Scheme of Studies for B.Sc. Mechanical Engineering

Semester 1		Contact hours		Credit hours
Course Code	**Course Title**	**Lecture**	**Lab.**	**Total**
BSI-101	Islamic Studies	2	0	2
BSI-110	Pakistan Studies	2	0	2
BSI-122	Calculus	3	0	3
BSI-142	English Composition and Comprehension	3	0	3
ME-101	Computer Prog. for Mechanical Engg.	1	0	1
ME-101L	Computer Prog. for Mechanical Engg. Lab	0	3	1
EE-109	Basic Electrical and Electronics Engineering	3	0	3
EE-109L	Basic Electrical & Electronics Engg. Lab	0	3	1
ME-141	Workshop Practice	0	3	1
	Total Contact Hours	14	9	
	Total Credit Hours	14	3	17

Semester 2		Contact hours		Credit hours
Course Code	**Course Title**	**Lecture**	**Lab.**	**Total**
BSI-231	Differential Equations	3	0	3
BSI-143	Communication and Presentation Skills	2	0	2
ME-111	Engineering Statics	3	0	3
ME-121	Thermodynamics-I	3	0	3
ME-121L	Thermodynamics Lab	0	3	1
ME-112	Engineering Drawing and Graphics	2	0	2
ME-112L	Engineering Drawing and Graphics Lab	0	3	1
ME-113	Mechanics of Materials-I	3	0	3
	Total Contact Hours	16	6	
	Total Credit Hours	16	2	18

Semester 3		Contact hours		Credit hours
Course Code	**Course Title**	**Lecture**	**Lab.**	**Total**
BSI-111	Linear Algebra	3	0	3
ME-211	Engineering Dynamics	3	0	3
ME-211L	Engineering Mechanics Lab	0	3	1
ME-212	Mechanics of Materials-II	3	0	3
ME-212L	Mechanics of Materials Lab	0	3	1
ME-213	CAD-I	0	3	1
ME-221	Thermodynamics-II	2	0	2
ME-222	Fluid Mechanics-I	3	0	3
	Total Contact Hours	14	9	
	Total Credit Hours	14	3	17

Semester 4		Contact hours		Credit hours
Course Code	**Course Title**	**Lecture**	**Lab.**	**Total**
BSI-242	Numerical Analysis	3	0	3
ME-214	Engineering Metallurgy	3	0	3
ME-214L	Engineering Metallurgy Lab	0	3	1
ME-215	Design of Machine Elements-I	3	0	3
ME-223	Fluid Mechanics-II	3	0	3
ME-223L	Fluid Mechanics Lab	0	3	1
ME-201	Entrepreneurship	2	0	2
ME-202	Ethical & Legal Dimensions of Engineering	2	0	2
	Total Contact Hours	16	6	
	Total Credit Hours	16	2	18

Semester 5		Contact hours		Credit hours
Course Code	**Course Title**	**Lecture**	**Lab.**	**Total**
BSI-351	Probability and Statistics	3	0	3
ME-311	Design of Machine Elements-II	3	0	3
ME-331	Mechanics of Machines and Vibration	3	0	3
ME-331L	Mechanics of Machines and Vibration Lab	0	3	1
ME-312	Engineering Materials	3	0	3
ME-341	Manufacturing Processes	3	0	3
ME-341L	Manufacturing Processes Lab	0	3	1
	Total Contact Hours	15	6	
	Total Credit Hours	15	2	17

Semester 6		Contact hours		Credit hours
Course Code	**Course Title**	**Lecture**	**Lab.**	**Total**
ME 301	Engineering Economics	3	0	3
ME-342	Quality Engineering	3	0	3
ME-321	Power Plants-I	3	0	3
ME-332	Introduction to Mechatronics	3	0	3
ME-332L	Introduction to Mechatronics Lab	0	3	1
ME-313	CAD-II	0	6	2
ME-303	Technical Report Writing	2	0	2
	Total Contact Hours	14	9	
	Total Credit Hours	14	3	17

Semester 7		Contact hours		Credit hours
Course Code	**Course Title**	**Lecture**	**Lab.**	**Total**
ME-441	Production Automation	3	0	3
ME-441L	Production Automation Lab	0	3	1
ME-421	Power Plants-II	3	0	3
ME-421L	Power Plants Lab	0	3	1
ME-422	Heat and Mass Transfer	3	0	3
ME-423	Heating, Ventilation and Air Conditioning	3	0	3
ME-411	Final Year Project	0	9	3
	Total Contact Hours	12	15	
	Total Credit Hours	12	5	17

Semester 8		Contact hours		Credit hours
Course Code	**Course Title**	**Lecture**	**Lab.**	**Total**
ME-401	Health, Safety and Environment	2	0	2
ME 431	Measurement and Instrumentation	2	0	2
ME-432	Control Engineering	3	0	3
ME-433L	Measurement, Instrumentation & Control Lab	0	3	1
ME-442	Industrial Management	3	0	3
ME-424L	Heat Transfer and HVAC Lab	0	3	1
ME-411	Final Year Project	0	9	3
	Total Contact Hours	10	15	
	Total Credit Hours	10	5	15

Total Credit Hours = 136

FIRST SEMESTER MECHANICAL ENGINEERING

Semester 1		Contact hours		Credit hours
No.	**Course**	**Lecture**	**Lab.**	**Total**
BSI-101	Islamic Studies	2	0	2
BSI-110	Pakistan Studies	2	0	2
BSI-122	Calculus	3	0	3
BSI-142	English Composition and Comprehension	3	0	3
ME-101	Computer Prog. for Mechanical Engg.	1	3	2
EE-109	Basic Electrical and Electronics Engineering	3	0	3
EE-109L	Basic Electrical & Electronics Engg. Lab	0	3	1
ME-141	Workshop Practice	0	3	1
	Total Contact Hours	14	9	
	Total Credit Hours	14	3	17

SEMESTER 1

Course Title: Islamic Studies (2, 0)

Course Code: BSI-101

Course Contents
Basic Concepts of Islam, Dawat and Seerat un Nabi, Concept of the Holy War in Islam (Jehad). Compilation of the Holy Quran, Basic Concepts of Hadith. Hadith as source of Islamic Law. Tafseer Surah Hujuraat and Surah Noor. Islam as a Complete Code of Life. Human Rights in Islam, and comparative study with other religions and Human rights granted by UNO. Quran, Science and Technology, Knowledge and Islam. Islamic Civilization. Woman Rights. Lawful earning. Population Dynamics in Islam.

Recommended books:

1. Islamiyat by Mukhtar Hassan
2. Family Planning in Islam by Khalid Saifullah Rehmani
3. Family Planning by Mufti Muhammad Shafi.
4. A guide book for Muslims by Syed Abul Hasan Ali Nadvi
5. An introduction to Islam by Dr. Muhammad Hameed Ullah
6. What is Islam by Maulana Manzoor Nomani.
7. Islamiat (A Standard Book for CSS), Prof. Dr. Arif Naseem.
8. Islamiat for Students O levels, Farkhanda Noor Muhammad
9. Deenyat by Syed Abul Aala Moudodi

COURSE LEARNING OUTCOMES (CLOs)				
S. No.	**CLO Statement**	**Domain**	**Mapping with Bloom's Taxonomy**	**Mapping with PLO**
1.	To understand the basic beliefs of Islam and concept of Ibadat (worship)	**Cognitive**	**2**	**PLO-12**
2.	To know about the Serat-u-Nabi	**Cognitive**	**2**	**PLO-8**
3.	To review Islamic civilization and its relevance to contemporary issues	**Cognitive**	**4**	**PLO-6**

Course Title: Pakistan Studies (2, 0)

Course Code: BSI-110

Course Contents
Ideology, definition, importance some kinds ideology. Pakistan Ideology, Sayings of Quaid-E-Azam, Allam Iqbal about Pakistan Ideology, Aims and objectives of the creation of Pakistan. Reformist Movements, Shah Waliullah, Mujadid Alf Sani and Sayyed Ahmad Shaheed. Muslim Nationalism, Partition of Bengal, Simla Deputation. Muslim League, Lucknow Pact 1916, Khilafat Movement. Nehro Report, Quaid-e-Azam 14 points, Iqbal's Address 1930, Act of 1935, The Congress Ministries. Lahore Resolution 1940, 3rd June and independence 1947. Constitution in Law, method of making the constitution, the formation of the constituent Assembly 1947, Objective Resolution 1949. Dissolution of the Cabinet of Khwaja Nazimuddin, M.Ali Bogra Formula 1954 and dissolution of the Constituent Assembly 1954. Decision of Sindh High Court and Supreme Court regarding the dissolution of Assembly in 1955 (Doctrine of Necessity). Features of 1956 and 1973 constitutions of Pakistan. Amendments in 1973 Constitution (17th – 20th). Foreign policy of Pakistan, goals and determinants of foreign policy. Population Dynamics in Pakistan. Strategy to control population growth in Pakistan. The role of society and State in controlling population, Socio-economic benefits of birth controlling.

Recommended books:

1. Struggle for Pakistan by Ishtiaq Hussain Qureshi
2. Pakistan Studies by Ikram Rabbani
3. Pakistan Studies by Javed Iqbal
4. Constitutional Development in Pakistan by Safdar Mehmood.
5. Constitutional Development by KB Saeed
6. Social change by Alama Iqbal University, Islamabad

COURSE LEARNING OUTCOMES (CLOs)

S. No.	CLO Statement	Domain	Mapping with Bloom's Taxonomy	Mapping with PLO
1.	Know about Pakistan's historical perspective, geo-strategic location constitutional phases, contemporary affairs, and future challenges	**Cognitive**	**2**	**PLO-6**
2.	Analyze major events and lives of prominent personalities related to Pakistan	**Cognitive**	**4**	**PLO-6**
3.	Review the role of national institutions social issues including population growth in Pakistan, ethnicity, foreign policy and future challenges	**Cognitive**	**4**	**PLO-6**

Course Title: Calculus (3, 0)

Course Code: BSI-122

Course Contents
Mathematical and physical meaning of functions, graphs of various functions, Hyperbolic functions. Theorems of limits and their applications to functions: Some Useful limits, right hand and left hand limits. Continuous and discontinuous functions and their applications. Introduction to derivatives: Geometrical and physical meaning of derivatives. Product Rules, quotient Rules and different rules of derivative, and its applications, problems (rate of change, marginal analysis). Tangent and normal lines, approximation by Taylor and Maclarum serious. Maxima and minima, First and Second derivative test. Integral Calculus, some rules of integrations. Integration by parts, areas bounded by Curve, Volume of Solid of revolution. Multivariable Calculus, Limit continuity of several variables local curve and local surfaces. Partial derivatives, Higher order partial derivatives, total differential, tangent plane, normal lines and its applications. Maxima and minima of two variables. Vector functions and its derivatives and its integrations, lines integrals, work done and its applications. Gradient, Divergence, Curve and its applications. Directional derivatives, solenoidal field, equations of continuity, rotational and irrational fields, scalar potential and its applications and fluid dynamics. Method of constraint optimization, Lagrange multiplier method and its applications.

Recommended books:

1. Calculus by Thomas Finney, Addison-Wesley Publishing Company, Latest available Edition.
2. Higher Engineering Mathematics by H.K. Dass and V. Sharma
3. Mathematics for Engineer 2nd Edition by Robert Davison, Latest available Edition.
4. Multivariate Calculus 2nd Edition by Robert T. Smith, Latest available Edition.

