorming, Cause and Effect Analysis.	5
4	I	**TAGUCHI METHOD:** Quality Loss Function, Taguchi Method, DOE using OR, Data Analysis from Taguchi Method. **(Example Based)**	5
5	I	Case Study-I (Application of DOE), Case Study-II (Application of DOE)	10
			30Hr

Beyond the Syllabus
1. Introduction to RSM

Course Outcome	
Students should able to	
CO1	Understand the issues and principles of Design of Experiments (DOE)
CO2	Understand experimentation is a process
CO3	List the guidelines for designing experiments
CO4	Recognize the key historical figures in DOE.
CO5	Understand the Application Design of Experiments (DOE) through Case Study

RecommendedResources	
Text Books	1. Applied Design of Experiments and Taguchi Methods by K. Krishnaiah, P. Shahabudeen, PHI Publication. 2. Design and Analysis of Experiments Paperback – 2012by Panneerselvam R (Author)
Reference Books	1.Design and Analysis of Experiments, 8ed, ISV (WSE) Paperback – 2013by Douglas C. Montgomery (Author) 2. Design and Analysis of Experiments, Volume 2: Advanced Experimental Design (Wiley Series in Probability and Statistics)by Klaus Hinkelmann and Oscar Kempthorne | 27 May 2005.
E-Resources	1. https://www.youtube.com/watch?v=k3lUo0XYG3E 2. https://methods.sagepub.com/video/introduction-to-experimental-design 3. https://www.youtube.com/watch?v=gsD8V2_eZ0A 4. https://www.youtube.com/watch?v=JY6NCfiTReE

SANDIP UNIVERSITY

School of Engineering and Technology
Department of Mechanical Engineering

Year: B.Tech **Semester:VII**

Course :Project Stage I **Course Code:17YME712**

Teaching Scheme (Hrs/Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	T	P	C	CIA-1	CIA-2	CIA-3	CIA-4	Lab	Theory	Lab	
-	-	6	3	-	-	-	-	-	-	100	100
Max. Time, End Semester Exam (Theory) - NA									End Semester Exam (Lab) - 2Hrs.		

Prerequisite **All the concepts of Mechanical Engineering**

Guidelines for Project Stage -I

The candidate shall submit the synopsis of the project work to the evaluation committee at the starting of forth year (Semester-VII). It shall include the problem definition, literature survey, the methodology for the project work etc.

A report of the work shall be submitted at the end of Semester VII after approval by the Guide and endorsement of the Head of Department. It will be assessed by the evaluation committee appointed by the Head of the Department, for appropriateness, sufficiency of contents and offer suggestions if any.

The candidate shall prepare a report of about 25-30 pages. The report typed on A4 sized paper and bound in the prescribed format and shall be submitted after approval by the Guide and endorsement of the Head of Department. The report copies must be duly signed by the guide and Head of department (one copy for university, one copy for guide and one copy for the candidate). Attendance of all students for all presentations scheduled in between for smooth conduction of this course is compulsory.

Note: Maximum two groups of four students per group, shall work under one faculty member of department. The group of one student is strictly not allowed.

INSTRUCTIONS FOR PROJECT WRITING

Guidelines: -

It is important that the procedures listed below be carefully followed by all the students of B.Tech. Mechanical Engineering.

1. Prepare Three Hard Bound Copies of your manuscript.

2. Limit your Dissertation report to 25 – 30 pages (preferably)

3. The footer must include the following:

University Name, B.Tech. Mechanical Engineering - Times New Roman 10 pt. and centrally aligned.

4. Page number as second line of footer, Times New Roman 10 Pt, centrally aligned.

5. Print the manuscript using

a) Letter quality computer printing.

b) The main part of manuscript should be Times New Roman 12 pt. with alignment - justified**.**

c) Use 1.5 line spacing.

d) Entire report shall be of 5- 7 chapters.

6. Use the paper size **8.5'' × 11''** or **A4 (210 × 197 mm).** Please follow the margins given below.

Margin Location	**Paper 8.5'' × 11''**	**Paper A4 (210 × 197 mm)**
Top	1''	25.4 mm
Left	1.5''	37 mm
Bottom	1.25''	32 mm
Right	1''	25.4 mm

7. All paragraphs will be 1.5 line spaced with a one blank line between each paragraph. Each paragraph will begin with without any indentation.

