Fifth Semester

HTM-901A	Universal Human Values II: Understanding Harmony						
Lecture	**Tutorial**	**Practical**	**Credit**	**MajorTest**	**Minor Test**	**Total**	**Time**
3	**0**	**0**	**3.0**	**75**	**25**	**100**	**3 Hours**
Purpose	Purpose and motivation for the course, recapitulation from Universal Human Values-I						
Course Outcomes (CO)							
CO 1	Development of a holistic perspective based on self-exploration about themselves (human being),family, society and nature/existence.						
CO 2	Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence.						
CO 3	Strengthening of self-reflection.						
CO 4	Development of commitment and courage to act.						

Module 1: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education

1. Purpose and motivation for the course, recapitulation from Universal Human Values-I
2. Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' andExperiential Validation- as the process for self-exploration
3. Continuous Happiness and Prosperity- A look at basic Human Aspirations
4. Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment ofaspirations of every human being with their correct priority
5. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario
6. Method to fulfil the above human aspirations: understanding and living in harmony at variouslevels.

Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking

Module 2: Understanding Harmony in the Human Being - Harmony in Myself!

7. Understanding human being as a co-existence of the sentient 'I' and the material 'Body'
8. Understanding the needs of Self ('I') and 'Body' - happiness and physical facility
9. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer)
10. Understanding the characteristics and activities of 'I' and harmony in 'I'
11. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail
12. Programs to ensure Sanyam and Health.

Include practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease

Module 3: Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship

13. Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as thefoundational values of relationship

14. Understanding the meaning of Trust; Difference between intention and competence

15. Understanding the meaning of Respect, Difference between respect and differentiation; the othersalient values in relationship

16. Understanding the harmony in the society (society being an extension of family): Resolution,Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals

17. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- fromfamily to world family.

Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value inrelationships. Discuss with scenarios. Elicit examples from students' lives

Module 4: Understanding Harmony in the Nature and Existence - Whole existence as Coexistence

18. Understanding the harmony in the Nature

19. Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self-regulation in nature

20. Understanding Existence as Co-existence of mutually interacting units in all-pervasive space

21. Holistic perception of harmony at all levels of existence.

Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

Module 5: Implications of the above Holistic Understanding of Harmony on Professional Ethics

22. Natural acceptance of human values

23. Definitiveness of Ethical Human Conduct

24. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order

25. Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people- friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.

26. Case studies of typical holistic technologies, management models and production systems

27. Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations

28. Sum up.

Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions eg. to discuss the conduct as an engineer or scientist etc.

READINGS:

Text Book

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books,New Delhi, 2010

Reference Books

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J CKumarappa
8. Bharat Mein Angreji Raj - PanditSunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)

MODE OF CONDUCT

Lecture hours are to be used for lecture/practice sessions.

Lectures hours are to be used for interactive discussion, placing the proposals about the topics at handand motivating students to reflect, explore and verify them.

Practice hours are to be used for practice sessions.

While analysing and discussing the topic, the faculty mentor's role is in pointing to essential elements to help in sorting them out from the surface elements. In other words, help the students explore the important or critical elements.

In the discussions, particularly during practice sessions, the mentor encourages the student to connect with one's own self and do self-observation, self-reflection and self-exploration. Scenarios may be used to initiate discussion. The student is encouraged to take up" ordinary" situations rather than" extra-ordinary" situations. Such observations and their analyses are shared and discussed with other students and faculty mentor, in a group sitting.

Practice experiments are important for the course. The difference is that the laboratory is everyday life, and practical are how you behave and work in real life. Depending on the nature of topics, worksheets, home assignment and/or activity are included. The practice sessions would also provide support to a student in performing actions commensurate to his/her beliefs. It is intended that this would lead to development of commitment, namely behaving and working based on basic human values.

It is recommended that this content be placed before the student as it is, in the form of a basic foundation course, without including anything else or excluding any part of this content. Additional content may be offered in separate, higher courses.

This course is to be taught by faculty from every teaching department, including HSS faculty. Teacher preparation with a minimum exposure to at least one 8-day FDP on Universal Human Values is deemed essential.

ASSESSMENT:

This is a compulsory credit course. The assessment is to provide a fair state of development of the student, so participation in classroom discussions, self-assessment, peer assessment etc. will be used in evaluation.

Example:

Assessment by

faculty mentor: 5 marks

Self-assessment: 5 marks

Assessment by peers: 5 marks

Socially relevant project/Group Activities/Assignments: 10 marks

Semester End Examination: 75 marks

The overall pass percentage is 40%. In case the student fails, he/she must repeat the course.

B. Tech (5th Semester) Mechanical Engineering							
MEC- 301A	**HEAT TRANSFER**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs)**
3	**1**	**0**	**4**	**75**	**25**	**100**	**3**
Purpose	To build a solid foundation in heat transfer and rigorous treatment of governing equations and solution procedures.						
Course Outcomes							
CO1	After completing the course, students will be able to formulate and analyze a heat transfer problem involving any of the three modes of heat transfer.						
CO2	Students will be able to obtain exact solutions for the temperature variation using analytical methods where possible or employ approximate methods or empirical correlations to evaluate the rate of heat transfer.						
CO3	Students will be able to classify and evaluate the design parameters of devices such as heat exchangers and also estimate the insulation needed to reduce heat losses where necessary.						

UNIT-I

Introduction: Definition of heat, modes of heat transfer, basic laws of heat transfer, application of heat transfer, simple problems.

Conduction: Derivation of heat balance equation - steady one dimensional solution for conduction heat transfer in Cartesian, cylindrical and spherical geometry, concept of conduction and film resistances, steady one dimensional heat conduction without internal heat generation, the plane slab, the cylindrical shell, the spherical shell, conduction through composite wall, critical insulation thickness, variable thermal conductivity,steady one dimensional heat conduction with uniform internal heat generation, the plane slab, the cylindrical and spherical systems, heat transfer through fins of uniform cross-section, governing equation, temperature distribution and heat dissipation rate, effectiveness and efficiency of fins.

Transient conduction: Lumped system approximation and Biot number, approximate solution to unsteady conduction heat transfer by the use of Heisler charts.

UNIT-II

Convection: Heat convection, basic equations, boundary layers, forced convection, external and internal flows, natural convective heat transfer, dimensionless parameters for forced and free convection heat transfer, boundary layer analogies, correlations for forced and free convection, approximate solutions to laminar boundary layer equations (momentum and energy) for both internal and external flow, estimating heat transfer rates in laminar and turbulent flow situations using appropriate correlations for free and forced convection. Boiling and Condensation heat transfer, pool boiling curve, Nusselt theory of laminar film condensation.

UNIT-III

Radiation: Interaction of radiation with materials, definitions of radiative properties, monochromatic and total emissive power, Planck's distribution law, Stefan Boltzman's law, Wien's displacement law, Kirchoff's law, intensity of radiation, Lambert's cosine law, heat transfer between black surfaces, radiation shape factor, heat transfer between non-black surfaces: infinite parallel planes, infinite long concentric cylinders, small gray bodies and small body in large enclosure, electrical network approach, radiation shields.

UNIT-IV

Heat exchangers: Types of heat exchangers; overall heat transfer coefficient, fouling factor, analysis and design of heat exchangers using logarithmic mean temperature difference, and NTU method, effectiveness of heat exchangers, multipass heat exchangers, applications of heat exchangers.

Text books:

1. Fundamentals of Heat and Mass transfer – Frank P. Incropera, David P. Dewitt, T.L. Bergman and A.S. Lavine, Sixth Edition, Wiley Publications, 2007.
2. Heat Transfer: A Practical Approach - Yunus A Cengel, McGraw Hill, 2002.
3. Heat and Mass Transfer – P.K. Nag, Tata McGraw Hill.
4. Heat Transfer – J.P. Holman, Eighth Edition, McGraw Hill, 1997.

Reference books:

5. Heat Transfer – A. Bejan, John Wiley, 1993.
6. A Text book of Heat Transfer - S.P Sukhatme, University press.
7. Principles of Heat Transfer – MassoudKaviany, John Wiley, 2002.
8. Heat and Mass Transfer - D.S Kumar, S.K. Kataria& Sons.
9. Heat Transfer – Y.V.C. Rao, University Press.

Note: The paper setter will set the paper as per the question paper template provided.

B. Tech (5th Semester) Mechanical Engineering							
MEC-303A	**PRODUCTION TECHNOLOGY**						
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose:	To acquaint the knowledge of different type of machines and machine tools used in machining of metals,cutting tools used in different operations, work holding devices and CNC machines.						
Course Outcomes							
CO 1	After completing the course, students will be able to explain the working of different machines, machine tools and analyze the forces in machining operations.						
CO 2	Students will be able to explain different types of cutting tools and cutting fluids used in machining.						
CO 3	Students will be able to describemetrology and working of inspection tools for different applications.						
CO 4	Students will be able to explainvarious thread operations, different workholding devices and different gear manufacturing processes.						
CO 5	Students will be able to distinguish between the advancements in CNC and conventional machining methods and develop programing for parts production.						