COURSE LEARNING OUTCOMES (CLOs)

S. No.	CLO Statement	Domain	Mapping with Bloom's Taxonomy	Mapping with PLO
1.	To know about different types of functions, their graphs, limits, continuities, derivatives and integrations and to describe the concepts of Differential Calculus.	**Cognitive**	**1**	**PLO-1**
2.	To Apply calculus to the problems involving rate of change, optimization, area under and between the curves, volumes, arc length and area of surface of revolution etc.	**Cognitive**	**2**	**PLO-2**

Course Title: English Composition and Comprehension (3, 0)

Course Code: BSI-142

Course Contents
Words & expressions commonly misused. Vocabulary Building skills. Introduction to parts of speech in detail. Word formation. Conditional Sentences & types. Tense, voice and narration. Common Grammatical mistakes. Sentence, its structure, types and kinds. Paragraph, its structure and types. Process of writing. Elementary Principles of Composition and its types. Relative Pronouns & Clauses. Getting the essential information. Order of importance. Critical reading & thinking. Drawing Conclusions; putting it all together.

Recommended books:

1. Writing Effective paragraphs by Howard CJ. Cambridge: Winthrop Publishers, 1976
2. Practical English Usage by Michael Swan. ELBS
3. Michael swan practical English usage
4. The Little Brown Handbook
5. Exploring the world of English by Sadaat Ali Shah

COURSE LEARNING OUTCOMES (CLOs)

S. No.	CLO Statement	Domain	Mapping with Bloom's Taxonomy	Mapping with PLO
1.	Practice English correctly in speaking and writing.	**Affective**	**2**	**PLO-10**
2.	Apply sound vocabulary and skills to use English in professional life.	**Cognitive**	**3**	**PLO-10**

Course Title: Computer Programming for Mechanical Engineering (1, 1)

Course Code: ME-101

Course Contents
Theory Introduction to Programming languages and their applications in Mechanical Engineering, C++ Programming Basics, Data types, Basic Program Structure, Loops and Decisions, Structures and Functions, Objects and Classes, Arrays and Strings, Operators overloading, Inheritance and Pointers, Virtual Functions, Streams and Files, Multi-file Programs, Templates and Exceptions, The Standard Template Library, Object-Oriented Software Development. **Laboratory** Ms. Office (Word, Excel, Power Point), Introduction to Programming in C++, Input/output statements, Conditional Structures, Looping Structures, Arrays, Structures, Functions (Built-in Functions / User-defined Functions), Pointers, File Handling, Programming for microcontroller for LED (Blinking), program burning to microcontroller IC chip, Introduction to MATLAB, Data Plotting, Differential equations solution, Matrices solution, Engineering equations solution (heat and wave)

Recommended books:

6. Robert Lafore, Object-Oriented Programming in C++, 4th edition, ISBN: 0672323087, SAMS Publishing, 2002.
7. John R. Hubbard, Programming with C++, 3rd edition, ISBN: 139780070144811, Tata McGraw Hill, 2009.

COURSE LEARNING OUTCOMES (CLOs)				
S. No.	**CLO Statement**	**Domain**	**Mapping with Bloom's Taxonomy**	**Mapping with PLO**
1.	Understand basic programming structure.	**Cognitive**	**1**	**PLO-1**
2.	Apply learnt skills to solve engineering problem using computer programming	**Cognitive**	**3**	**PLO-5**

Course Title: Basic Electrical and Electronics Engineering (3,0)

Course Code: EE-109

Course Contents
Introduction to Electrical Concepts (Voltage/Current/Power/Power Supplies), DC and AC circuits, DC and AC signals, types of power sources (Constant voltage/Constant current), Ohm's law and its application, Kirchoff's Voltage Law (KVL), Kirchoff's Current Law (KCL), Network analysis (Mesh and Nodal), Network theorems(Thevenin's / Norton's/ Superposition and Maximum Power Transfer), Introduction to Electrical Machines,Transformers (Potential Transformer/ Current Transformer/ Auto Transformer), Design and workingof (induction Motors/ Synchronous motors), Introduction to Semiconductor devices (Semiconductors/ Doping/ Fabrication/ P-N junction diodes/ Bipolar junction Transistors(BJTs)/ Field Effect Transistors (FETS) and their applications).

Recommended books:

1. B.L Theraja, A.K Theraja, Electrical Technology, volume1, ISBN=81-219-2440-5, S. Chand & Company Ltd.
2. John O 'Malley, Theory and Problems of Basic Circuit Analysis, Second Edition, ISBN=0-07047824-4, Mc Graw-Hill.
3. Robert L.Boylested, Louis Nashelsky, K.Lal Kishore, Electronic Devices and Circuit Theory, 9th Edition, ISBN= 81-7758-158-9, Pearson Education.

COURSE LEARNING OUTCOMES (CLOs)				
S. No.	**CLO Statement**	**Domain**	**Mapping with Bloom's Taxonomy**	**Mapping with PLO**
1.	Explain with Examples various concepts related to fundamentals of Electrical Engineering	**Cognitive**	**2**	**PLO-1**
2.	Solve, Analyze and Evaluate the problems related to Electrical Circuits based on various laws, analysis techniques and theorems	**Cognitive**	**3**	**PLO-2**
3.	Explain the working principles of various Electrical machines backed by related problem solving	**Cognitive**	**2**	**PLO-1**
4.	Understand, Analyze and Evaluate various Electronics devices including their fabrication and applications	**Cognitive**	**3**	**PLO-2**
5.	Acquire the basic knowledge related to Electrical and Electronic devices	**Cognitive**	**1**	**PLO-1**

Course Title: Basic Electrical and Electronics Engineering Lab (0, 1)

Course Code: EE-109L

List of Experiments
1. To get familiar with the usage of power supply, voltmeter, ammeter and multimeter.
2. To measure the resistance, capacitance, frequency, AC and DC voltage with the help of multimeter.
3. To demonstrate a series circuit to measure and calculate its equivalent resistance.
4. To demonstrate a parallel circuit to measure and calculate its equivalent resistance.
5. To verify KVL
6. To verify KCL
7. To find turn ratio of a single phase step down transformer.
8. To find the turn ration of single phase step up transformer.
9. To design and observe the working of a half wave rectifier circuit.
10. To design and observe the working of a full wave rectifier circuit.
11. To design and observe the working of a Zener voltage regulator circuit.

Recommended books:

1. Thomas L.Floyd, Electric Circuit Fundamentals, Sixth Edition, ISBN=0-13-111139-6, Pearson Education

COURSE LEARNING OUTCOMES (CLOs)

S. No.	CLO Statement	Domain	Mapping with Bloom's Taxonomy	Mapping with PLO
1.	Illustrate knowledge of various laws of Electrical Circuits, Series and Parallel Circuit	**Psychomotor**	**2**	**PLO-1**
2.	Show knowledge of constructing basic electrical/ electronic circuits and demonstration of relevant knowledge.	**Cognitive**	**3**	**PLO-2**

Course Title: Engineering Workshops (0,1)

Course Code: ME-141

List of Experiments
1. Introduction to pattern shop tools, machines, and to make bearing bracket.
2. Manufacturing of T-Lap Joint, and Dovetail Lap Joint in pattern shop.
3. Introduction to lathe machine, tools and to perform plain turning and facing on lathe machine.
4. Manufacturing of Job as per drawing from given raw material by performing various operations on lathe machine.
5. Manufacturing of bolt on lath machine.
6. Shaping a round rod of mild steel into a square by forging method.
7. Shaping a round rod of mild steel into wall hook geometry by forging method.
8. Making butt, lap, and T-joints by electric arc welding. Joining of metal sheets by spot welding.
9. Making butt, lap, and T-joints by Oxy-Acetylene welding. Joining of various electronics components by soldering method.
10. Use of various tools and processes to make a mould.
11. Making mould of bearing bracket from green sand and perform casting.
12. Use of various tools to perform drilling, reaming, and taping operations.
13. Perform measuring, cutting, filling, drilling and reaming operations.
14. Introduction to various tools used in making electrical circuits. Making a simple electrical circuit.
15. Making a hotel wiring circuit controlled by various switches.

Recommended books:

1. Krar Steve F., Check Albert F., Machine Tools, 5th edition, ISBN: 0-07-116421-9 McGraw-Hill, 1998.

COURSE LEARNING OUTCOMES (CLOs)				
S. No.	**CLO Statement**	**Domain**	**Mapping with Bloom's Taxonomy**	**Mapping with PLO**
1.	Apply ethical principles while working in the laboratory and adopt necessary guidelines for student's health & safety.	**Affective**	**A3**	**PLO-8**
2.	Apply, explain, express and collect information regarding the course contents and labs.	**Cognitive**	**C3**	**PLO-4**
3.	Practice the experimental task and writing skills to develop an assigned task.	**Psychomotor**	**P3**	**PLO-5**
4.	Ability to work in a team by participating in group projects.	**Affective**	**A2**	**PLO-9**

SECOND SEMESTER
MECHANICAL ENGINEERING

Semester 2		Contact hours		Credit hours
No.	**Course**	**Lecture**	**Lab.**	**Total**
BSI-231	Differential Equations	3	0	3
BSI-143	Communication and Presentation Skills	2	0	2
ME-111	Engineering Statics	3	0	3
ME-121	Thermodynamics-I	3	0	3
ME-121L	Thermodynamics Lab	0	3	1
ME-112	Engineering Drawing and Graphics	2	0	2
ME-112L	Engineering Drawing and Graphics Lab	0	3	1
ME-113	Mechanics of Materials-I	3	0	3
	Total Contact Hours	16	6	
	Total Credit Hours	16	2	18

SEMESTER 2

Course Title: Differential Equations (3, 0)

Course Code: BSI-231

Course Contents
PDE, Linear Differential equations, Non-Linear, Differential equations, Solutions of differential equations, General solutions, Particular solutions, Initial and boundary value problems. Separable equations, Homogeneous equations, Differential equations reducible to homogeneous form and related examples. Exact equations, Integrating factors, Linear equations and related examples. Bernoulli's equations, orthogonal trajectories, Equations solvable for p, Equations solvable for y, Equations solvable for x and related examples. Homogeneous linear equations, Differential operators, Non-homogeneous linear equations, Undetermined coefficients, Cauchy-Euler equations and related examples. Variation of parameters, exact linear equations, linear system of Differential Equations and related examples. Power series solutions of first order Differential Equations, Second order linear equations and related examples. Applications of Ordinary differential equations in Electrical Engineering. Partial Differential Equations: Method of Separation of variables and related examples. Applications of partial differential equations in Engineering.

Recommended books:

1. Advanced Engineering Mathematics by Erwin Kreyzig, John Wiley & Sons Inc. Latest Edition.
2. Differential Equation with Boundary Value problems by D. G. Zill, M. R Cullen Latest Edition, Brook/Cole Publishers.
3. Mathematical Methods by Dr. S.M Yousuf, Ilmi Kitab Khana, Latest Edition.

COURSE LEARNING OUTCOMES (CLOs)

S. No.	CLO Statement	Domain	Mapping with Bloom's Taxonomy	Mapping with PLO
1.	To solve different types of differential equations by understanding fundamental methods and techniques	**Cognitive**	**3**	**PLO-2**
2.	To develop force balancing models based on differential equations for different engineering problems	**Cognitive**	**3**	**PLO-3**

Course Title: Communication and Presentation Skills (2, 0)

Course Code: BSI-143

Course Contents
The Nature of Communication, Process of communication, Communication in an organization, Basic Principles of Effective Communication, Importance and Components of Communication. Meetings Various Kinds of Meetings, Purposes of Meetings, Leadership Responsibilities in Meetings. Key Points to Remember While Writing a Resume, Various Formats of Resume Writing, Why Include a Cover Letter, Writing a Cover Letter. Writing Business Letter, Minutes and Memorandums. Communication through Debat. How to Express Effectively During Debate, Better public speaking and presentation. Interview and its types. The Rules of Interview Taking, What Makes an Interview Successful. The Significance of Technology in Communication, Power Point Presentations. Speaking in public places. Strategies for improving oral delivery, Phonetic symbols and rules of pronunciation. Long (Formal Reports). Prefatory Sections, Supplemental Sections, Presentations of Long Reports. Persuasive Written Messages and Presentations, Persuasive speaking. Writing and Presenting Proposals. Kinds of Proposals, Parts of Proposals. Team Communication. Listening. Process and kinds of listening, TOEFL and IELTS Practice Tests. Negotiation Skills.