8. Section titles should be bold with 14 pt typed in all capital letters and should be left aligned.

9. Sub-Section headings should be aligning at the left with 12 pt, bold and Title Case (the first letter of each word is to be capitalized).

10. Illustrations (charts, drawings, photographs, figures) are to be in the text. Use only illustrations really pertinent to the text. Illustrations must be sharp, clear, black and white. Illustrations downloaded from internet are not acceptable.

a. Illustrations should not be more than two per page.

b. Figure No. and Title at bottom with 12 pt

c. Legends below the title in **10 pt**

d. Leave proper margin in all sides

e. Illustrations as far as possible should not be photo copied.

11. **Photographs** if any should of glossy prints

12.Use **SI** system of units only.

13.**Number the pages** on the front side, centrally below the footer

14. **References** should be either in order as they appear in the thesis or in alphabetical order by last name of first author

15. **Symbols** and **notations** if any should be included in nomenclature section only

16. Following will be the order of report

i. **Cover page** and **Front page** as per the specimen on separate sheet

ii. **Certificate** from the Institute as per the specimen on separate sheet

iii. **Acknowledgements**

iv. **List of Figures**

v. **List of Tables**

vi. **Nomenclature**

vii. **Contents**

viii. **Abstract** (A brief abstract of the report not more than 150 words. The heading of abstract i.e. word "Abstract" should be bold, Times New Roman, 12 pt and should be typed at the centre. The contents of abstract should be typed on new line without space between heading and contents. Try to include one or two sentences each on motive, method, key-results and conclusions in Abstract along with key words (preferably)

1 Introduction (2-3 pages) (TNR – 14 Bold)

1.1 Problem statement (TNR – 12)

1.2 Objectives

1.3 Scope

1.4 Methodology

1.5 Organization of Dissertation

2 Literature Review (15-20 pages)

Discuss the work done so far by researchers in the domain area and their significant conclusions. No derivations, figures, tables, graphs are expected.

3 This chapter shall be based on your own simulation work (Analytical/ Numerical/FEM/CFD) (8- 10 pages)

4 Concluding Remarks (1-2 pages)

References

ANNEXURE (if any) (Put all mathematical derivations, Simulation program etc. as Annexure)

17. All section headings and subheadings should be numbered. For sections use numbers **1, 2, 3, ….** and for subheadings **1.1**, **1.2**, **….** etc and section subheadings **2.1.1**, **2.1.2, ….** etc.

18. **References** should be given in the body of the text and well spread. No verbatim copy or excessive text from only one or two references. If **figures** and **tables** are taken from any reference then indicate source of it. Please follow the following procedure for references :

Reference Books

Doan, T. G. and Krenchel, A. J., Engineered interfaces in fibre reinforced composites, 4th ed., Shanghai University Press, China, 2003, pp. 218-224.

Papers from Journal or Transactions

Jung, D. S. and Radermacher, R., Transport properties and surface tension of pure and mixed refrigerants, *ASHRAE Trans*, 1991, 97 (1), pp. 90 – 98.

Bansal, P. K., Rupasinghe, A. S. and Jain, A. S., An empirical correction for sizing capillary tubes, *Int. Journal of Refrigeration*, 1996, 19 (8), pp.123-126.

Papers from Conference Proceedings

Colbourne, D. and Ritter, T. J., *Quantitative assessment of flammable refrigerants in room air conditioners*, Proc. of the Sixteenth International Compressor Engineering Conference and Ninth International Refrigeration and Air Conditioning Conference, Purdue University, West Lafayette, Indiana, USA, 2002, pp. 34 – 40.

Reports, Handbooks etc.

United Nations Environmental Programme, Report of the Refrigeration, Air Conditioning and Heat Pumps, Technical Option Committee, 2002, Assessment - 2002.

ASHRAE Handbook: Refrigeration, 1994 (Chapter 44)

Patent

Patent No., Country (in parenthesis), date of application, title, year.

Internet

www.(Site) [Give full length URL]