UNIT-I

Theory of metal machining: Overview of machining technology: types of machining operation, cutting tools, cutting conditions, theory of chip formation in metal cutting: orthogonal cutting model, actual chip formation, forces relationships and the merchant equation: forces in metal cutting, the merchant equation, power and energy relationships in machining, cutting temperatures.

Machine tools and machining operations: Turning and related operations: cutting conditions, operations related to turning, engine lathe, other lathes and turning machines, boring machines, drilling and related operations: cutting conditions, operations related to drilling, drill presses, Milling: types of milling operations, cutting conditions, milling machines, high speed machining, grinding machines: types, wet and dry grinding, abrasives, grit, grade and structure of wheels, selection of grinding wheels.

UNIT-II

Technology and materials of cutting tools: Tool life, tool wear, taylor tool life equation, tool materials: high speed steels, cast cobalt alloys, cemented carbides, cermets and coated carbides, ceramics, synthetic diamonds and cubic boron nitrides, tool geometry: single point tool geometry, effect of tool material on tool geometry, multiple-cutting-edge tools, cutting fluids: types of cutting fluids, applications and selection of cutting fluids.

Metrology and inspection: Limits, fits, and tolerances, gauge design, interchangeability, linear, angular, and form measurements(straightness, squareness, flatness, roundness, and cylindricity) by mechanical and optical methods, inspection of screw threads, surface finish measurement by contact and non-contact methods, tolerance analysis in manufacturing and assembly.

UNIT-III

Threads: Standard forms of screw threads, methods of making threads, thread cutting on lathe, thread chasing, thread milling, thread rolling, thread grinding, thread tapping, automatic screw cutting machines, inspection and measurement of threads.

Workholding devices for machine tools: Introduction, conventional fixture design, tool design steps, clamping considerations, chip disposal, unloading and loading time, example of jig design, types of jigs, conventional fixtures, modular fixturing, setup and changeover: single-minute-exchange-of-die (SMED),

clamps, other workholding devices: assembly jigs, magnetic workholders, electrostatic workholders, economic justification of jigs and fixtures.

UNIT-IV

Gear manufacturing and finishing: Introduction to different types of gears, terminology, methods of gears manufacturing, gear forming: selecting a form gear cutter for cutting spur gears, selecting gear cutter for cutting helical or spiral gear, broaching of gears, generating methods: gear shaper process, rack planning process, gear hobbing process. Gear finishing operations: Shaving, burnishing, grinding, lapping, honing, gears inspection.

Computer numerical control (CNC) machines: Classification of CNC machines, modes of operation of CNC, Working of Machine Structure, Automatic tool changer (ATC), Automatic pallet changer (APC), CNC axis and motion nomenclature, CNC toolings – tool pre-setting, qualified tool, tool holders and inserts, Axes Identification in CNC turning and Machining centers, CNC part programming: Programming format and Structure of part programme, ISO G and M codes for turning and milling-meaning and applications of important codes.

Text Books:

1. Fundamentals of modern manufacturing: materials processing and systems by Mikell P. Grover, John Wiley and Sons.
2. Materials and processes in manufacturing by J.T. Black and R.A. Kohser, John Wiley and Sons.
3. Production Technology by R. K. Jain, Khanna Publishers.
4. Machine Tools by R. Kesavan& B. VijayaRamnath, Laxmi Publications.
5. Machining and Machine Tools by A. B. Chattopadhyay, WILEY INDIA.

Reference Books:

1. Principles of Machine Tools by G.C. Sen & A. Bhattacharya, Tata McGraw Hill, New Delhi
2. Manufacturing Engg. & Tech by S. KalpakJian and S.R. Schmid, Pearsons.
3. Modern Machining Processes by P.C. Pandey & H.S. Shan, T.M.H. Company, New Delhi
4. Production Engineering: P.C. Sharma, S.Chand& Sons.
5. Introduction to Jig and Tool Design byKempster M.H.A, Hodder& Stoughton, England

Note: The paper setter will set the paper as per the question paper template provided.

B.Tech. (5th Semester) Mechanical Engineering							
MEC-305A	**MECHANICAL VIBRATIONS AND TRIBOLOGY**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total Time**	**Time (Hrs)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose:	To understand the vibration systems with different degrees of freedom in different modes and conditions and the basics of tribology.						
Course Outcomes							
CO1	Students will be capable ofdescribing the fundamentals of vibration for a single degree of freedom (D.O.F.)system under free and damped vibrations.						
CO2	Students will be able to analyze different types of forced vibration system in single degree of freedom (D.O.F.) and damped, undamped, free and forced systems with two D.O.F.						
CO3	Students will be able to explain the principal modes of vibrations using different methods for various combinations of spring-mass, rotor-shaft systems; transverse, longitudinal and torsional vibration for beams, bars and shafts respectively.						
CO4	Students will be able to describe the fundamentals of tribology, lubrication, friction and wear.						

UNIT-I

Fundamentals: Introduction, elements of a vibratory system, periodic and S.H.M., degrees of freedom (DOF), types of vibrations, work done by a harmonic force, beats, problems.

Free vibration systems with single degree of freedom

Undamped systems: Introduction, differential equations, torsional vibrations, spring and shaft combinations: series & parallel, linear and torsional systems, compound pendulum, bifilar and trifilar suspensions, problems.

Damped systems: Introduction, types of damping, differential equations of damped free vibrations, initial conditions, logarithmic decrement, vibrational energy,problems.

UNIT-II

Forced vibration systems with single degree of freedom: Introduction, excitation and sources, equations of motion, rotating and reciprocating unbalanced system, support motion, vibration isolation, force and motion transmissibility, forced vibration system with different types of damping, vibration measuring instruments, resonance, bandwidth, quality factor and half power points, critical speed of shaft with and without damping with single and multiple discs, problems.

Two degree of freedom system: Introduction, torsional vibrations, principal modes of vibrations for two D.O.F., damped and undamped forced and free vibrations, semi-definite systems, co-ordinate coupling, spring and mass type vibration absorber, problems.

UNIT-III

Multi-degree of freedom systems: Introduction, principal modes of vibrations for three or more DOF, influence coefficients, orthogonality principle, matrix method, matrix iteration method, Dunkerley's equation, Holzer's Method, Rayleigh Method, Rayleigh-Ritz method, Stodola method,problems.

Continuous systems: Introduction, lateral vibrations of strings, longitudinal vibrations of bars, transverse vibration of beams, torsional vibration of uniform shafts, problems.

UNIT-IV

Tribology: Introduction, tribology in design, tribology in industry, economic aspects.

Lubrication: Introduction, basic modes of lubrication, lubricants, properties of lubricants: physical and chemical, types of additives, extreme pressure lubricants, recycling of used oils and oil conservation, disposal of scrap oil, oil emulsion.

Friction and wear: Introduction, laws of friction, kinds of friction, causes of friction, friction measurement, theories of friction, effect of surface preparation. Introduction to wear, types of wear, various factors affecting wear, measurement of wear, wear between solids and liquids, theories of wear.

Text Books:

1. Mechanical Vibrations by G. K. Grover, Nem Chand and Bros., Roorkee
2. Elements of Mechanical Vibrations byMeirovitch, McGraw Hill
3. Introductory course on theory and practice of Mechanical Vibration by J.S. Rao and K.Gupta, New Age International.
4. Friction and wear of Materials by E. Robinowicz, Johan Wiley
5. Tribology an Introduction by Sushil Kumar Srivastava
6. Introduction to Tribology and Bearings byB. C. Majumdar, S. Chand and Company Ltd. New Delhi.

Reference Books:

1. Mechanical Vibrations by S. S. Rao, Pearson Education Inc. Dorling Kindersley (India) Pvt. Ltd. New Delhi.
2. Mechanical Vibrations byV.P. Singh, DhanpatRai& Co. Pvt. Ltd., Delhi
3. Engineering Tribology by PrashantSahoo, PHI publications.
4. Principles of Tribology byJ. Hailing, McMillan Press Ltd.

Note: The paper setter will set the paper as per the question paper template provided.

B. Tech. (5th Semester) Mechanical Engineering								
MEC- 307LA	**HEAT TRANSFER LAB**							
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Practical**	**Total**	**Time (Hrs)**
0	**0**	**2**	**1**	**0**	**40**	**60**	**100**	**3**
Purpose	To impart practical knowledge ofdifferent modes of heat transfer by conducting experiments.							
Course Outcomes								
CO1	Students will be able to design and conduct experiments, acquire data, analyze and interpret data.							
CO2	Students will be able to measure the thermal conductivity of metal rod, insulating material and liquids.							
CO3	Students will be able to explain the concept of composite wall and determine its thermal resistance.							
CO4	Students will be able to evaluate heat transfer coefficients in free and forced convection.							
CO5	Students will be able to measure the performance of a heat exchanger.							
CO6	Students will be able to determine the Stefan Boltzmann constant and emissivity.							