Recommended books:

1. Effective Business Communication by H.A Murphy, H.W Hildebrandt and J.P Thomas
2. Summary Writing (book-I) by Christopher Fry (OUP), latest Edition
3. Speaking Clearly by Pamela Rogerson & Judy B. Gilbert,Latest edition
4. Basic Technical Writing by Herman M Weisman, latest Edition
5. English Course by Linguaphone Institute, London, latest edition
6. Practical English grammar by A.J Thomson and A.V.Martinet Exercises 01 third Edition, Oxford University Press.

COURSE LEARNING OUTCOMES (CLOs)

S. No.	CLO Statement	Domain	Mapping with Bloom's Taxonomy	Mapping with PLO
1.	To solve different types of differential equations by understanding fundamental methods and techniques	**Affective**	**4**	**PLO-10**
2.	To develop force balancing models based on differential equations for different engineering problems	**Affective**	**2**	**PLO-10**

Course Title: Engineering Statics (3, 0)

Course Code: ME-111

Course Contents
Force System. Force, rectangular components, moment, couples, resultant of forces, moments and couples (two and three dimensional systems). ***Equilibrium.*** Mechanical systems, isolation and equilibrium equations for two and three dimensional systems. Free body diagram, two force and three force members. ***Distributed Forces.*** Center of Mass, Centroids of Lines, Areas, and Volumes, Composite Bodies and Figures; Approximations, Area moments of inertia parallel axis theorem. ***Structures.*** Plane trusses, method of joints, method of sections, frames and machine analysis. Forces in beams and cables ***Friction.*** Types of friction, dry friction, application of friction: wedges, Cone, Plate and Collar Bearings.

Recommended books:

1. J. L. Meriam, Engineering Mechanics (Statics).
2. Beer and Johnston, Vector Mechanics for Engineers.
3. R. C. Hibbler, Engineering Mechanics (Statics).

COURSE LEARNING OUTCOMES (CLOs)				
S. No.	**CLO Statement**	**Domain**	**Mapping with Bloom's Taxonomy**	**Mapping with PLO**
1.	**COMPREHEND** concepts of vectors and scalars, forces, moments and couples.	**Cognitive**	**2**	**PLO-1**
2.	**APPLY** the learned concepts of forces, moments and couples to solve problems of equilibrium in 2-D and 3-D equilibrium in 2-D and 3-D	**Cognitive**	**3**	**PLO-2**
3.	**ANALYZE** structures such as plain trusses, Frames and machines for reaction forces	**Cognitive**	**4**	**PLO-2**
4.	Solve mechanics problems	**Cognitive**	**3**	**PLO-2**

Course Title: Thermodynamics I (3,0)

Course Code: ME-121

Course Contents
Basics: The System and Control Volume, State and Properties, Process and Cycles, working substance, Heat and Work, state and path functions, temperature scales, processes and cycles, PV diagram, Internal energy, specific heats, Ideal gas laws, equations of state, ***Properties of Pure Substance:*** The pure substance, Vapor-Liquid-Solid Phase Equilibrium, Independent properties of pure substance, equations of state for the vapor phase, Tables of thermodynamic properties, thermodynamic surfaces. ***First law of thermodynamics:*** First law of thermodynamics, system and control volume concept. Application of conservation of energy principle to processes (isobaric, isochoric, isothermal, adiabatic, isentropic and polytropic), Steady State Steady Flow equation (SSSF) and its application, transient state equations, ***Second law of thermodynamics:*** Second law of thermodynamics and its consequences, reversibility, Heat engines, thermal efficiency, the Carnot cycle, Concept of entropy, TS Diagrams for processes. Clausius inequality, Concept of Lost work, Second Law efficiency, Calculation of Change of Entropy for reversible and Irreversible Processes, Availability and Irreversibility, Concept of Stagnation Properties, Flow Measurement for Gases.

Recommended books:

1. Borgnakke and Sonntag, Fundamentals of Classical Thermodynamics, 7th Edition, Wiley.
2. Moran, Shapiro Boettner and Bailey, Principle of Engineering Thermodynamics, 8th Edition, Wiley.
3. Cengel and Boles, Thermodynamics – An Engineering Approach, 8th Edition, McGrawHill.

COURSE LEARNING OUTCOMES (CLOs)

S. No.	CLO Statement	Domain	Mapping with Bloom's Taxonomy	Mapping with PLO
1.	State the First Law and define heat, work, thermal efficiency and the difference between various forms of energy	**Cognitive**	**1**	**PLO-1**
2.	Apply the steady-flow energy equation to a system of thermodynamic components (heaters, coolers, pumps, turbines, pistons, etc.) to estimate required balances of heat, work and energy flow	**Cognitive**	**1**	**PLO-2**
3.	Define Second Law and entropy; and using entropy calculations as a tool for evaluating irreversibility (lost work) in engineering processes	**Cognitive**	**2**	**PLO-1**
4.	Apply entropy to simple heat engine and refrigeration cycles to estimate thermal efficiency and work	**Cognitive**	**3**	**PLO-2**

Course Title: Thermodynamics Lab (0,1)

Course Code: ME-121L

List of Experiments
1. Introduction to Thermodynamics lab and to study the layout of lab
2. Experimental introduction to temperature measurement: methods, areas of application and characteristics.
3. Learn different pressure measurement methods.
4. Demonstrate the laws of state changes in gases experimentally (Isothermal change of state, Boyle-Mariotte law, Isochoric change of state, Gay- Lussac's 2nd Law).
5. Find the calorific value and flash point of a fuel.
6. Learn about the function and operational behavior of the refrigeration circuit components.
7. Understand two-stroke and four stroke engine.
8. Understand different systems (cooling, Ignition, lubrication, fuel & transmission) of an engine.
9. Determination of Torque measurement, Speed measurement, Fuel flow rate measurement, Air Flow rate measurement through Single Cylinder Engine Test Bed.
10. Determination and analysis of Exhaust gases.

Recommended books:

1. William H.Crouse, Donald L.Anglin, Automotive Mechanics, 10th edition, ISBN: 007112599, McGraw-Hill, 2007.

COURSE LEARNING OUTCOMES (CLOs)				
S. No.	**CLO Statement**	**Domain**	**Mapping with Bloom's Taxonomy**	**Mapping with PLO**
1.	Adopt ethical principles and necessary guidelines for students' health and safety while working in the laboratory	**Affective**	**3**	**PLO-8**
2.	Analyze experimental data and document findings of the experiment through writing technical report	**Cognitive**	**4**	**PLO-10**
3.	Ability to **observe** basic thermodynamics laws	**Psychomotor**	**1**	**PLO-1**
4.	Ability to **operate** thermodynamic equipment while applying thermodynamic laws on it.	**Psychomotor**	**3**	**PLO-1**

Course Title: Engineering Drawing & Graphics (2,0)

Course Code: ME-112

Course Contents

1. Engineering Drawing Basics

Instruments and Scales used in Engineering Drawing, Dimensioning and Lettering, Types of lines, Construction of Basic Geometrical Shapes.

2. Orthographic Projection

Principle and Methods of projection, Orthographic projection, Planes of projection, First and Third-angle projection, Reference line.

3. Projection of Points

A point situated in the first, second, third and fourth quadrant.

4. Projection of Straight Lines

Line parallel and perpendicular to one or both the planes, Line contained by one or both the planes, Projections of lines inclined to both the planes, True length of a straight line and its inclinations, Methods of determining traces of a line.

5. Projection of Planes (2D)

Projections of planes parallel and Perpendicular to Priciples Planes of Projection, Projections of oblique planes.

6. Projections on Auxiliary Planes (2D)

Types of auxiliary planes and views, Projection of a point on an auxiliary plane, Projections of lines and planes.

7. Projections of Solids (3D)

Types of solids and their projections, Projections of solids with axes inclined

8. Section of Solids (3D)

Section of planes, prisms, pyramids, cylinders, cones, spheres.

9. Isometric Projections (3D)

Isometric axis, lines, planes, and scale, Isometric drawing or isometric view, Isometric drawing of planes or plane figures, prisms and pyramids, cylinders, cones and sphere.

10. Development of Surfaces

Methods of development, Triangulation development, Developments of lateral surfaces of right.

Recommended books:

1. Bhutt, N.D., Engineering Drawing, 50th edition, ISBN: 9380358172, Charotar Publishing House, 2010.
2. French, E. Thomas, Vierck. J. Charles, Foster J. Robert, Engineering Drawing and Graphic Technology, 14th edition, ISBN: 0-07-022347-5, McGraw-Hill, 1993.
3. Parkinson, A.C., First Year Engineering Drawing, 6th edition, ISBN: 0273413937, Pitman Publishing, 1962.

COURSE LEARNING OUTCOMES (CLOs)				
S. No.	**CLO Statement**	**Domain**	**Mapping with Bloom's Taxonomy**	**Mapping with PLO**
1.	Recognize and explain engineering drawing and graphics as a language of communication.	**Cognitive**	**2**	**PLO-1**
2.	Explain engineering visualization principles and projection theory and apply those principles in engineering drawing development.	**Cognitive**	**3**	**PLO-2**
3.	Produce orthographic projections, isometric views and sectional views of different mechanical parts.	**Psychomotor**	**3**	**PLO-3**

Course Title: Engineering Drawing & Graphics Lab (0, 1)

Course Code: ME-112L

List of Experiments
1. Introduction to drawing instruments and their uses and safety guidelines
2. Introduction to Sheet Layout and Free-hand Sketching
3. Introduction to Lines, Lettering and Scaling
4. Practice of Dimensioning and lettering
5. Hand on practice of Geometric drawings
6. Practice on Sheet Planning
7. Introduction to Orthographic Projections (1st Angle)
8. Introduction to Orthographic Projection (3rd Angle)
9. Practice and drawing of three views of different objects using orthographic projection
10. Conversion of orthographic projection into isometric view
11. Practice of Sectioning and its various types
12. Creating drawings of engineering fasteners like rivets, cotter joint, threads etc.
13. Introduction to Geometric dimensioning and Tolerances in Engineering Drawing

Recommended books:

1. Bhutt, N.D., Engineering Drawing, 50th edition, ISBN: 9380358172, Charotar Publishing House, 2010.
2. Parkinson, A.C., First Year Engineering Drawing, 6th edition, ISBN: 0273413937, Pitman Publishing, 1962

COURSE LEARNING OUTCOMES (CLOs)

S. No.	CLO Statement	Domain	Mapping with Bloom's Taxonomy	Mapping with PLO
1.	Adopt ethical principles and necessary guidelines for students' health and safety while working in the laboratory	**Affective**	**3**	**PLO-8**
2.	Analyze the drawings through submission of lab Report of engineering drawing & graphics	**Cognitive**	**4**	**PLO-10**
3.	Recognize engineering drawing and CAD as language of communications	**Psychomotor**	**1**	**PLO-10**
4.	Practice and apply different features of engineering drawing for drafting process	**Psychomotor**	**3**	**PLO-9**

Course Title: Mechanics of Materials-I (3,0)

Course Code: ME-113

Course Contents
Mechanical Properties of Materials; Axial loading Stresses and Strains: Tensile, Compressive and Shear; Residual stresses; Thermal Stresses; Hooke's law and Stress-strain relationship; Elastic Constants and Their Relationships; Shearing Force and Bending Moment, Pure Bending of Beams; Moment of Inertia, Shear Stresses in Beams; Torsion of Circular Bars, Thin Walled Cylinders. Analysis of statically indeterminate problems.

Recommended books:

4. Ferdinand P. Beer, E. Russell Johnston Jr., John T. DeWolf, David F. Mazurek, Mechanics of Materials, 7th edition, ISBN: 007339823, McGraw-Hill, 2014.
5. P. P. Benham & R. J. Crawford, Mechanics of Engineering Materials, ISBN: 0582251648 Pearson; 2nd edition, 1996.
6. Popov, Mechanics of Materials, 2nd edition, ISB: 0135713560, Prentice Hall, 1976.
7. R.C. Hibbeler, Mechanics of Materials, 10th edition, ISBN: 0134319656, Pearson, 2016.
8. W. Nash, *Schaum's Outline of Strength of Materials, (Schaum's Outlines)*, 6th edition, ISBN: 9780071830805, McGraw-Hill Education, 2013.