List of Experiments:

1. To determine the thermal conductivity of a metal rod.
2. To determine the thermal conductivity of an insulating slab.
3. To determine the thermal conductivity of a liquid using Guard plate method.
4. To determine the thermal conductivity of an insulating powder.
5. To determine the thermal resistance of a composite wall.
6. To plot the temperature distribution of a pin fin in free-convection.
7. To plot the temperature distribution of a pin fin in forced-convection.
8. To study the forced convection heat transfer from a cylindrical surface.
9. To determine the effectiveness of a concentric tube heat exchanger in a parallel flow arrangement.
10. To determine the effectiveness of a concentric tube heat exchanger in a counter flow arrangement.
11. To determine the Stefan-Boltzman constant.
12. To determine the emissivity of a given plate.
13. To determine the critical heat flux of a given wire.
14. To study the performance of an evacuated tube based solar water heater.

Note: At least eight experiments are required to be performed by students from the above list and two may be performed from the experiments developed by the institute.

B. Tech. (5th Semester) Mechanical Engineering								
MEC-309LA	**PRODUCTION TECHNOLOGY LAB**							
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Practical**	**Total**	**Time (Hrs.)**
0	**0**	**2**	**1**	**0**	**40**	**60**	**100**	**3**
Purpose	To impart practical knowledge of various measuring instruments, machining and welding operations by performing experiments.							
Course Outcomes								
CO 1	Students will be able to measure the linear and angular dimensions using various							
CO 2	Students will be able to executevarious machining operations for the preparation of jobs on different machine tools.							
CO 3	Students will be able to create various jobs using TIG/MIG welding.							
CO 4	Students will be able to develop jobs on CNC lathe and CNC milling.							

LIST OF EXPERIMENTS:

1. Study of linear, angular measuring devices and to measure the linear and angular dimensions using various equipment's.
2. Manufacture and assembly of a unit consisting of 2 to 3 components to have the concept of tolerances and fits (shaft and bush assembly or shaft, key and bush assembly or any suitable assembly).
3. To prepare a job on a lathe having various operations viz. drilling, boring, taper turning, thread cutting, knurling, etc.
4. Demonstration of formation of cutting parameters of single point cutting tool using bench grinder / tool & cutter grinder.
5. To make a spur gear of given part drawing involving operations namely drilling, boring, reaming, honing, key slotting, gear teeth machining, lapping and gear teeth finishing.
6. Introduction to various grinding wheels and demonstration on the cylindrical and surface grinder.
7. To demonstrate surface milling /slot milling.
8. To cut gear teeth on milling machine using dividing head.
9. To cut V Groove/ dovetail / Rectangular groove using a shaper.
10. To prepare a useful product containing different types of welded joints using simple arc/TIG/MIG welding set.
11. To cut external threads on a lathe and practice thread measurements.
12. To study CNC lathe trainer and its components (hardware and software) especially controllers (Fanuc and Siemens) and make a CNC programme using APT language of given part drawing for machining cylindrical job involving operations namely turning, step turning, taper turning, threading, radius contour cutting, chamfering etc.
13. To study CNC milling trainer and its components (hardware and software) especially controllers (Fanuc and Siemens) and make a CNC programme using APT language of given drawing for

milling job operations namely end cutting, side cutting, contour cutting, face cutting, etc. and run the programme in simulation and actual mode in Cut Viewer or other software and run the program in actual mode using CNC controllers.

.**Note:**At least eight experiments are required to be performed by students from the above list and two may be performed from the experiments developed by the institute.

B. Tech. (5th Semester) Mechanical Engineering								
MEC-311LA	**MECHANICAL VIBRATIONSAND TRIBOLOGY LAB**							
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Practical**	**Total Time**	**Time (Hrs.)**
0	**0**	**2**	**1**	**0**	**40**	**60**	**100**	**3**
Purpose:	To provide practical knowledge of free and forced vibration systemfundamentalsand the mechanisms of friction, wear and lubrication.							
Course Outcomes								
CO1	Students will be able to evaluatefree and forced vibrationsof various elements in Universal Vibration Apparatus.							
CO2	Students will be able to measure the surface roughness of different materials and analyse the machinery faults, causes and sources using Machinery Fault Simulator (MFS).							
CO3	Students will be able to analyse the sliding wear and abrasive behavior of different materials using wear and friction monitoring apparatus and dry abrasion tester respectively.							
CO4	Students will be able to evaluate extreme pressure properties of different lubricants using four ball tester.							

LIST OF EXPERIMENTS:

1. To study undamped free vibrations and determine the natural frequency of:
   1.1 Spring mass system
   1.2 Simple Pendulum
   1.3 Torsional spring type double pendulum and compare them with theoretical values.
2. To study the torsional vibration of a single rotor shaft system and determine the natural frequency.
3. To study the free vibration of system for different damper settings. Draw decay curve and determine the log decrement and damping factor. Find also the natural frequency.
4. To verify the Dunkerley's rule.
5. To determine the radius of gyration for:
   5.1 Bifilar suspension.
   5.2 Compound pendulum.
   5.3 Trifilar suspension.
6. To study the forced vibration system with damping, Load magnification factor vs. Frequency and phase angle vs frequency curves. Also determine the damping factor.
7. To find out and locate machinery faults viz. vibrations and unbalancing using Machinery Fault Simulator (MFS) in:
   7.1 Direct Driven reciprocating pump;
   7.2 Direct Driven centrifugal pump;
   7.3 Defective straight tooth gearbox pinions.
8. To determine the wear rate, friction force and coefficient of friction of a metallic pin/ball by using wear and friction monitor apparatus.
9. To determine abrasion index of a material with the help of dry abrasion test rig.
10. To evaluate the wear and extreme pressure properties of a lubricating oil by using four ball tester.

11. To determine the roughness of a specimen using surface roughness tester.

Note: At least eight experiments are required to be performed by students from the above list and two may be performed from the experiments developed by the institute.

B. Tech. (5th Semester) Mechanical Engineering								
MEC-313 LA	**PROJECT-I**							
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Practical**	**Total Time**	**Time (Hrs.)**
0	**0**	**2**	**1**	**--**	**0**	**100**	**100**	**3**
Purpose:	To implement the engineering principles and theories into innovative practical projects for solving real world problems.							
Course Outcomes								
CO1	Students will be able to apply the theoretical knowledge into practical/software projects.							
CO2	Students will be able to design new productsusing latest technologies.							

The project work could be done for the problem statement of an industry or practical project in the institute. The students may also opt for the analysis based software projects with proper validation. Participation in any technical event/ competition to fabricate and demonstrate an innovative machine or product could be encouraged under this course.

Note: The maximum number of students in a group should not exceed four.

	B.Tech. (5th Semester) Mechanical Engineering							
MEC-315A	**INDUSTRIAL TRAINING-II**							
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Practical**	**Total**	**Time (Hrs.)**
2	**0**	**0**	**--**	**--**	**100**	**--**	**100**	**--**
Purpose	To providean industrial exposure to the students and enhance their skills and creative capability for conversion of their innovative ideas into physical reality.							
Course Outcomes								
CO 1	Students will be able toself-improve through continuous professional development and life-long learning.							
CO 2	Students will beable to develop social, cultural, global and environmental responsibility as an engineer.							
CO 3	Students will be able to weighall the latest changes in technological world.							

Note:MEC-315 is a mandatory non-credit course in which the students will be evaluated for the industrial training undergone after 4thsemester and students will be required to get passing marks to qualify.

The candidate has to submit a training report of his/her work/project/assignment completed in the industry during the training period. The evaluation will be made on the basis of submitted training report and viva-voce/presentation.

	B.Tech. (5th Semester) Mechanical Engineering							
MC-903A	**ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE**							
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Practical**	**Total**	**Time (Hrs.)**
3	**0**	**0**	**--**	**100**	**--**	**--**	**100**	**3**
Purpose	To impart basic principles of thought process, reasoning and inferencing.							
Course Outcomes								
CO 1	Students will be able to understand, connect up and explain basics of Indian traditional knowledge in modern scientific perspective.							

Course Contents

- Basic structure of Indian Knowledge System: अष्टादशविद्या -४वेद,४उपवेद (आयुर्वेद, धनुर्वेद, गन्धर्ववेद, स्थापत्य आदि) ६वेदांग (शिक्षा, कल्प, निरुक्त, व्याकरण, ज्योतिष, छंद) ४ उपाङ्ग (धर्मशास्त्र, मीमांसा, पुराण, तर्कशास्त्र)
- Modern Science and Indian Knowledge System
- Yoga and Holistic Health care
- Case studies

References

- V. Sivaramakrishnan (Ed.), *Cultural Heritage of India-course material*, Bharatiya Vidya Bhavan, Mumbai. 5th Edition, 2014
- Swami Jitatmanand, *Modern Physics and Vedant*, Bharatiya Vidya Bhavan
- Swami Jitatmanand, *Holistic Science and Vedant*, Bharatiya Vidya Bhavan
- Fritzof Capra, *Tao of Physics*
- Fritzof Capra, *The Wave of life*
- VN Jha (Eng. Trans.), *Tarkasangraha of Annam Bhatta*, International Chinmay Foundation, Velliarnad, Arnakulam
- *Yoga Sutra of Patanjali*, Ramakrishna Mission, Kolkata
- GN Jha (Eng. Trans.), Ed. RN Jha, *Yoga-darshanam with Vyasa Bhashya*, Vidyanidhi Prakashan, Delhi 2016
- RN Jha, *Science of Consciousness Psychotherapyand Yoga Practices*, Vidyanidhi Prakashan, Delhi 2016
- P B Sharma (English translation), *Shodashang Hridayan*

Pedagogy: Problem based learning, group discussions, collaborative mini projects.

Note: The paper setter will set the paper as per the question paper template provided.

Sixth Semester

B. Tech (6th Semester) Mechanical Engineering							
HM-901A	**ORGANIZATIONAL BEHAVIOUR**						
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose:	To make the students conversant with the basics concepts of organizational culture and behavior fornurturingtheirmanagerial skills.						
Course Outcomes							
CO 1	An overview about organizational behavior as a discipline and understanding the concept of individualbehavior.						
CO 2	Understand the concept and importance of personality, emotions and its importance in decision makingandeffectiveleadership.						
CO 3	Enablingthe students to know about the importance of effective motivationandits contributionin groupdynamicsandresolvingconflicts.						
CO 4	Understand how to overcome organizational stress by maintaining proper organizational culture andeffective communication						

UNIT-I

Introduction to organizational behavior: Concept and importance of organizational behavior, role of ManagersinOB,foundationsorapproachestoorganizationalbehavior,challengesandopportunitiesforOB.

Foundation of individual behavior: Biographical characteristics, concept of abilities and learning, learning and learning cycle, components of learning, concept of values and attitude, types of attitude, attitude and workforcediversity.

UNIT-II

Introduction to personality and emotions: Definition and Meaning of Personality, Determinants of Personality, Personality Traits Influencing OB, Nature and Meaning of Emotions, Emotions dimensions, concept of Emotional intelligence.

Perception and individual decision making: meaning of perception, factors influencing perception, rational decision making process, concept of bounded rationality. Leadership-trait approaches, behavioural approaches, situational approaches,andemergingapproachestoleadership.

UNIT-III

Motivation: Concept and theories of motivation, theories of motivation-Maslow, two factor theory, theory X and Y,ERG Theory, McClelland's theory of needs, goal setting theory, application of theories in organizational scenario, linkage between MBO and goal setting theory, employee recognition and involvement program.

Foundations of group behavior and conflict management: Defining and classifying of groups, stages of group development, Informal and formal groups- group dynamics, managing conflict and negotiation, a contemporary perspective of intergroup conflict, causes of group conflicts, managing intergroup conflict through resolution.

UNIT-IV

Introduction to Organizational Communication: Meaning and importance of communication process, importance of organizational communication, effective communication, organizational stress: definition and meaning sources and types of stress, impact of stress on organizations, stress management techniques.

Introduction to Organization Culture: Meaning and nature of organization culture, types of culture, managing cultural diversity, managing change and innovation-change at work, resistance to change, a model for managing organizational change.

TextBooks:

1. Colquitt,JasonA.,JefferyA.LePine, andMichaelWesson.OrganizationalBehavior: Improving Performance and Commitment in the Workplace. 5th ed. New York: McGraw-HillEducation,2017.
2. Hitt, Michael A., C. Chet Miller, and Adrienne Colella.Organizational Behavior. 4th ed.Hoboken,NJ:JohnWiley, 2015.
3. Robbins, Stephen P., and Timothy Judge.Organizational Behavior. 17th ed. Harlow, UK:PearsonEducation,2017. Stephen P. Robins, Organisational Behavior, PHI Learning / Pearson Education, 11thedition,2008.

ReferenceBooks:

1. Schermerhorn, Hunt and Osborn, Organisationalbehavior, John Wiley.
2. UdaiPareek, Understanding OrganisationalBehaviour, Oxford Higher Education.
3. Mc Shane & Von Glinov, OrganisationalBehaviour, Tata McGrawHill.
4. Aswathappa, K., OrganisationalBehaviour– Text and Problem, Himalaya Publication.

Note: The paper setter will set the paper as per the question paper template provided.

B. Tech. (6th Semester) Mechanical Engineering							
MEC-302A	**MANUFACTURING TECHNOLOGY**						
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose:	To build a foundation in different manufacturing processes related to castings, metal forming, joining, powder metallurgy and plastic material shaping processes.						
Course Outcomes							
CO 1	Studentswill be able to explain the fundamentals of casting processes and evaluate design parameters.						
CO 2	Students will be able to describe different metal forming processes and analysis.						
CO 3	Students will be able to explain different welding processes with their applications.						
CO 4	Students will be able to evaluate design parameters of powder metallurgy processes andexplain different powder metallurgy andplastic shaping processes.						

UNIT-I

Fundamentals of castings: Introduction to casting: basic requirements of casting processes, casting terminology, solidification process: cooling curves, prediction of solidification time,the cast structure, molten metal problems, fluidity and pouring temperature, role of gating system, solidification shrinkage, riser and riser design, risering aids, Patterns, design considerations in castings.

Expandable-mold casting processes: Sand casting, cores and core making, other expendable-mold processes with multiple use patterns, expendable-mold processes with multiple use patterns, shakeout, cleaning and finishing.**Multiple-use-mold casting processes**: Permanent mold casting, die casting, squeeze casting and semisolid metal casting, centrifugal casting, cleaning treating and heat treating of castings, automation in foundry operations.

UNIT-II

Metal forming processes: classifications of metal forming processes, bulk deformation processes, material behavior in metal forming, temperature in metal forming, rolling: flat rolling and its analysis, shape rolling, rolling mills, forging: open-die forging, impression-die forging, flashless forging, forging hammers, presses, and dies, extrusion: types of extrusion, analysis of extrusion, extrusion dies and presses, defects in extruded products, wire and bar drawing, analysis of drawing, drawing practice, tube drawing

Sheet metal working: Cutting operations: shearing, blanking, and punching, engineering analysis of sheet-metal cutting, other sheet-metal-cutting operations, bending operations: v-bending and edge bending, engineering analysis of bending, drawing: mechanics of drawing, engineering analysis of drawing, defects in drawing.

UNIT-III

Joining processes: Principles of fusion welding processes, arc welding processes-consumable electrodes: shielded metal arc welding, gas metal arc welding, flux-cored arc welding, submerged arc welding, Arc welding processes-non-consumable electrodes: gas tungsten arc welding, plasma arc welding, resistance welding processes, other fusion-welding processes: electron-beam welding, laser-beam welding, electro-slag welding, thermit welding.

Principles of solid state welding processes: friction welding, explosive welding, ultrasonic welding processes.**Brazing, soldering, and adhesive bonding:**Principles of adhesive, brazing and soldering processes, origins of welding defects.

UNIT-IV

Powder metallurgy: Characterization of engineering powders: geometric features, other features production of metallic powders: atomization: other production methods, conventional pressing and sintering: blending and mixing of the powders, compaction, sintering, heat treatment and finishing, design considerations in powder metallurgy.

Shaping processes for plastics: Properties of polymer melts, extrusion, production of sheet and film, fiber and filament production (spinning), coating processes, injection molding, compression and transfer molding, blow molding and rotational molding, thermoforming.

Text Books:

1. Fundamentals of modern manufacturing: materials processing and systems by Mikell P. Grover, John Wiley and Sons.
2. Materials and processes in manufacturing by J.T. Black and R.A. Kohser, John Wiley and Sons.
3. Principles of Manufacturing Materials & Processes by Campbell J. S., Publisher – McGraw Hill.
4. Production Technology by R. K. Jain, Khanna Publishers
5. Manufacturing Technology-Foundry, Forming and Welding by P.N. Rao, Tata McGraw Hill
6. Advanced Manufacturing Process by Hofy, H.E., B and H Publication.
7. Manufacturing Science by Ghosh, A. and Mullik, A, East –West private Limited.

Reference Books:

1. Welding and Welding Technology by Richard L. Little Tata McGraw Hill Ltd.
2. Manufacturing Processes and Systems by Ostwald Phillip F., Munoz Jairo, John Wiley & Sons
3. Elements of Manufacturing Processes by B.S. NagendraParasher, RK Mittal, PHI N. Delhi

Note: The paper setter will set the paper as per the question paper template provided.

B. Tech. (6th Semester) Mechanical Engineering							
MEC-304A	**DESIGN OF MACHINE ELEMENTS**						
Lecture	**Tutorial**	**Practical**	**Credits**	**Major test**	**Minor Test**	**Total**	**Time (Hrs.)**
2	**4**	**0**	**6**	**75**	**25**	**100**	**4**
Purpose	To understand the fundamentals for solving engineering problems relating to design of machine components.						
Course Outcomes							
CO1	Students willbe able to explainthe design procedures and methods, properties of engineering materials and their selection, design against static and fluctuating loads.						
CO2	Students will be able to solve the design problems of different types of joints i.e. bolted, riveted joint and welded joint and the problems related to the design of springsunder different loading conditions.						
CO3	Students will be able to analyse the transmission shafts and keys.						
CO4	Students will be able to solve the design problems related to clutches and brakes and selection of bearings from manufacturer's catalogue.						