COURSE LEARNING OUTCOMES (CLOs)				
S. No.	**CLO Statement**	**Domain**	**Mapping with Bloom's Taxonomy**	**Mapping with PLO**
1.	**Understand** the basics of mechanics of materials and their mechanical properties	**Cognitive**	**1**	**PLO-1**
2.	**Calculate** the stresses and strains in mechanical structures	**Cognitive**	**2**	**PLO-2**
3.	**Solve** problems related to bending and torsion and in mechanical structures	**Cognitive**	**3**	**PLO-2**

THIRD SEMESTER MECHANICAL ENGINEERING

Semester 3		Contact hours		Credit hours
No.	**Course**	**Lecture**	**Lab**	**Total**
BSI-111	Linear Algebra	3	0	3
ME-211	Engineering Dynamics	3	0	3
ME-211L	Engineering Dynamics Lab	0	3	1
ME-212	Mechanics of Materials-II	3	0	3
ME-212L	Mechanics of Materials Lab	0	3	1
ME-213	CAD-I	0	3	1
ME-221	Thermodynamics-II	2	0	2
ME-222	Fluid Mechanics-I	3	0	3
	Total Contact Hours	14	9	
	Total Credit Hours	14	3	17

SEMESTER 3

Course Title: Linear Algebra (3, 0)
Course Code: BSI-111

Course Contents
Solution of System of linear equations and applications. (Gauss Elimination, Gauss-Jordan, Pivoting methods, LU decomposition). Matrix Algebra, Matrix Transformations, Determinants, Inverse of a matrix, Cramer's Rule.Vectors in Rn , Properties of vectors, application of vectors, vector algebra, inner product. Computer graphics by using different matrix transformations, that is, Reflection, rotation, dilation, contraction, shear in X- and Y-direction. Applications of linear systems and matrices in electrical circuit, Markov process and then Markov process in Psychology, Business, Sociology, Genetics and Mass transit. Introduction to linear transformations, their applications in coding and decoding the messages. Basis for range and kernel of a given transformation. Lines and planes in R3. Introduction to vector spaces, Subspaces, linear combination, spanning sets and dependence Basis and dimension. Solution space, null space and rank of a matrix. Eigenvalues and eigenvectors, similar matrices, diagonalization, Application of eigenvalues in dynamical systems. Introduction to linear programming, optimization, graphical method, simplex method, optimization problems in engineering and economics.

Recommended books:

1. Introductory Linear Algebra: By Bernard Kolman and David R. Hill, Latest Edition.
2. Elementary Linear Algebra: By Howard Anton and Chris Rorrers, Latest Edition.

COURSE LEARNING OUTCOMES (CLOs)

S. No.	CLO Statement	Domain	Mapping with Bloom's Taxonomy	Mapping with PLO
1.	To describe different concepts of linear algebra and optimization	**Cognitive**	**2**	**PLO-2**
2.	To apply these concepts for solution of the problems in Sciences and Engineering	**Cognitive**	**3**	**PLO-1,2**

Course Title: Engineering Dynamics (3,0)
Course Code: ME-211

Course Contents
Kinematics of Particles. Rectilinear motion, plane curvilinear motion, rectangular coordinates, normal and tangential coordinates polar coordinates, Relative Motion, Constrained Motion of Connected Particles. **Kinetics of Particles.** Force, mass, and acceleration, Newton's second law of motion, equations of motion, kinetic diagrams, rectilinear motion, curvilinear motion. Work and energy, potential energy. Linear and angular Impulse Linear and angular momentum. **Plane Kinematics of Rigid Bodies.** Angular motion relations, absolute motion, relative velocity, instantaneous center of zero velocity, relative acceleration, Motion Relative to Rotating Axes. **Plane Kinetics of Rigid Bodies.** Force, mass, and acceleration, equation of motion, translation, fixed axis rotation, general plane motion, work and energy relationship, impulse and momentum equations.

Recommended books:

1. Beer and Johnston, Vector Mechanics for Engineers (Dynamics).
2. J. L. Meriam, Engineering Mechanics (Dynamics).
3. R. C. Hibbler, Engineering Mechanics (Dynamics).

COURSE LEARNING OUTCOMES (CLOs)

S. No.	CLO Statement	Domain	Mapping with Bloom's Taxonomy	Mapping with PLO
1.	**Comprehend** key concepts related to kinematics and kinetics of particles in different Coordinate Systems.	**Cognitive**	**2**	**PLO-1**
2.	**Solve** problems related to Kinematics and kinetics of particles.	**Cognitive**	**3**	**PLO-2**
3.	**Calculate** various motion Parameters related to the Kinematics of rigid bodies Under translation and Rotation/general plane motion.	**Cognitive**	**4**	**PLO-2**
4.	**Analyze** and solve the problems related to kinetics of rigid Different techniques for their solution.	**Cognitive**	**3**	**PLO-2**

Course Title: Engineering Dynamics Lab (0,1)

Course Code: ME-211L

List of Experiments
1. To verify the link polygon for various uniplanar forces.
2. To determine tension in various parts of a hanging cord.
3. To verify the principle of moments on a bent lever.
4. To verify the principle of moments on disc apparatus.
5. To calculate supporting reactions in a simple supported beam.
6. To find forces developed in various parts of a simple roof truss.
7. To find forces developed in various parts of a wall crane.
8. To calculate moment of inertia of a flywheel by falling-weight method.
9. To calculate moment of inertia of a wheel by rolling it down an inclined plane.
10. To calculate coefficient of friction between two materials on an inclined plane.
11. To calculate the coefficient of friction between the given belts and the cast iron pulley.
12. To calculate efficiency and to draw load-efficiency curve for a screw jack.
13. To draw load-efficiency curve for a simple lifting crab.
14. To draw load-efficiency curve for a worm and worm wheel (helical block)
15. To draw load-efficiency curve for a wheel and axle.
16. To determine Centre of gravity of an irregular shaped body.

Recommended books:

1. Engineering Mechanics (Vols. 2). By J. L. Meriam & L. G. Kraige. John

COURSE LEARNING OUTCOMES (CLOs)				
S. No.	**CLO Statement**	**Domain**	**Mapping with Bloom's Taxonomy**	**Mapping with PLO**
1.	Perform series of experiments on prescribed equipment both individually and in teams and **assemble/dismantle** experimental setup proficiently.	**Psychomotor**	**4**	**PLO-9**
2.	**Complete** lab reports individually in time and follow the set of instructions given while presenting the work done in report.	**Affective**	**3**	**PLO-9**
3.	**Relate** the concepts taught in lab to the questions asked in viva and defend various concepts through logical reasoning.	**Affective**	**4**	**PLO-10**

Course Title: Mechanics of Materials-II (3,0)

Course Code: ME-212

Course Contents
State of Stress and Strain: General State of Stress and Strain, Plane state of stress and strain; Analysis of stress and strain in two dimensions: 2D Stress Transformation, Mohr's circle for stress and strain, Principal stresses and strains. Introduction to failure types: Yielding, Fatigue, Fracture Mechanics, and Creep; Thick-walled Cylinders Theories of Failure: Maximum Normal Stress Theory, Maximum Shear Stress Theory, and Maximum Distortion Energy Theory; Beam deflection: Castigliano's Theorem, Area-Moment Method, and Virtual Work; Curved bars; Theory of columns; Symmetrical and asymmetrical loading

Recommended books:

1. Ferdinand P. Beer, E. Russell Johnston Jr., John T. DeWolf, David F. Mazurek, *Mechanics of Materials*, 7th edition, ISBN: 007339823, McGraw-Hill, 2014.
2. P. P. Benham & R. J. Crawford, *Mechanics of Engineering Materials*, ISBN: 0582251648 Pearson; 2nd edition, 1996.
3. Andrew Pytel and F. L. Singer, *Strength of Materials*, 4th edition, ISBN: 0060453133, Addison-Wesley, 1987.
4. Popov, *Mechanics of Materials*, 2nd edition, ISB: 0135713560, Prentice Hall, 1976.
5. R.C. Hibbeler, *Mechanics of Materials*, 10th edition, ISBN: 0134319656, Pearson, 2016.
6. W. F. Riley, L. D. Sturges and D. H. Morris, *Mechanics of Materials*, 6th edition, ISBN: 047170511X, Wiley, 2006.
7. W. Nash, *Schaum's Outline of Strength of Materials, (Schaum's Outlines)*, 6th edition, ISBN: 9780071830805, McGraw-Hill Education, 2013.

COURSE LEARNING OUTCOMES (CLOs)

S. No.	CLO Statement	Domain	Mapping with Bloom's Taxonomy	Mapping with PLO
1.	**Analyse** stresses and strains for two dimensional cases using various techniques	**Cognitive**	**4**	**PLO-2**
2.	**Explain** theories of failure of materials for failure prediction in real-life components	**Cognitive**	**2**	**PLO-1**
3.	**Solve** problems related to failure of materials due to Fatigue, Creep etc. and also problems related to beam deflection	**Cognitive**	**3**	**PLO-2**
4.	**Analyze** stresses in thick-walled cylinders and columns	**Cognitive**	**4**	**PLO-2**

Course Title: Mechanics of Materials Lab (0, 1)

Course Code: ME-212L

List of Experiments
1. Introduction to Mechanics of Materials Laboratory, its layout, and safety guidelines
2. Determine the Yield strength and Ultimate strength of a steel bar
3. Determine strain in mild steel specimen and to plot a graph between Stress-Strain
4. Demonstrate Bend test on a steel bar
5. Determine Compressive Strength of a Concrete Cube
6. Determine stiffness of a Helical Spring
7. Determine the relationship between torque and angle of twist of a shaft
8. Determine Modulus of rigidity of a Rubber Pad
9. Demonstrate Creep phenomenon in Rubber Pad
10. Determine Fatigue Strength using fatigue measuring apparatus

Recommended books:

1. Ferdinand P. Beer, E. Russell Johnston Jr., John T. DeWolf, David F. Mazurek, Mechanics of Materials, 7th edition, ISBN: 007339823, McGraw-Hill, 2014.
2. Andrew Pytel and F. L. Singer, Strength of Materials, 4th edition, ISBN: 0060453133, Addison-Wesley, 1987.

COURSE LEARNING OUTCOMES (CLOs)

S. No.	CLO Statement	Domain	Mapping with Bloom's Taxonomy	Mapping with PLO
1.	Adopt ethical principles and necessary guidelines for students' health and safety while working in the laboratory	**Affective**	**3**	**PLO-8**
2.	Analyze experimental data and document findings of the experiment through writing technical report	**Cognitive**	**4**	**PLO-10**
3.	Conduct experiments and find out the unknowns such as yield strength, ultimate tensile strength of a specimen	**Psychomotor**	**4**	**PLO-5**
4.	Measure key variables of interest (such as displacements, angular displacements and strains) with confidence and proficiency	**Psychomotor**	**3**	**PLO-4**

Course Title: CAD-I (0,1)

Course Code: ME-213L

List of Experiments
1. Introduction to AutoCAD, Graphical User Interface (GUI) and general commands, setting up drawing sheet Units & toolbars
2. Using coordinate system and applying draw toolbar, modify toolbar commands
3. Applying dimensioning and discussing its types
4. Layout drawing of objects using different layer and line colors indicating all details. Name the details using text commands, Make a Title Block.
5. Draw Different type's bolts and nuts with internal and external threading in Acme and Square threading standards. Save the bolts and nut as blocks suitable for insertion.
6. To draw 2D drawing of Plummer block bearing
7. To draw 2D drawing of non-return valve
8. To draw 2D drawing of safety valve
9. To make an isometric dimensional drawing of a connecting rod using isometric grid and snap
10. Draw quarter sectional isometric view of a cotter joint
11. Draw 3D models by extruding simple 2D objects, dimension and name the objects
12. To draw 3D assembly of flange coupling
13. To draw 3D assembly of universal coupling
14. To draw 3D assembly of knuckle joint
15. To draw 3D assembly gib and cotter joint
16. To draw 3D assembly connecting rod

Recommended books:

1. French, Thomas E.; Vierck, Charles J. Engineering Drawing and Graphic Technology 12th Edition, ISBN 10: 0070221588, McGraw-Hill, 1978.
2. T. Jeyapoovan, Engineering Drawing and Graphics Using AutoCAD, 3rd edition, ISBN 10: 8125940006, Vikas Publishing, 2010.
3. N.D Bhatt, Engineering Drawing, 53rd Edition, ISBN-10: 9380358962, Charotar Publishing House Pvt. Ltd, 2014.