UNIT-I

Introduction: Basic procedure of the design of machine elements, standards in machine design, selection of preferred sizes, engineering materials, properties and selection,BIS system of designation of steels.

Design against static load: Modes of failure, factor of safety, stress concentration: causes and mitigation.

Design against fluctuating load: Fluctuating stresses, endurance limit, low cycle and high cycle fatigue, notch sensitivity, endurance limit-approximate estimation, reversed stresses- design for finite and infinite life, cumulative damage in fatigue, Soderberg and Goodman lines, Modified Goodman diagrams.

UNIT-II

Bolted, riveted and welded Joints:Bolt of uniform strength**,** bolted joint- simple analysis,eccentrically loaded bolted joints, riveted joints for boiler shell according to I. B. R., riveted structural joint, eccentrically loaded riveted joint, types of welded joints, strength of welds under axial load, welds under eccentric loading.

Springs: Types of spring, helical spring terminology, design for helical springs, spring design-trial and error method, design against fluctuating load, surge in springs, design of leaf springs, rubber springs.

UNIT-III

Transmission shafts: Shaft design on strength basis and torsional rigidity basis, ASME code for shaft design, design of hollow shaft on strength basis and torsional rigidity basis, **Keys:**types of keys, design of square and flat keys.

Clutches: Various types of clutches, design of friction clutches-single disc, multi-disc, cone and centrifugal clutches, torque transmitting capacity, friction materials, thermal considerations.

Brakes: Energy equations, block brake with short shoe, block brake with long shoe, internal expanding brake, band brakes, disc brakes, thermal considerations.

UNIT-IV

Rolling contact bearings: Types of rolling contact bearing, selection of bearing-type, static and dynamic load carrying capacity, equivalent bearing load, load-life relationship, selection of bearings from manufacturer's catalogue, selection of taper roller bearing, design for cyclic loads and speeds, bearing failure-causes and analysis.

Sliding contact bearings: Basic modes of lubrication, Raimondi and Boyd method, bearing design-selection of parameters, bearing materials, bearings failure-causes and remidies.

Text Books:

1. Mechanical Engineering Design by Joseph E. Shigley and Charles R. Mischke, Tata McGraw Hill Book Co.
2. Design of Machine Element byV. B. Bhandari, McGraw Hill Edu. Pvt. Ltd.
3. Machine Design by R.S. Khurmi and J.K. Gupta, S. Chand.

Reference Books:

1. Machine Component Design by Robert C. Juvinall and Kurt M. Marshek, Wiley India Pvt. Ltd.
2. Mechanical Design of Machine Elements and Machines by Collins and Busby, Wiley India Pvt. Ltd.
3. Machine Design by U.C. Jindal, Pearsons publications.
4. Analysis and Design of Machine elements by V.K.Jadon and Suresh Verma, IK International Publishing House.

Design Data Books:

1. Design Data Book of Engineers, Compiled by Faculty of Mechanical Engineering, PSG College of Technology, Publisher KalaikathirAchchagam, Coimbataore, 2009.
2. Design Data Handbook for Mechanical Engineers in SI and Metric Units byMahadevan and Balaveera Reddy.

Note: The paper setter will set the paper as per the question paper template provided.

B. Tech. (6th Semester) Mechanical Engineering								
MEC-310 LA	**PROJECT-II**							
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Practical**	**Total Time**	**Time (Hrs.)**
0	**0**	**6**	**3**	**--**	**0**	**100**	**100**	**3**
Purpose	To implement the engineering principles and theories into innovative practical projects for solving real world problems.							
Course Outcomes								
CO1	Students will be able to apply the theoretical knowledge into practical/software projects.							
CO2	Students will be able to design new products using latest technologies.							

The project work could be done for the problem statement of an industry or practical project in the institute. The analysis based software projects undergone in the previous semester can be extended to its fabrication i.e. functional machine/product in this semester. Participation in any technical event/ competition to fabricate and demonstrate an innovative machine or product could be encouraged under this course.

Note: The maximum number of students in a group should not exceed four.

B. Tech. (6th Semester) Mechanical Engineering							
MEP-302A	**INTERNAL COMBUSTION ENGINES**						
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**1**	**0**	**4**	**75**	**25**	**100**	**3**
Purpose:	To provide the detailed understanding of internal combustion engine, air compressors and gas turbines mainly based on its performance and emission parameters.						
Course Outcomes							
CO1	Student will be able to describe the basic concepts of Internal and External combustion engines and different air standard cycles.						
CO2	Students will be able toexplain different types of injection systems, lubrication systems, carburetor; detonation, C.I. combustion chambers andtheir applications.						
CO3	Students will be able to determine the performance parameters of S.I. and C.I. engines.						
CO4	Students will be able toexplain the basic concepts of reciprocating air compressors and gas turbine along with exhaust gas heat exchanger.						

UNIT-I

Heat engines; Internal and external combustion engines; Classification of I.C. Engines; Cycle of operations in four strokes and two-stroke IC engines; Wankle Engine.

Air standard cycles: Assumptions made in air standard cycles; Otto cycle; Diesel cycle; Dual combustion cycle; Comparison of Otto, diesel and dual combustion cycles; Sterling and Ericsson cycles; Air standard efficiency, Specific work output. Specific weight; Work ratio; Mean effective pressure; Deviation of actual engine cycle from ideal cycle.

UNIT-II

Carburetor and Injection systems: Mixture requirements for various operating conditions in S.I. Engines; Elementary carburetor, Calculation of fuel air ratio; The complete carburetor; Requirements of a diesel injection system; Type of injection system; Petrol injection; Requirements of ignition system; Types of ignition systems, ignition timing; Spark plugs.

Engine parameters andknocking: S.I. engines; Ignition limits; Stages of combustion in S. I. Engines; Ignition lag; Velocity of flame propagation; Detonation; Effects of engine variables on detonation; Theories of detonation; Octane rating of fuels; Pre-ignition; S.I. engine combustion chambers. Stages of combustion in C.I. Engines; Delay period; Variables affecting delay period; Knock in C.I. Engines; Cetane rating; C.I. Engine combustion chambers.

UNIT-III

Lubrication and cooling systems: Functions of a lubricating system, Types of lubrication system; Mist, Wet sump and dry sump systems; Properties of lubricating oil; SAE rating of lubricants; Engine performance and lubrication; Necessity of engine cooling; Disadvantages of overcooling; Cooling systems; Air-cooling, Water-cooling; Radiators.

Heat balance andemission control: Performance parameters; BHP, IHP, Mechanical efficiency; Brake mean effective pressure and indicative mean effective pressure, Torque, Volumetric efficiency;

Specific fuel consumption (BSFC, ISFC); Thermal efficiency; Heat balance; Basic engine measurements; Fuel and air consumption, Brake power, Indicated power and friction power, Heat lost to coolant and exhaust gases; Performance curves; Pollutants from S.I. and C.I. Engines; Methods of emission control, Alternative fuels for I.C. Engines; The current scenario on the pollution front.

UNIT-IV

Air compressor: Working of a single stage reciprocating air compressor; Calculation of work input; Volumetric efficiency; Isothermal efficiency; Advantages of multi stage compression; Two stage compressor with inter-cooling; Perfect inter cooling; Optimum intercooler pressure; Rotary air compressors and their applications; Isentropic efficiency.

Gas turbine: Brayton cycle; Components of a gas turbine plant; Open and closed types of gas turbine plants; Optimum pressure ratio; Improvements of the basic gas turbine cycle; Multi stage compression with inter-cooling; Multi stage expansion with reheating between stages; Exhaust gas heat exchanger; Application of gas turbines.

Text books:

1. Internal Combustion Engine by V. Ganeshan Tata Mc-Graw Hill Publications.
2. Internal Combustion Engine by Mathur& Sharma, Dhanpat Rai Publications.
3. Internal Combustion Engine by RamalingamSci-tech publications.
4. Internal Combustion Engine Fundamentals by John B. Heywood, Tata Mc-GrawHill Publications.

Reference Books

1. Heat Power Engineering by Dr. V.P. Vasandhani& Dr. D.S. Kumar
2. Fundamentals of Internal Combustion Engine by H. N. Gupta, PHI publications.

Note: The paper setter will set the paper as per the question paper template provided.

B. Tech (6th Semester) Mechanical Engineering							
MEP-304A	**GAS DYNAMICS AND JET PROPULSION**						
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs)**
3	**1**	**0**	**4**	**75**	**25**	**100**	**3**
Purpose:	To familiarize the students with the concept of compressible and incompressible flows and to understand the aircraft androcket propulsion.						
Course Outcomes							
CO 1	Students will be able to explain thefundamentals ofcompressible flow, Mach number, types of waves and effect of Mach number on compressibility.						
CO 2	Students will be able todescribecompressible flow with friction and its effect in flow through nozzles.						
CO 3	Students will be able to explain the concepts of normal shock, oblique shock, Rayleigh line and Rayleigh flow equation in compressible flows.						
CO 4	Students will be able to describe the aircraft propulsion systems and rocket propulsion with their applications, solid and liquid propellants.						

UNIT-I

Compressible flow – fundamentals: Energy and momentum equations for compressible fluid flows, various regions of flows, reference velocities, stagnation state, velocity of sound, critical states, Mach number, critical Mach number, types of waves, Mach cone, Mach angle, effect of Mach number on compressibility

UNIT-II

Flow through variable area ducts: Isentropic flow through variable area ducts, T-s and h-s diagrams for nozzle and diffuser flows, area ratio as a function of Mach number, mass flow rate through nozzles and diffusers, effect of friction in flow through nozzles.

UNIT-III

Flow through constant area ducts: Flow in constant area ducts with friction (Fanno flow) - Fanno curves and Fanno flow equation, variation of flow properties, variation of Mach number with duct length. Flow in constant area ducts with heat transfer (Rayleigh flow), Rayleigh line and Rayleigh flow equation, variation of flow properties, maximum heat transfer.

Normal and oblique shock: Governing equations, variation of flow parameters like static pressure, static temperature, density, stagnation pressure and entropy across the normal shock, Prandtl – Meyer equation, impossibility of shock in subsonic flows, flow in convergent and divergent nozzle with shock. Flow with Oblique Shock – Fundamental relations, Prandtl‟s equation, Variation of flow parameters.

UNIT-IV

Propulsion: Aircraft propulsion – types of jet engines – study of turbojet engine components – diffuser, compressor, combustion chamber, turbine and exhaust systems, performance of turbo jet engines – thrust, thrust power, propulsive and overall efficiencies, thrust augmentation in turbo jet engine, ram jet and pulse jet engines. Rocket propulsion – rocket engines thrust equation – effective jet velocity specific impulse – rocket engine performance, solid and liquid propellants.

Text Books:

1. Fundamental of compressible flow with Aircraft and Rocket propulsion by S.M., Yahya, New Age International (p) Ltd., New Delhi.
2. Compressible fluid flow by Patrich.H. Oosthvizen, William E.Carscallen, McGraw-Hill.
3. Gas turbine theory by Cohen.H., Rogers R.E.C and Sravanamutoo, Addison Wesley Ltd.

Reference Books:

1. Gas Turbines by V.Ganesan,Tata McGraw-Hill, New Delhi.
2. Gas Dynamics by E.Rathakrishnan, Prentice Hall of India, New Delhi.

B. Tech (6th Semester) Mechanical Engineering							
MEP-306A	**Design of Transmission Systems**						
L	**T**	**P**	**Credits**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**1**	**0**	**4**	**75**	**25**	**100**	**3**
Purpose	To understand the components of transmission systems and make the students capable of design the transmission system and its various elements.						
Course Outcomes							
CO 1	Students will be able todesign and select belt drives, pulleys and the chain drives from manufacturer's catalogue.						
CO2	Students will be able to explain themechanism of manual transmission, clutch synchronization and gear drives.						
CO4	Students will be able to apply the Lewi's and Buckingham's equations for the design of spur, helical and bevel gears.						
CO5	Students will be able to design worm gear based on strength rating, wear rating and thermal rating and to select belts and chain drives from manufacturer's catalogue.						
CO6	Students will be able to describe torque converters, perform torque formulation and evaluate torque capacity.						
CO7	Students will beable to design gear boxes, couplings and discusstheir applications.						

UNIT-I

Flat belt drives and pulleys: Introduction, Selection of flat belts from manufacturer's catalogue, Pulleys for flat belts. **V-Belts and pulley:** Selection of V-Belts and V-grooved pulley. **Chain Drives:** Roller chains, geometric relationships, polygonal effect, power rating, sprocket wheels, design of chain drives, chain lubrication.

Manual transmissions: Powertrain layout and manual transmission structure, power flows and gear ratios.

UNIT-II

Manual transmission clutches: Clutch structure, clutch torque capacity, synchronizer and synchronization: shift without synchronizer, shift with synchronizer, equivalent mass moment of inertia, equation of motion during synchronization, condition for synchronization, shifting mechanisms.

Gear drives: Classification of gears, selection of type of gears, law of gearing, standard systems of gear tooth, interference and undercutting, backlash.

Design of spur gears: geometry and nomenclature, force analysis, material selection, beam strength of gear tooth, effective load on gear tooth, module estimation based on beam strength, wear strength of gear tooth, module estimation based on wear strength, spur gear design procedure.

Design ofhelical gears: geometry and nomenclature, force analysis, beam strength of helical gears, effective load on gear tooth, wear strength of helical gears, design procedure.

UNIT-III

Design of bevel gears: Geometry and nomenclature, force analysis, beam strength of bevel gears, effective load on gear tooth, wear strength of bevel gears, design procedure. **Design of worm gears:** Terminology, force analysis, friction in worm gears, material selection, strength rating and wear rating, thermal considerations and design procedure.

Torque converters: Torque converter structure and functions: torque multiplication and fluid coupling, torque converter locking up, automatic transmission fluid (ATF) circulation and torque formulation, torque capacity and input–output characteristics.

UNIT-IV

Design of speed reducers (gear boxes): Geometric progression, standard step ratio, ray diagram, kinematics layout, design of sliding mesh gear box, design of multi speed gear box for machine tool applications, constant mesh gear box, speed reducer unit, variable speed gear box.

Design of couplings: Design of muff coupling, clamp coupling, rigid flange couplings and bushed-pin flexible couplings.

Text Books:

1. Mechanical Engineering Design, Joseph E. Shigley and Charles R. Mischke, Tata McGraw Hill Book Co.
2. Automotive Power Transmission Systems, Yi Zhang and Chris Mi, Wiley Publications.
3. Design of Machine Element, V. B. Bhandari, McGraw Hill Edu. Pvt. Ltd.
4. Machine Design, R.S. Khurmi and J.K. Gupta, S. Chand.

Reference Books:

1. Machine Component Design, Robert C. Juvinall and Kurt M. Marshek, Wiley India Pvt. Ltd.
2. Mechanical Design of Machine Elements and Machines, Collins and Busby, Wiley India Pvt. Ltd.
3. Machine Design, U.C. Jindal, Pearsons publications.
4. Design of Transmission Systems, E.V.V. Ramamurthy and S. Ramachandaran, Air Walk Publications.
5. Handbook of Gear Design and Manufacture, S. P. Radzevich, CRC Press, T&F.

Design Data Books:

1. Design Data Book of Engineers, Compiled by Faculty of Mechanical Engineering, PSG College of Technology, Publisher KalaikathirAchchagam, Coimbataore, 2009.
2. Design Data Handbook for Mechanical Engineers in SI and Metric Units, 4th Ed, Mahadevan and Balaveera Reddy.
3. Machine design data book, V.B. Bhandari, McGraw Hill Edu. Pvt. Ltd.

Note: The paper setter will set the paper as per the question paper template provided.

MEP-308A	Composite Materials						
L	T	P	Credits	Major Test	Minor Test	Total	Time (Hrs)
3	1	0	4	75	25	100	3
Purpose	To acquaint the student with the knowledge of different composite materials manufacturing techniques and familiarization with the basic expressions and methods used in the mechanics of composite structures, characterization techniques and understanding of practical implementation.						
Course Outcomes							
CO 1	Students will be able to explain different reinforcement and matrix materials with their practical applications.						
CO 2	Students will be able to differentiate between various composite fabrication techniques and analyse the behaviour of unidirectional composites at micro and macro level.						
CO 3	Students will be able to determine the stresses and strains in the short fiber reinforced composites and laminated composites.						
CO 4	Students will be able to describe different experimental techniques for physical and mechanical characterization and different non-destructive techniques.						

Unit- I

Introduction: Definitions, characteristics, classification, particulate composites, fiber-reinforced composites, applications of fiber composites, Advance fibers: glass fibers, carbon and graphite fibers, aramid fibers, boron fibers, other fibers, matrix materials.

Emerging composite materials: Nanocomposites, carbon-carbon composites, bio-composites, composites in "smart" structures.

Unit- II

Fabrication of composites: Fabrication of thermosetting resin Matrix composites: Handlay-up technique, bag molding processes, resin transfer molding,filament winding,pultrusion; Fabrication of thermoplastic-resin matrix composites (Short-fiber composites), Fabrication of Metal matrix and ceramic matrix composites.

Behavior of unidirectional composites: Nomenclature, volume and void fraction,longitudinal behavior of unidirectional composites, transverse stiffness and strength, failure modes, expansion co-efficient and transport properties.

Unit-III

Short-fiber composites: Introduction, theories of stress transfer: approximate analysis of stress transfer, stress distribution from finite-element analysis, average fiber stress. Modulus and strength of short-fiber composites: prediction of modulus, prediction of strength, effect of matrix ductility.