COURSE LEARNING OUTCOMES (CLOs)

S. No.	CLO Statement	Domain	Mapping with Bloom's Taxonomy	Mapping with PLO
1.	Adopt ethical principles and necessary guidelines for students' health and safety while working in the laboratory	**Affective**	**3**	**PLO-8**
2.	Analyze experimental data and document findings of the experiment through writing technical report	**Cognitive**	**4**	**PLO-10**
3.	Understand and **manipulate** the concepts of 2D drawing using AutoCAD software	**Psychomotor**	**3**	**PLO-1**
4.	Generate and **Produce** the 3D models and drawing views of Mechanical components and assemblies in AutoCAD	**Psychomotor**	**4**	**PLO-5**

Course Title: Thermodynamics II (2,0)

Course Code: ME-221

Course Contents
Exergy Analysis: Exergy, Exergy of System, Closed System Exergy Balance, Exergy Rate Balance for Open System, Exergetic (Second Law) Efficiency, Thermo-economics *Ideal Gas Mixture:* Mixtures of Ideal Gases, Model of mixture and vapor, first law to gas-vapor mixtures, adiabatic saturation process, Psychometric Chart, determination of Properties for Mixtures, definition of Gibbs function and enthalpy. *Chemical Reactions*: Fuels, the combustion process, enthalpy of formation, first law analysis for reacting substances, internal energy and enthalpy of combustion, adiabatic flame temperature, Combustion efficiency the third law of thermodynamics and absolute entropy, second law analysis of reacting systems, Engineering Applications. *Phase and Chemical Equilibrium:* Requirements for Equilibrium, Equilibrium between two phases of a pure substance, Equilibrium of a multi-component, multiphase system, the Gibbs phase rule, metastable equilibrium, chemical equilibrium, simultaneous reactions, and ionization.

Recommended books:

1. Borgnakke and Sonntag, Fundamentals of Classical Thermodynamics, 7th Edition, Wiley
2. Moran, Shapiro Boettner and Bailey, Principle of Engineering Thermodynamics, 8th Edition, Wiley
3. Cengel and Boles, Thermodynamics – An Engineering Approach, 8th Edition, McGrawHill.

COURSE LEARNING OUTCOMES (CLOs)

S. No.	CLO Statement	Domain	Mapping with Bloom's Taxonomy	Mapping with PLO
1.	Analysis of the Exergy for the System	**Cognitive**	**4**	**PLO-4**
2.	To understand the behavior of the Ideal Gas Mixture and determination of the properties for mixtures	**Cognitive**	**3**	**PLO-2**
3.	First and second law analysis of systems undergoing a chemical reaction.	**Cognitive**	**3**	**PLO-2**
4.	Examine the criteria for Phase and Chemical Equilibrium and determine the properties of the system under these conditions.	**Cognitive**	**3**	**PLO-2**

Course Title: Fluid Mechanics-I (3, 0)

Course Code: ME-222

Course Contents
Introduction Definition of fluid, Density, Specific weight, Specific volume, Specific gravity, Surface tension, Compressibility of fluid, Viscosity of fluid, and fluid classification. **Fluid Statics** Concept of Pressure and basic equations, Pressure variation in fluid with rigid body motion, Different pressure gauges, Hydrostatic forces on submerged planes and Curved Surfaces, Buoyancy and Stability of Submerged and Floating Bodies. **Types of Flow** Uniform and Non-Uniform Flow, Steady and Unsteady Flows, Laminar and Turbulent Flow, Path Line, Streamlines, Stream Tubes. **Basic Equations and Their Application** Integral and differential forms of Continuity Equation, Bernoulli's Equation, Flow Through Venturimeter, Flow Through Orifice, Pitot Tube, Total, stagnation and dynamic pressure. **Flow through Pipes** Characteristics of pipe flow, Laminar and turbulent low, calculating friction factor and wall shear stresses, Solving pipe flow network problems, Power Transmission through Pipes, Hydraulic Gradient. **Dimensional Analysis, Similitude and Modeling** Dimensional analysis, Buckingham Pi theorem and determination of Pi terms

Recommended books:

1. Philip J. Pritchard and John C. Leylegian, Fox and McDonald's Introduction to Fluid Mechanics, 9th Edition, 2015, Wiley & Sons.
2. Munson, Young, Okiishi, HT John, Fundamentals of Fluid Mechanics, 7th Edition, 2012, J. Wiley & Sons.

COURSE LEARNING OUTCOMES (CLOs)

S. No.	CLO Statement	Domain	Mapping with Bloom's Taxonomy	Mapping with PLO
1.	**To Solve** the problems of fluid static including Manometry, hydrostatic force on submerged surfaces, and stability of floating bodies.	**Cognitive**	**3**	**PLO-1** **PLO-2**
2.	**To Apply** the continuity equation (both in integral and differential form) for control volume to engineering problems for different types of flows including steady and unsteady flow, uniform and non-uniform flow, compressible and incompressible flow.	**Cognitive**	**3**	**PLO-1** **PLO-2**
3.	**To Analyze** the problems related to fluid dynamics especially for incompressible flow, including flow measuring devices (venturimeter, orifice meter Pitot tube), and for flow through orifice/notches, using Bernoulli's equation.	**Cognitive**	**4**	**PLO-1** **PLO-2**
4.	**To Analyze** fully developed laminar and turbulent flow through pipes and calculating various loss of heads for flow through pipes and design the pipe for power transmission.	**Cognitive**	**4**	**PLO-1** **PLO-2**

FOURTH SEMESTER MECHANICAL ENGINEERING

Semester 4		Contact hours		Credit hours
No.	**Course**	**Lecture**	**Lab.**	**Total**
BSI-242	Numerical Analysis	3	0	3
ME-214	Engineering Metallurgy	3	0	3
ME-214L	Engineering Metallurgy Lab	0	3	1
ME-215	Design of Machine Elements-I	3	0	3
ME-223	Fluid Mechanics-II	3	0	3
ME-223L	Fluid Mechanics Lab	0	3	1
ME-201	Entrepreneurship	2	0	2
ME-202	Ethics & Legal Dimensions of Engineering	2	0	2
	Total Contact Hours	16	6	
	Total Credit Hours	16	2	18

SEMESTER 4

Course Title: Numerical Analysis (3, 0)

Course Code: BSI-242

Course Contents
Error analysis, types of error, condition number.Interpolation: Newton forward and backward difference formula for interpolation, central difference based interpolation formulae, Lagrange's interpolation polynomial. Numerical differentiation of first order and higher order and its application in engineering. Numerical integration (Trapezoidal, Simpson's rules, Boole's rule, Weddle's rule, Romberg integration), Application of integration in Engineering (Area, Volume, Surface area, length of arc etc). Numerical method for solution of ODE, Picard's method, Taylor's method, Euler method and its variations. Runge Kutta method, Multi step methods. Solution of initial and boundary value problem using numerical methods. Solution of nonlinear equations: graphical method, bracketing methods, iterative methods. Solution of system equation by numerical methods, Jacobi method, Gauss Seidel method. Eigenvalues and Eigenvectors: power method, Inverse power method, Shifted inverse power method.

Recommended books:

1. Numerical Analysis: By Richard L. Burden, J. Douglas Faires, Latest Edition
2. Reference Book:
3. Numerical methods for scientist and engineers by R.W. Hamming (Latest Edition)

COURSE LEARNING OUTCOMES (CLOs)				
S. No.	**CLO Statement**	**Domain**	**Mapping with Bloom's Taxonomy**	**Mapping with PLO**
1.	To describe different numerical techniques in interpolation, differentiation, integration, eigenvalues and solution of algebraic and differential equations	**Cognitive**	**2**	**PLO-**
2.	To apply these techniques for the solution of engineering problems	**Cognitive**	**3**	**PLO-2**

Course Title: Engineering Metallurgy (3,0)

Course Code: ME-214

Course Contents
Introduction to Materials Science and Engineering. Introduction and classification of materials, atomic bonding and crystallography of materials. Imperfections in solids. Mechanical behavior and testing of materials. Phase diagrams and microstructure. Diffusion and phase transformations. Heat treatment. Introduction to polymers, ceramics and composites. Introduction to failure analysis. Materials selection in mechanical design. Case studies.

Recommended books:

1. William D. Callister, Jr. Materials Science and Engineering: An Introduction, Seventh Edition, 2006.
2. James F. Shakelford, Introduction to Materials Science for Engineers.
3. William F. Smith and Javad Hashemi, Foundations of Materials Science and Engineering.
4. Lawrence H. Van Vlack, Elements of Materials Science and Engineering.
5. Donald R. Askeland and Pradeep P. Phule. The Science and Engineering of Materials.
6. Michael F. Ashby and D. R. H. Jones, Engineering Materials: Vol. I and II.
7. Vernon John, Introduction to Engineering Materials.

COURSE LEARNING OUTCOMES (CLOs)				
S. No.	**CLO Statement**	**Domain**	**Mapping with Bloom's Taxonomy**	**Mapping with PLO**
1.	Recognize the various categories of materials: metals, polymers, ceramics, and composites	**Cognitive**	**2**	**PLO-1**
2.	Understand the different levels of materials structures, develop a structure-property perspective and understand the physical and mechanical properties of materials	**Cognitive**	**3**	**PLO-1**
3.	Interpret the equilibrium phase diagram of metallic materials, and analyze microstructure at different temperatures. Understand and select proper heat treatment of steel and aluminum	**Cognitive**	**4**	**PLO-2**
4.	Develop the relationship between processing, design and selection of engineering materials	**Cognitive**	**5**	**PLO-3**

Course Title: Engineering Metallurgy (0, 1)

Course Code: ME-214L

List of Experiments
1. Introduction to Engineering Metallurgy Laboratory, its layout, and safety guidelines
2. Recognize annealing, normalizing and quenching operation for mild steel specimen
3. Heat treatment of mild steel specimen using box furnace and different cooling mediums
4. Macro examination and preparation of specimen using Cut-off Wheel Apparatus
5. Preparation of specimen using Mounting press
6. Planar grinding, polishing and micro-examination of the mounted specimen
7. Final preparation of specimen by fine polishing and etching, followed by micro examination
8. Crack Detection by Magnetic Particle Inspection (MPI)
9. Determine the hardness of different materials using Micro-Vickers Hardness apparatus
10. Identification and classification of Metals by Sound and Spark test

Recommended books:

1. William D. Jr. Callister, Materials Science and Engineering: An Introduction, 7th Edition Hardcover, ISBN-13: 978-0006970118, 2006.
2. Sidney H. Anver, Introduction Physical Metallurgy, 2nd Edition, McGraw-Hill, ISBN-13: 978-0070024991.