Analysis of laminated composites: Introduction, laminate strains, variation of stresses in laminates, resultant forces and moments, laminate description system, determination of laminate stresses and strains, analysis of laminates after initial failure, performance of fiber composites: fatigue and impact effects.

Unit-IV

Experimental characterization of composites: Introduction, measurement of physical properties: density, constituent weight and volume fractions,void volume fraction, thermal expansion coefficient,

moisture absorption and diffusivity and moisture expansion co-efficient, measurement of mechanical properties:properties in tension, compression, in-place shear properties.

Damage identification using non-destructive evaluation techniques:-Ultrasonic, X-Radiography, Laser Shearography, Thermography.

Text Books:

1. Analysis and performance of Fiber Composites byBhagwan D. Agarwal, Lawrence J. Broutman, K. Chandrashekhara, Wiley India Pvt. Ltd., India.
2. Fiber Reinforced Composites: Materials Manufacturing and Design by P.K. Mallick, 3rd Edition, CRC Press.
3. Mechanics of Composite Materials byAutar K. Kaw, 2nd Edition, CRC Taylor and Francis Group.
4. Composite Materials, Design and Applications by Daniel Gay, Suong V. Hoa, 2nd Edition, CRC Taylor and Francis Group.

Reference Books:

1. Mechanics of Composite Materials byR. M. Jones, CRC Press.
2. Fibrous Materials by K. K. Chawla, Cambridge University Press.

Note: The paper setter will set the paper as per the question paper template provided.

B. Tech. (6th Semester) Mechanical Engineering							
MEP-310A	**REFRIGERATION AND AIR CONDITIONING**						
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**1**	**0**	**4**	**75**	**25**	**100**	**3**
Purpose	The objective of this course is to make the students aware of refrigeration, Air-conditioning, various methods of refrigeration. The course will help the students to build the fundamental concepts in order to solve engineering problems and to design HVAC applications.						
Course Outcomes							
CO 1	Students will be able to explain different refrigeration processes like ice refrigeration, evaporative refrigeration, refrigeration by expansion of air, steam jet refrigeration systems etc.						
CO 2	Students will be able to identify, formulate and solve air refrigeration, vapour refrigeration and vapour absorption refrigeration problems.						
CO 3	Students will be able to identify different refrigerants and discuss their uses.						
CO 4	Students will be able to describepsychrometric properties, psychrometric chart and its use for different cooling and heating processes along with humidification and dehumidification.						
CO 5	Students will be able to design various air-conditioning systems by including the internal and external heat gain.						

REFRIGERATION

UNIT-I

Introduction: Basics of heat pump & refrigerator, Carnot refrigeration and heat pump, units of refrigeration, COP of refrigerator and heat pump, Carnot COP, Ice refrigeration, evaporative refrigeration, refrigeration by expansion of air, refrigeration by throttling of gas, vapour refrigeration system, steam jet refrigeration, thermo- electric cooling, adiabatic demagnetization.

Air refrigeration: Basic principle of operation of air refrigeration system, Bell Coleman air refrigerator, advantages of using air refrigeration in air craft, disadvantage of air refrigeration in comparison to other cold producing methods, simple air refrigeration in air craft, simple evaporative type, air refrigeration in air craft, necessity of cooling the aircraft.

UNIT-II

Simple vapour compression refrigeration system: Simple vapour compression refrigeration system, different compression processes (wet, dry and saturated Compression, superheated compression), Limitations of vapour compression refrigeration system if used on reverse Carnot cycle, representation of theoretical and actual cycle on T-S and P-H charts, effects of operating conditions on the performance of the system, advantages of vapour compression system over air refrigeration system.

Advanced vapour compression refrigeration system: Methods of improving COP, flash chamber, flash inter cooler, optimum inter stage pressure for two stage refrigeration system, single expansion and multi expansion cases, basic introduction of single load and multi load systems, cascade systems.

Vapour absorption refrigeration system and special topics: Basic absorption system, COP and maximum COP of the absorption system. Actual NH_3 absorption system, function of various components, Li-Br absorption system, Selection of refrigerant and absorbent pair in vapour absorption system, Electro-Lux refrigerator, comparison of compression and absorption refrigeration system,

Nomenclature of refrigerants, desirable properties of refrigerants, cold storage and Ice Plants.

AIR-CONDITIONING

UNIT-III

Introduction: Difference between refrigeration and Air-conditioning, Psychrometric properties of moist air (wet bulb, dry bulb, dew point temperature, relative and specific humidity, temperature of adiabatic saturation), empirical relation to calculate P_v of moist air.

Psychrometry: Psychrometric chart, construction and use, mixing of two air streams, sensible heating and cooling, latent heating and cooling, humidification and dehumidification, cooling with dehumidification, cooling with adiabatic humidification, heating and humidification, By- pass factor of coil, sensible heat factor, ADP of cooling coil, Air washer.

UNIT-IV

Air-conditioning Systems: Classification, factors affecting air-conditioning systems, comfort air-conditioning system, winter air-conditioning system, summer air-conditioning system, year round air-conditioning system, unitary air-conditioning system, central air-conditioning system, Room sensible heat factor, Grand sensible heat factor, effective room sensible heat factor.

Cooling Load calculation: Inside design conditions, comfort conditions, components of cooling load, internal heat gains (occupancy, lighting, appliances, product and processes), system heat gain (supply air duct, A.C. fan, return air duct), External heat gain (heat gain through building, solar heat gain through outside walls and roofs), sol-air temperature, solar heat gain through glass windows, heat gain due to ventilation and infiltration.

Industrial and Commercial Application: Transport air conditioning, evaporative condensers, cooling towers, heat pumps.

Text Books:

1. Refrigeration and Air-conditioning by C.P. Arora, Tata McGraw-Hill
2. Basic Refrigeration and Air-conditioning byAnanthana and Rayanan, McGraw-Hill

Reference Books:

1. Refrigeration and Air Conditioning byArora and Domkundwar, DhanpatRai.
2. Refrigeration and air-conditioning by R.C.Arora, PHI

Note: The paper setter will set the paper as per the question paper template provided.

B. Tech (6th Semester) Mechanical Engineering							
MEP-312A	**PRODUCT ENGINEERING**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
3	**1**	**0**	**4**	**75**	**25**	**100**	**3**
Purpose	To acquaint the students with the knowledge of engineering techniques used to produce an engineering product.						
Course Outcomes							
CO1	Students will be able to explain different work, method and time studytechniques.						
CO2	Students will be able to appraisethe inventory control and solve the problems related to queuing theory.						
CO3	Students will be able to describe sales forecasting methods and explain the network analysis representations.						
CO4	Students will be able to explain the concept of value engineering and different modern approaches of product design.						

Unit-I

Introduction to Work Study: Work study, human considerations in work study, relationship of work-study person with management, relationship of work-study person and supervisor, Method Study:procedure of method study,Therbligs, Motion study, cycle graph and chronocycle graph: equipment used, procedure and uses, principles of motion economy, Work measurement: definitions and objectives, time-study procedures, work-measurement techniques, job selection for work measurement, equipment's and forms used for time study, performance rating, determination of normal time and standard time allowances, pre-determined motion time systems.

Ergonomics: Human being as applicator of forces, Anthropometry, the design of controls, the design of displays, Man/Machine information exchange, Workplace layout from ergonomic considerations.

Unit-II

Inventory Control: Functions of inventory; Types of inventory; Control importance functions, Inventory costs, factors affecting inventory control, various inventory controls models; A.B.C. analysis, lead-time calculations.

QueuingTheory: Introduction, applications of Queuing theory, waiting time and idle time cost, Single channel queuing theory and multi-channel queuing theory with Poisson arrivals and exponential services, numerical on single channel and multi channels theory.

Unit-III

Sales Forecasting: Introduction, objectives and importance of sales forecasting, Types of forecasting, Methods of sales forecasting, Collective opinion method, Delphi technique, economic indicator method; Regression analysis.

Network Analysis: Phases of project management, network representation, techniques for drawing network, numbering of events (Fulkersen rule), PERT calculations, Critical path method (CPM): Forward pass computation, backward pass computation, computation of float and slack time, critical path, time cost optimization algorithm, updating a project, resource allocation and scheduling, Management operation system technique (MOST).

Unit-IV

Value Engineering: Value, Nature and measurement of value, Maximum value, Normal degree of value, Importance of value, value analysis job plan, creativity, steps to problem solving and value analysis, value analysis tests, value engineering idea generation check list, Cost reduction through value engineering-case study, materials and process selection in value engineering.

Modern Approaches: Concurrent engineering, Quality function deployment (QFD), Reverse engineering, 3D printing.

Text Books:

1. Work study and Ergonomics by Prof. P.C. Tewari, Ane Books Pvt. Ltd., New Delhi-110002.
2. Operations Research by A. M., Natarajan and P. Balasubramanie, Pearson Education India.
3. Industrial Engineering and Production Management by TelSangMartand, S. Chand and company Ltd.

Reference Books:

1. Operation Research by Prem Kumar Gupta and D.S. Heera, S. Chand Publications.
2. Motion and time study: Improving Productivity by Marvin E, Mundel and David L, Pearson Education.
3. Work study and Ergonomics by S. K. Sharma and Savita Sharma, S. K. Kataria and Sons, Delhi.
4. Product design and engineering by A. K. Chitale and Gupta, PHI

Note: The paper setter will set the paper as per the question paper template provided.

B. Tech. (6th Semester) Mechanical Engineering								
MEC-306 LA	**MECHANICAL ENGINEERING LAB-I**							
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Practical**	**Total Time**	**Time (Hrs.)**
0	**0**	**2**	**1**	**0**	**40**	**60**	**100**	**3**
Purpose:	To provide practical knowledge in the concerned subject that a student opt from the program electives offered in the curriculum.							

INTERNAL COMBUSTION ENGINES PRACTICALS:

COURSE OUTCOMES:

CO 1: Students will be able to explain the principles, construction and working of S.I. and C.I. engines.

CO 2: Students will be experiment onfuel injection systems, lubrication and cooling systems.

CO 3: Students will also be able to evaluate the performance parameters of reciprocating air compressor, petrol and diesel engines.

LIST OF EXPERIMENTS

1. To make a trial on single cylinder 4-stroke Diesel Engine to calculate B. H. P., S.F.C. and to draw its characteristics curves.
2. To make a trial on 4-stroke high-speed diesel engine and to draw its Heat Balance Sheet.
3. To make a trial on Wiley's jeep Engine at constant speed to calculate B. H. P., S. F. C. Thermal efficiency and to draw its characteristic Curves.
4. To make Morse Test to calculate IHP of the multi cylinder petrol engine and to determine its mechanical efficiency.
5. To calculate the isothermal efficiency and volumetric efficiency of a 2 stage reciprocating air compressor.
6. To find out the efficiency of an air Blower.
7. To make a trial on the Boiler to calculate equivalent evaporation and efficiency of the boiler.
8. To study the following models;
   (a) Gas Turbine (b) Wankle Engine.
9. To study
   (a) Lubrication and cooling systems employed in various I. C. Engines in the Lab
   (b) Braking system of automobile in the lab
10. To study a Carburetor.
11. To study (I) the Fuel Injection System of a C. I. Engine. (II) Battery Ignition system of a S.I. Engine
12. To study Cooling Tower.
13. To make a trial with multi-cylinder four stroke vertical Diesel Engine test Rig with Hydraulic Dynamometer.

DESIGN OF TRANSMISSION SYSTEMS PRACTICALS:

COURSE OUTCOMES:

CO 1: Students will be able to analyse and simulate transmission elements using different modules of SOLIDWORKS/ANSYS.

CO 2: Students will be able to apply the design principles and concepts in designing and simulation of various transmission elements of an automobile under different operating conditions.

CO 3: The students will be able toconstruct and work withdifferent transmission components used in automobiles.

LIST OF EXPERIMENTS

1. To model and simulate the V-belt drive/belt conveyor.
2. To simulate and analyze the rack and pinion arrangement under different loading conditions.
3. Static structural analysis of different gears.
4. Transient and explicit analysis on transmission system gears.
5. To simulate and analyze rigid flange coupling and bushed-pin flexible coupling.
6. To simulate and analyze the camshaft.
7. Static structure and fatigue analysis of crank shaft.
8. To study the construction details, working principles and operations of different types of automotive clutches.
9. To study the direct-shift continuous variable transmission (CVT) system.
10. To study the constructional details, working principles and operations of different types of automotive brakes.

GAS DYNAMICS AND JET PROPULSION PRACTICALS

COURSE OUTCOMES:

CO 1: Students will be able to simulate and analyse the flow through the nozzle and an airfoil.

CO 2: Students will be able to simulate the vortex shedding phenomenon.

CO 3: Students will be able to develop and validate the computer program for Coutte flow.

CO 4: Students will be able to develop the computer based program of fully developed laminar flow in a pipe.

LIST OF EXPERIMENTS

1. To simulate and analyze the compressible flow through a nozzle.
2. To simulate and analyze the transonic flow over an airfoil.
3. To simulate vortex shedding phenomenon over a cylinder in laminar flow.
4. To make and validate a computer program for the coutte flow.
5. To make and validate a computer program for the fully developed laminar flow in circular pipe.
6. To simulate and analyze the laminar flow pipe.

Note: At least six experiments are required to be performed by students from the above list and remaining fourmay be performed from the experiments developed by the institute.

B. Tech. (6th Semester) Mechanical Engineering								
MEC-308 LA	**MECHANICAL ENGINEERING LAB-II**							
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Practical**	**Total Time**	**Time (Hrs.)**
0	**0**	**2**	**1**	**0**	**40**	**60**	**100**	**3**
Purpose:	To provide practical knowledge in the concerned subject that a student opt from the program electives offered in the curriculum.							

COMPOSITE MATERIALS PRACTICALS

COURSE OUTCOMES:

CO 1: Students will be able to develop composites such as polymer matrix composites, MMC etc.usingdifferent types of composites development techniques.

CO 2: Students will be capable of analysing the physical, mechanical and tribological behaviorof the developed composites.

LIST OF EXPERIMENTS

1. To study the hot compression molding technique for the preparation of thermosetting-resin matrix composites.
2. To develop the advanced fiber reinforced polymer composites and characterize for their physical properties (density, constituent weight and volume fractions, void volume fraction, thermal expansion coefficients, moisture absorption and diffusivity, moisture expansion coefficients).
3. To find the hardness and tensile and flexural properties of the advanced fiber reinforced polymer composites.
4. To develop the particle reinforced polymer composites and characterize for their physical properties (density, constituent weight and volume fractions, void volume fraction, thermal expansion coefficients, moisture absorption and diffusivity, moisture expansion coefficients).
5. To develop the Al metal-matrix composites using friction stir casting and characterize for various mechanical properties.
6. To find the friction and wear properties of Al metal matrix composites using pin-on-disc apparatus.
7. To find the hardness and tensile and flexural properties of the particle reinforced polymer composites.
8. To find the friction and wear properties of fiber reinforced/particle reinforced polymer composites using pin-on-disc apparatus.

REFRIGERATION AND AIR CONDITIONING PRACTICALS

COURSE OUTCOMES:

CO 1: Students will be able to evaluate the performance of water cooler, Ice plant, cooling towers and Cascade refrigeration system.

CO 2: Students will be able to analysedifferent cycles of operation in air-conditioning.

CO 3: Students will be able to measure humidity in air-conditioning systems.

CO 4: Students will be able to operate various control devices in refrigeration and air-conditioning systems.

LIST OF EXPERIMENTS

1. To study and perform experiment on basic vapour compression Refrigeration Cycle.
2. To study and perform experiment on Solar Air-conditioner based on vapour absorption cycle.
3. To find C.O.P. of water cooler.
4. To study and perform experiments on compound compression and multi-load systems.
5. To study and perform experiment on vapour absorption apparatus.
6. Perform the experiment & calculate various performance parameters on a blower apparatus.
7. To find the performance parameter of cooling tower.
8. To study various components in room air conditioner.
9. To find RH of atmospheric air by using Sling Psychrometer.
10. To find performance of a refrigeration test rig system by using different expansion devices.
11. To study different control devices of a refrigeration system.
12. To find the performance parameters of Ice Plant.
13. To study and perform experiment on Cascade system.

PRODUCT ENGINEERING PRACTICALS

COURSE OUTCOMES:

CO 1: Students will be able to analyze P-Chart and C-Chart.

CO 2: Students will be able to analyze normal distribution and universal distribution.

CO 3: Students will be able to interpret the two handed process chart and Multi activity chart (Man-Machine Chart).

CO 4: Students will be able to interpret the concept of$\bar{X}$,R Charts and Process capability.

LIST OF EXPERIMENTS

1. To draw left and right hand process charts and to conduct time study for the bolt, washer & nut assembly of present and improved methods.
2. To show that sample means for a normal universe follow a normal distribution.
3. To learn performance rating through observation of the activity of dealing pack of 52 playing cards.
4. To study the changes in heart beat rate for different subjects using Treadmill.
5. To plot the operating charters tic curve for a single sampling attributes plan of a given lot of plastic balls and to compare the actual O.C curve with theoretical O.C curve.
6. To study the changes in heart beat rate for different subjects using Ergocycle.
7. To draw P-Chart for fraction defective and to check the control of the process for a given set of plastic balls.

8. To draw a C- chart for a given set of metal discs and to check the control of the process by taking each disk with 10 holes of each 6 mm size as one unit.
9. To show that the sample means from a rectangular universe follow a normal distribution.
10. To draw multiple activity chart or man-machine chart for the subject of toasting 3 slices of bread in one electric double compartment toaster.
11. To draw $\bar{X}$ and R charts and to determine the process capability from the measurement of large diameter of a given set of stepped pins.
12. Measure the skill and dexterity in the moment of wrist and fingers using pin board.

Note: At least eight experiments are required to be performed by students from the above list and two may be performed from the experiments developed by the institute.