COURSE LEARNING OUTCOMES (CLOs)

S. No.	CLO Statement	Domain	Mapping with Bloom's Taxonomy	Mapping with PLO
1.	Apply ethical principles while working in the laboratory and adopt necessary guidelines for student's health & safety	**Affective**	**3**	**PLO-8**
2.	Analyze experimental data and document findings of the experiment through writing technical report	**Cognitive**	**4**	**PLO-10**
3.	Conduct different heat treatment processes and identify grain structures formed as a result of these heat treatment processes	**Psychomotor**	**4**	**PLO-5**
4.	Measure mechanical properties of materials such as micro hardness using suitable equipment's	**Psychomotor**	**3**	**PLO-4**

Course Title: Design of Machine Elements-I (3,0)

Course Code: ME-215

Course Contents
Introduction to Design. Basic Concepts in Design of Machine Parts: Factor of Safety, Codes and Standards. Role of Economics, Reliability. Fits, Allowances and Tolerances. Design of Threaded Fasteners, Riveted Joints, Pins, Keys and Cotters. Design of Welded Joints. Design of Clutches, Brakes, Flywheels and Couplings. Design of Rolling Element Bearings. Design of Journal Bearings

Recommended books:

4. Richard G. Budynas, J Keith Nisbett, Mechanical Engineering Design, 10th edition ISBN 978-0-07-339820-4, McGaw Hill, 2015
5. Robert C. Juvinall, Kurt M. Marshek, Fundamentals of Machine Component Design 5th EditionISBN-13: 978-1118012895 Wiley; 5 edition (September 27, 2011)
6. T E French; C J Vierck; R J Foster, Engineering drawing and graphic technology, 14th edition ISBN 0070223475 9780070223479 New York, N.Y. : McGraw-Hill, 1993

COURSE LEARNING OUTCOMES (CLOs)				
S. No.	**CLO Statement**	**Domain**	**Mapping with Bloom's Taxonomy**	**Mapping with PLO**
1.	To apply mechanical engineering design process for problem solution	**Cognitive**	**3**	**PLO-1**
2.	To design mechanical elements such as clutches, brakes, bearings and joints	**Cognitive**	**5**	**PLO-3**
3.	To evaluate mechanical systems using standards, codes	**Cognitive**	**6**	**PLO-2**

Course Title: Fluid Mechanics-II (3, 0)

Course Code: ME-223

Course Contents
Introduction Basic Laws of Fluid Mechanics, General Forms of Continuity, Momentum and Energy Equations for Control Volume. **Fluid Kinematics** Introduction to Potential Flow theory, Stream Function, Velocity Potential Function, Rotational and Irrotational Flow. **Fluid Dynamics** Integral and differential forms of linear momentum Equation Integral and differential forms of moment of momentum Equation, evaluating velocity and acceleration field using material derivative, Deriving Navier-Stokes equation and some simple analytical solution Steady state incompressible viscous flow, Flow over flat plate, Development of boundary layer theory. Laminar Boundary Layer, Turbulent Boundary Layer, Velocity profile in boundary layer, Drag and Drag coefficient, Lift and Lift coefficient. **Compressible Flow** Elements of one dimensional gas dynamics speed of sound, Mach number, local and stagnation properties, isentropic flow through varying area duct, isentropic flow through convergent nozzle, and Convergent-Divergent nozzle. **Hydraulic Machinery and Equipment** Impact of Jet, Hydraulic Turbines, Pelton Wheel, Francis Turbine, Kaplan Turbine, Draft Tube, Specific Speed of Turbine. Reciprocating Pump. Air Vessel and its effects on the performance of Reciprocating Pump. Centrifugal Pumps, Pumps and turbine performance characteristic curves

Recommended books:

1. Philip J. Pritchard and John C. Leylegian, Fox and McDonald's Introduction to Fluid Mechanics, 9th Edition, 2015, Wiley & Sons.
2. Munson, Young, Okiishi, HT John, Fundamentals of Fluid Mechanics, 7th Edition, 2012, J. Wiley & Sons.
3. Fluid Mechanics and Hydraulic Machinery, By K. R. Arora, 9th Edition, 2011, Standard Publisher.

COURSE LEARNING OUTCOMES (CLOs)

S. No.	CLO Statement	Domain	Mapping with Bloom's Taxonomy	Mapping with PLO
1.	**To use** moment equation (differential and integral form) for finding the force on control volumes, and its application for various flow channels.	**Cognitive**	**3**	**PLO-1** **PLO-2**
2.	**To apply** the potential flow theory and to solve the problems in fluid mechanics using this theory.	**Cognitive**	**3**	**PLO-1** **PLO-2**
3.	**To understand** the working principle of different types of hydraulic turbines / pumps and to **design/investigate** their performance at different operating conditions.	**Cognitive**	**5**	**PLO-1** **PLO-2**
4.	**To analyze** one dimensional compressible isentropic flow and its application on subsonic and supersonic flows, especially for the design of convergent / convergent-divergent nozzles.	**Cognitive**	**4**	**PLO-1** **PLO-2** **PLO-3**

Course Title: Fluid Mechanics Lab (0,1)

Course Code: ME-223L

List of Experiments
1. Introduction to Fluid Mechanics Lab, Hydraulic Bench and Lab Safety.
2. Calibration of the Bourdon type Pressure Gauge using a Dead Weight Pressure Gauge Calibrator.
3. Determination of the Center of Pressure of a submerged plane surface.
4. Study of stability of a floating body using Floating Pontoon Apparatus.
5. Study of the flow through Rectangular and Triangular Notches.
6. Verification of Bernoulli's theorem and determination of coefficient of discharge using venturimeter apparatus.
7. Study of flow through Orifice flow meter and determination of co-efficient of velocity of an Orifice by Free Jet Apparatus.
8. Determination of the Impact force of Jet on Flat Plate and Hemispheric Cup.
9. Study of the characteristics of a Pelton Wheel Turbine at various speeds.
10. Determination of the characteristics of Single stage Centrifugal Pump and testing the performance of two similar pumps connected in series and parallel configuration.
11. Demonstration of the Laminar and Turbulent flow using the Classical Reynolds apparatus.
12. Study of the Energy losses in Pipes using Pipe Friction Apparatus.
13. Introduction to Sub-sonic Wind Tunnel and its applications.

Recommended books:

1. Robert W. Fox and Alan T. Donald, Introduction to Fluid Mechanics, ISBN: 9788126523177, 2015.
2. K. R. Arora, Fluid Mechanics and Hydraulic Machinery, ISBN: 9788180140709, 2009.

COURSE LEARNING OUTCOMES (CLOs)

S. No.	CLO Statement	Domain	Mapping with Bloom's Taxonomy	Mapping with PLO
1.	Adopt ethical principles and necessary guidelines for students' health and safety while working in the laboratory	**Affective**	**3**	**PLO-8**
2.	Analyze experimental data and document findings of the experiment through writing technical report	**Cognitive**	**4**	**PLO-10**
3.	Operate and Perform experiments on various equipment of Fluid statics including pressure measuring devices, submerged planes and floating bodies, etc.	**Psychomotor**	**3**	**PLO-1**
4.	Ability to conduct experiments and execute various equipment related to fluid dynamics including venturis, orifices, flow through open channels, closed pipes and fittings, etc.	**Psychomotor**	**4**	**PLO-2**
5.	Proficiently manage the experiments related to Hydraulic machinery like centrifugal pumps, hydraulic turbines, etc. and sub-sonic wind tunnel.	**Psychomotor**	**5**	**PLO-4**

Course Title: Entrepreneurship (2,0)

Course Code: ME-201

Course Contents
Entrepreneurship and the Entrepreneurial Mind-Set Functions of an entrepreneur, Types of entrepreneur. Entrepreneur. Entrepreneurial Feelings, Entrepreneur background and Characteristics, An Introduction to entrepreneurship, Concepts of entrepreneurship, Economic Development, Factors affecting entrepreneurial growth. **The Entrepreneurial Process** Evaluating opportunities for new enterprise. **Creating and Starting the Venture** Creativity and sources of new business ideas, Methods of generating ideas, Creative problem Solving. Analysis of idea/opportunity (SWOT). **Marketing Strategy** Marketing as a philosophy, marketing management: Creating a marketing plan, Analyze the environmental situation and the market opportunity, setting marketing objective, formulating a marketing strategy, Screening and evaluating opportunities, Product planning and development process. **Protecting the idea and other legal issues for the entrepreneur** Legal forms of business, franchising, intellectual properties, etc. **External Assistance for startups and small Businesses.** Assessing business opportunities in Pakistan, why you should consider external assistance program, External assistance available in Pakistan, External assistance for special groups, locations, and industries.

Recommended books:

1. Robert D. Hisrich and Michael P. Peter, Entrepreneurship,10th Edition, McGraw Hill, ISBN-10: 0078029198, 2016.
2. William D. Bygrave, The Portable MBA in Entrepreneurship CEFE, Germany, 4th Edition, ISBN: 978-0-470-48131-8, 2009.
3. S.S. Khanka, Entrepreneurial Development 3rd edition, ISBN-10: 8121918014, 2006.
4. McGraw-Hill, Modern Business Management, A System & Environment Approach, ISBN-13: 978-0070287563, 1974.

COURSE LEARNING OUTCOMES (CLOs)				
S. No.	**CLO Statement**	**Domain**	**Mapping with Bloom's Taxonomy**	**Mapping with PLO**
1.	**Understanding** the basic concepts of Entrepreneurship, its characteristics, factors affecting entrepreneurship growth, Business plan and issues, marketing strategies	**Cognitive**	**2**	**PLO-6**
2.	**Applying** the entrepreneurial concepts for preparing the process cycle of starting and managing a new venture	**Cognitive**	**3**	**PLO-11**
3.	**Developing** an entrepreneurial process individually and as team member during assignments and projects for different case studies	**Cognitive**	**5**	**PLO-10**

Course Title: Ethical & Legal Dimensions of Engineering (2,0)

Course Code: ME-202

Course Contents
Ethics and Professionalism: Introduction to professional and socioeconomic concepts essential to successful engineering practice and in preparation for senior design courses **Moral Reasoning and Codes of Ethics:** Importance, Limitations and Abuse of Codes **Ethical Dilemmas, Moral Frameworks and Steps in Resolving Ethical Dilemmas:** Rights Ethics, Duty Ethics, Utilitarianism, Virtue Ethics, Self-Realization Ethics **Moral Autonomy and Accountability:** Engineers as Responsible Experimenters, Comprehensive Islamic Perspective **Safety and Risk and the Concept of Safety:** Assessing and Reducing Risk and Risk-Benefit Analyses **Workplace Responsibilities and Rights:** An Ethical Corporate Climate, Confidentiality and Conflicts of Interest, Teamwork and Rights, Loyalty and Collegiality, Managers and Engineers, Professional and Employee Rights **Academic and research Integrity:** Truth and Truthfulness, Whistleblowing, Honesty and trustworthiness **Environmental Ethics:** Case studies relating ethical codes to industrials norms and practices, with an emphasis on safety and public welfare.

Recommended books:

1. D.L. Marston, Law for Professional Engineers, 5th Ed., McGraw-Hill Ryerson, ISBN-13: 978-1260135909, 2019.
2. Mike W. Martin & Roland Schinzinger, Ethics in Engineering, 4th Edition, ISBN-13: 978-0072831153, 2004.

COURSE LEARNING OUTCOMES (CLOs)

S. No.	CLO Statement	Domain	Mapping with Bloom's Taxonomy	Mapping with PLO
1.	Defining, Understanding and Applying Engineering Code of Ethics	**Cognitive**	**1**	**PLO-6**
2.	Analyze and relate the morally complex scenarios to the practical situations in order to choose between right and wrong	**Cognitive**	**4**	**PLO-8**
3.	Application of the learned concepts of codes of ethics to identify and solve the morally complex situations at workplace	**Cognitive**	**5**	**PLO-8**

FIFTH SEMESTER MECHANICAL ENGINEERING

Semester 5		Contact hours		Credit hours
No.	**Course**	**Lecture**	**Lab.**	**Total**
BSI-351	Probability and Statistics	3	0	3
ME-311	Design of Machine Elements-II	3	0	3
ME-331	Mechanics of Machines and Vibration	3	0	3
ME-331L	Mechanics of Machines and Vibration Lab	0	3	1
ME-312	Engineering Materials	3	0	3
ME-341	Manufacturing Processes	3	0	3
ME-341L	Manufacturing Processes Lab	0	3	1
	Total Contact Hours	15	6	
	Total Credit Hours	15	2	17

SEMESTER 5

Course Title: Probability and Statistics (3, 0)

Course Code: BSI-351

Course Contents
Basic Statistics Statistics, Branches of Statistics, Importance of statistics, population, sample, observation, variables, measurement of variable, Data, primary data, secondary data **Data Presentation** Frequency distribution (grouped, ungrouped), stem and leaf display histogram, frequency polygon, cumulative frequency polygon **Measure of central tendency** Introduction and computation of measure of central tendency by five methods (A.M, G.M, H.M, Median, Mode), applications, Merits, Demerits, **Measure of Dispersion** Introduction and computation of measure of dispersion by five methods(Range, Quartile deviation, Mean deviation, Variance, Standard deviation), Types, Application, Merits, Demerits **Moments** Measure of Skewness, Measure of Kurtosis, Central moment, Raw moments, Moments ratio **Simple Regression and Correlation** Introduction to regression theory, Simple linear regression line, Line fitting by least square methods, Coefficient of determination, Simple correlation, types, correlation coefficient of correlation **Probability, Las of Probability** Experiments, Random experiments, Sample Space, Events, Types of Events, Counting rules(Multiplication, Permutation, Combination), Definition of probability(classical, empirical, axiomatic approach), Laws of probability(complementation, addition, conditional, multiplication, Bayes), independent, dependent events **Random Variable** Random Variable, types (Discrete Random Variable, Continuous Random Variable), Probability functions, probability density functions, distribution function, probability distribution, Joint probability distribution, mathematical expectation, Measure of central tendency and dispersion of random variables. Covariance and

correlation b/w two random variables

Discrete Probability Distribution

(Binomial, Hypergeometric, Poisson, Negative binomial, geometric) distribution, properties of the above distribution

Continuous Probability Distribution

Normal distribution, exponential distribution, properties

Statistical Inference

Introduction to inferential statistics, branches (Estimation, hypothesis testing of population mean, proportion)

Recommended books:

1. Introduction to Statistical theory part 1, by Sher Muhammad Chuadary (Latest Edition)
2. Advanced Engineering Mathematics, by Erwin Kreyszig (Latest Edition)
3. Ronald E. Walpole, Raymond H, Myers and Sharon L. Myers and Keying Ye,
4. Probability and Statistics for Engineers and Scientists, Prentice Hall Decoursey W., Statistics and Probability for Engineering Applications, Newness
5. Soong T. F., Fundamentals of Probability and Statistics for Engineers, John Wiley and Sons

COURSE LEARNING OUTCOMES (CLOs)				
S. No.	**CLO Statement**	**Domain**	**Mapping with Bloom's Taxonomy**	**Mapping with PLO**
1.	To acquire the basic concept of Statistics, probability and their need in engineering	**Cognitive**	**1**	**PLO-1**
2.	To apply the rules of Probability and Statistics for the understanding of different engineering problems	**Cognitive**	**3**	**PLO-2**
3.	To analyze various engineering problems through probabilistic techniques	**Cognitive**	**4**	**PLO-2**

Course Title: Design of Machine Elements-II (3, 0)

Course Code: ME-311

Course Contents
Design of Belts, Ropes and Chains. Design of Mechanical Springs. Design of Shafts. Kinematics, Force Analysis and Design of Gears.

Recommended books:

1. Richard G. Budynas, J Keith Nisbett, Mechanical Engineering Design, 10th edition ISBN 978-0-07-339820-4, McGaw Hill, 2015
2. Robert C. Juvinall, Kurt M. Marshek, Fundamentals of Machine Component Design 5th EditionISBN-13: 978-1118012895 Wiley; 5 edition (September 27, 2011)
3. T E French; C J Vierck; R J Foster, Engineering drawing and graphic technology, 14th edition ISBN 0070223475 9780070223479 New York, N.Y. : McGraw-Hill, 1993

COURSE LEARNING OUTCOMES (CLOs)				
S. No.	**CLO Statement**	**Domain**	**Mapping with Bloom's Taxonomy**	**Mapping with PLO**
1.	To design mechanical elements such as springs, gears and shafts	**Cognitive**	**5**	**PLO-3**
2.	To design/select flexible power transmission elements (belts, ropes and chains)	**Cognitive**	**5**	**PLO-3**
3.	To evaluate mechanical systems (with springs and power transmission) using standards and codes	**Cognitive**	**6**	**PLO-2**

Course Title: Mechanics of Machines and Vibrations (3, 0)

Course Code: ME-231

Course Contents
Introduction to Machine & Mechanisms: Mechanism Terminology, Kinematic Diagram, Kinematic Inversion, Four Bar Mechanism, Slider Crank Mechanism, Techniques of Mechanism Analysis; Analysis and Design of Cams; Balancing of Rotating and Reciprocating Masses. Introduction to Mechanical Vibration: Harmonic Motion, Periodic Motion, Vibration Terminology. Single degree of freedom system: Equation of Motion for Free Vibrations; Energy Method, Viscously Damped Free Vibration, Logarithmic Decrement, Harmonically Excited Vibration, Forced Harmonic Vibration, Vibration Isolation and Vibration Measuring Instruments. Two Degree of Freedom System: Normal Modes of Vibration, Coordinates Coupling, Forced Harmonic Vibration, Vibration Absorber, and Vibration Damper, Eigen Values and Eigen Vectors.

Recommended books:

1. John J. Uicker Jr., Gordon R. Pennock, Joseph E. Shigley, Theory of Machines and Mechanisms, 5th Edition, ISBN-13: 978-0190264482, McGraw Hill Book Company, 2014.
2. Robet L. Norton, Design of Machinery, 3rd Edition, ISBN-13: 978-0070599710, Tata McGraw-Hill, 2004.
3. Singiresu S. Rao, Mechanical Vibrations, 4th Edition, ISBN: 978-81-7758-874-3, Dorling Kindersley, 2004.
4. Leonard Meirovitch, Elements of vibration analysis,2nd Edition, ISBN: 0-07-100271-5, McGraw-Hill, 1986.

COURSE LEARNING OUTCOMES (CLOs)

S. No.	CLO Statement	Domain	Mapping with Bloom's Taxonomy	Mapping with PLO
1.	Understand the concept of Machine & mechanisms: Four Bar Mechanism, Slider Crank Mechanism and Techniques of Mechanism Analysis	**Cognitive**	**2**	**PLO-1**
2.	Explain the working of different types of cams and followers and able to design them	**Cognitive**	**2**	**PLO-1**
3.	Analyze unbalanced rotating and reciprocating systems of balancing	**Cognitive**	**4**	**PLO-2**
4.	Prepare mathematical model and Write equation of motion using various techniques for single and two degree of freedom systems.	**Cognitive**	**3**	**PLO-2**
5.	Analyze the system (SDOF, 2DOF) for natural frequency and mode shapes and solve the relevant problems	**Cognitive**	**4**	**PLO-3**

Course Title: Mechanics of Machines and Vibrations Lab (0, 1)

Course Code: ME-231L

List of Experiments
12. Introduction to Mechanics of Machines and vibration Laboratory, its layout, and safety guidelines.
13. Determine the effect of mass, angular speed and radius on the centrifugal force.
14. Balance the shaft both statically and dynamically.
15. Measure the gyroscopic torque with the gyroscope for different combination of precessional and angular speed.
16. Draw a cam profile of given cam and follower mechanism.
17. Determine stiffness of spring during free vibration.
18. Determine the theoretical natural frequency of a spring in free vibration and compare it with the natural frequency measured experimentally and study the effect of damping on the time period and frequency of vibrating spring.
19. Determine the natural frequency of Cantilever beam in forced vibration and demonstrate the resonance phenomenon.
20. Verify the relation between linear and angular speed.
21. Demonstrate whirling of shaft and determine the whirling frequency of shaft.
22. Determine the modulus of rigidity of bronze rod.
23. Determine the natural frequency of simple and compound pendulum.

Recommended books:

2. R.S.Khurmi and J.K.Gupta, Theory of Machines, 14th edition, ISBN: 81-219-0132-4, 1998
3. Singiresu S. Rao, Mechanical Vibration, 4th edition, ISBN: 978-0130489876, Prentice Hall, 2003.

COURSE LEARNING OUTCOMES (CLOs)

S. No.	CLO Statement	Domain	Mapping with Bloom's Taxonomy	Mapping with PLO
1.	Adopt ethical principles and necessary guidelines for students' health and safety while working in the laboratory	**Affective**	**3**	**PLO-8**
2.	Analyze experimental data and document findings of the experiment through writing technical report	**Cognitive**	**4**	**PLO-10**
3.	**Conduct** the experiment to verify gyroscopic law, Centrifugal force equation and the static and dynamic balancing technique to balance the unbalance mass to minimize the shaft vibration.	**Psychomotor**	**4**	**PLO-1**
4.	**Demonstrate** the resonance phenomenon, the whirling of shaft and the effect of damping on frequency and time period of vibration experimentally.	**Psychomotor**	**4**	**PLO-1**

Course Title: Engineering Materials (3,0)

Course Code: ME-312

Course Contents
Introduction Review of materials, their classification, processing and applications. **Ceramic Materials** Short Range Order in Crystalline Ceramic Materials, Long Range Order in Crystalline Ceramic Materials, Silicate Structure, Imperfection in Crystalline Ceramic Structures, Non-Crystalline Ceramic Materials, Deformation and Failure, Processing of Ceramic, Properties and Applications. **Polymers** Classification of Polymers, Structure of Polymers, Chain Formation by the Addition and condensation polymerisation, Degree of Polymerization, Chain Formation by Condensation Mechanism, Deformation Thermoplastic Polymers, crystallinity of polymers. Effect of Temperature on behaviour of Thermoplastics, Controlling the Structure and Properties of Thermoplastics, Elastomers (Rubbers), Additives to Polymers, processing of Polymers. **Composite Materials** Particulate-Reinforced Composite Materials, Dispersion Strengthened Composites, True Particulate Composites, Application of Particulate Composites. Fiber Reinforced Composites, Predicting Properties of Fiber-Reinforced Composite, Manufacturing Fibers and Composites, Fiber Reinforced Systems. Laminar Composite Materials and Its Applications, Manufacturing Laminar Composites. Wood, Concrete and Asphalt, Sandwich Structure. **Corrosion and protection:** Types of corrosion, Protection /remedies against different types of corrosion in engineering materials. **Application and selection of Materials** Advanced engineering materials and their applications, materials selection process using modern tools/techniques/applications.

Recommended books:

1. William D. Callister Jr., David G. Rethwisch, Materials Science and Engineering: An Introduction, 8th Edition, ISBN 10: 0470419970, John Wiley and Sons; 2009.
2. Donald R. Askeland, Wendelin J. Wright, Essentials of Materials Science and Engineering, 4th Edition, ISBN 10: 9781337385497, Cengage Learning, 2018.
3. Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, 6th Edition, ISBN 10: 1119128692, Wiley, 2015.

COURSE LEARNING OUTCOMES (CLOs)

S. No.	CLO Statement	Domain	Mapping with Bloom's Taxonomy	Mapping with PLO
1.	**Explain** and describe various classes of materials, structure and characteristics of engineering materials.	**Cognitive**	**2**	**PLO-1**
2.	**Analyze** the properties of commonly used metals , their alloys, plastics, Ceramics and Composites system	**Cognitive**	**4**	**PLO-2**
3.	**Selection** of Material for different applications using computer based tools and techniques.	**Cognitive**	**5**	**PLO-4** **PLO-5**

Course Title: Manufacturing Processes (3,0)

Course Code: ME-341

Course Contents
Introduction: Basic Concept of Manufacturing Processes **Metal Casting Process & Equipment:** Molding and Molding Sand, Classification of Foundry Process, Casting and its Types, Pattern and Pattern Making, Core and Core Making, Furnace, Crucibles, Molding Tools and Foundry Equipment. Sand Properties, Sand Testing, Advantage/Disadvantage of Green/Dry Sand. Die Casting, Casting Defects, Investment Casting. **Bulk Deformation Processes:** Rolling, Flat Rolling, Rolling Mills, Sheet Metal Forming, Shapes Rolling, Production of Seam Less Tubing and Piping. Extrusion and Drawing. Hot and Cold Extrusion, Extrusion and Drawing Equipment, Hydrostatic Extrusion. **Sheet Metal Forming**: Sheet Metal Characteristics, Formability of Sheet Metals, Bending Sheet and Plate, Tube Bending & Forming, Deep Drawing, Supper Plastic Forming, Explosive Forming Equipment for Sheet Forming. **Machine Processes for Producing Various Shapes:** Lathe Machine, Lathe Parts, Lathe Operations, and Lathe Cutting tools, Milling Operation, Milling Machines, Sensitive Drilling Machine, Operation of Planning and Shaping, Gear Manufacturing by Milling, Cutting Fluids, Materials removal, cutting forces, safety measures. **Abrasive Machining & Finishing Operations:** Abrasive, Bonded Abrasives (Grinding Wheels), Grinding Process, Grinding Fluids, Design Considerations for Grinding, Ultrasonic Machining. **Joining Processes:** Welding, Brazing, Soldering, Sintering, Adhesive Bonding, Fastening, Press Fitting **Non-Conventional Machining Process:** Machining, Electrochemical, Electrical Discharge Machining, Wire EDM.

Recommended books:

1. Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials Processes, and Systems, 5th Edition, John Wiley & Sons Inc., New York (2012)
2. Serope Kalpakjian and Steven Schmid, Manufacturing Engineering and Technology**,** 7th Edition, Pearson Prentice Hall, New Jersy (2013)
3. B. H. Amstead, Phillip F. Ostwald and Myron L. Begeman, Manufacturing Processes**,** 8th Edition, John Willey & Sons Inc., New York (1987)
4. E. P. DeGarmo, J. T. Black and R. A. Kohser, Materials and Processes in Manufacturing, 11th Edition, John Willey & Sons Inc., New York (2011)
5. George E. Dieter, Mechanical Metallurgy, SI Metric Edition, McGraw Hill, NY (1998)
6. John A. Schey, Introduction to Manufacturing Processes, 3rd Edition, McGraw Hill, NY (1999)

COURSE LEARNING OUTCOMES (CLOs)				
S. No.	**CLO Statement**	**Domain**	**Mapping with Bloom's Taxonomy**	**Mapping with PLO**
1.	Understand and appreciate the breadth and depth of the field of manufacturing and the related processes.	**Cognitive**	**1**	**PLO-1**
2.	Understand the basic concepts in casting, metal-forming and machining, and to apply these fundamentals to the specific manufacturing processes.	**Cognitive**	**3**	**PLO-2**
3.	Understand and apply basic principles and theories used to describe the manufacturing processes.	**Cognitive**	**3**	**PLO-2**
4.	Compare the advantages and limitations of different manufacturing processes and select the most appropriate manufacturing process for the production of any metal product or product part.	**Cognitive**	**5**	**PLO-4**

Course Title: Manufacturing Processes Lab (0, 1)

Course Code: ME-304L

List of Experiments
1. Introduction to Manufacturing Processes Laboratory, its layout, and safety guidelines
2. Taper Turning using Compound Rest method, Tail Off-set method, Taper attachment in Lathe Machine.
3. Threading operation on a cylindrical rod using Lathe Machine and find out the theoretical & experimental time required for Threading Operation.
4. Manufacturing of hexagonal head bolt using Capstan Lathe Machine
5. Manufacturing of 34 Teeth Spur Gear using Milling Machine.
6. Drilling of Through Hole/Blind Hole using Drilling Machine and find out the theoretical & experimental time required for drilling Operation.
7. Grinding the Surfaces of work Piece using Surface Grinding Machine.
8. Manufacturing of Rectangular Work Piece from Cylindrical work piece using Shaper machine and find out the theoretical & experimental time required for Shaping Operation.
9. Slotting/Grooving and surface finishing operation on work piece using Planner machine and find out the theoretical & experimental time required for planning Operation.
10. Finishing of cylindrical surface of cylindrical Using Universal Grinding Machine.
11. Introduction to 3D Scanning & Rapid Prototyping

Recommended books:

1. Ferdinand P. Beer, E. Russell Johnston Jr., John T. DeWolf, David F. Mazurek, Mechanics of Materials, 7th edition, ISBN: 007339823, McGraw-Hill, 2014
2. Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes and Systems, 7th Edition. ISBN: 978-1-119-47521-7
3. W.A.J. Chapman, Workshop Technology, Part 1, 5th Edition, ISBN: 0713132698

COURSE LEARNING OUTCOMES (CLOs)

S. No.	CLO Statement	Domain	Mapping with Bloom's Taxonomy	Mapping with PLO
1.	Adopt ethical principles and necessary guidelines for students' health and safety while working in the laboratory	**Affective**	**3**	**PLO-8**
2.	Analyze experimental data and document findings of the experiment through writing technical report	**Cognitive**	**4**	**PLO-10**
3.	Recognize different type of manufacturing operations and its parameters for manufacturing operations	**Psychomotor**	**1**	**PLO-1**
4.	Produce a given job with its specification using machine tools.	**Psychomotor**	**4**	**PLO-9**

SIXTH SEMESTER MECHANICAL ENGINEERING

Semester 6		Contact hours		Credit hours
No.	**Course**	**Lecture**	**Lab.**	**Total**
ME-301	Engineering Economics	3	0	3
ME-342	Quality Engineering	3	0	3
ME-321	Power Plants-I	3	0	3
ME-332	Introduction to Mechatronics	3	0	3
ME-332L	Introduction to Mechatronics Lab	0	3	1
ME-313	CAD-II	0	6	2
ME-303	Technical Report Writing	2	0	2
	Total Contact Hours	14	9	
	Total Credit Hours	14	3	17

Semester 6

Course Title: Engineering Economics (3,0)

Course Code: ME-301

Course Contents
Introduction The Role of Engineering Economics, The Decision Making Process, Types of Engineering Costs, Cash Costs Versus Book Costs, Cost Estimation Models & Cash Flow Diagram, Life Cycle Cost **Interest and Equivalence** Time value of money, equivalence, use of spread sheet, simple and compound interest, Uniform series, Arithmetic & geometric gradient interest formulae, Nominal & effective interest, continuous compounding, Economic criteria, Present Worth, future worth and annuity analysis **Rate of Return** Internal Rate of Return, Rate of Return Analysis, Choosing the best alternative, Incremental Analysis **Incremental Analysis** Elements in Incremental Rate of Return Analysis, Present Worth Analysis with Benefit-Cost Graph, Choosing an Analysis Method **Other Analysis Techniques** Future Worth Analysis, Benefit and cost ratio (B/C Ratio) analysis, Payback period, Sensitivity & breakeven analysis, Principle of comparative advantage **Depreciation** Basic Aspect of Depreciation, Historical Depreciation Methods, Modified Accelerated Cost Recovery System MACRS, Unit of Production Depreciation, Depletion **Taxes** Calculation of Taxable Income, Income Tax Rates, Before and After Tax Rate of Returns RoR, Economic Analysis Taking Income Taxes into Accounts **Replacement analysis** The Replacement problem, Replacement Analysis Decision Maps, Upgradation Vs Replacement **Inflation and price change** Meaning and effect of inflation. Real interest rates, market interest rate and inflation rate, Real Dollar versus Actual Dollars, Analysis in Constant Dollars versus Then-Constant Dollars, Price Change with Indexes Inflation Effect on After-Tax Calculations **Uncertainty in Future Events** Estimation of Future Events, Probability Distribution, Risk versus Returns

Recommended books:

1. Newnan, G. Donald, Eschenbach, G.Tedd, Lavella, P. Jerome, Engineering Economics Analysis, 9th edition, ISBN: Mc-Grahill 0-19-516807-0, Oxford University Press, 2004.
2. E. Paul, Degarmo, William, Sullivan, James, Bontadelli, Engineering Economy, 8th edition, ISBN: 0029461391, Prentice Hall, 1990.

COURSE LEARNING OUTCOMES (CLOs)

S. No.	CLO Statement	Domain	Mapping with Bloom's Taxonomy	Mapping with PLO
1.	Understand the role of Economics analysis and to recognize different cost involved in engineering economics.	**Cognitive**	**2**	**PLO-1**
2.	Draw the cash flow diagrams based on the time value of money.	**Cognitive**	**3**	**PLO-2**
3.	Utilization of analytical and computational techniques to compare and select the best alternatives for the given economic projects.	**Cognitive**	**3**	**PLO-5**

Course Title: Quality Engineering (3, 0)

Course Code: ME-342

Course Contents
Quality Control Introduction, needs of quality tools, Principles of Quality Control, Quality Inspections vs Quality Assurance, Quality Gurus, cost of quality models, acceptable quality level (AQL), Methods to quality improvement and analysis of quality costs, TQM approaches **Metrology and Measurements** Introduction to metrology, Types of Metrology, General principles of measurement, Errors in measurements and their types, Geometric dimensioning and tolerances, Linear and circular Measurements, Gauges and comparators, Interferometers and associated devices, Surface texture measurement. **Statistical Process Control (SPC)** Study of Frequency distributions and probability models in quality control, Sources of variation, Preparation and use of various control charts, control charts for variables and attributes , constructions of control charts, Process Capability Index, sampling plans, Computer applications in SPC

Recommended books:

1. Dale H. Besterfield Ph.D. P.E. Quality Improvement, 9th Edition, ISBN-13: 978-0132624411, Pearson, 2012
2. J.F.W. Galyer, Charles Reginald Shotbolt, Metrology for Engineers, 5th Edition, ISBN-10: 0304318442, Thomson, 1990
3. Eugene L. Grant, Richard S. Leavenworth, Statistical Quality Control, 6th Edition, ISBN-10: 007024118X, McGraw-Hill, 1988
4. Jay Heizer (Author), Barry Render, Principles of Operations Management, 7th Edition, ISBN-10: 0132343282, Prentice Hall, 2008

COURSE LEARNING OUTCOMES (CLOs)				
S. No.	**CLO Statement**	**Domain**	**Mapping with Bloom's Taxonomy**	**Mapping with PLO**
1.	**Explain** Quality, quality control costs, tools and approaches for quality improvement.	**Cognitive**	**2**	**PLO-1**
2.	**Use** measurement systems and equipment for metrology.	**Cognitive**	**3**	**PLO-2**
3.	**Construct** and apply quality control charts for variables and attributes	**Cognitive**	**5**	**PLO-4** **PLO-5**

Course Title: Power Plants-I (3,0)

Course Code: ME-321

Course Contents
Reciprocating Internal Combustion Engines: The ideal Carnot cycle, Otto cycle, Diesel cycle, efficiencies in terms of Pressure and Volumetric Ratio, representation on PV and TS Diagrams, criteria for the comparison of cycles. The Working of IC Engines, Criteria of Performance, Engine Output and Efficiency. Performance characteristics, Factors influencing performance, Real Cycles and the Air-Standard Cycles, Properties of Fuels for IC Engines, Fuel Systems, Supercharging and Turbo Charging, Engine Emissions and Legal Requirements, Alternative Forms of IC Engines, Developments in IC Engines. *Positive Displacement Machines:* Reciprocating Compressors, Reciprocating Compressor Including Clearance, Multi-Stage Compression, Steady-Flow Analysis, Rotary Machines, Vacuum Pumps, Air Motors. *Nozzles and Jet Propulsion:* Jet Propulsion; Ram Jet, The Turbojet, The Turboprop, Rocket Propulsion. *Turbo Machinery:* Roto-dynamic Machines for Steam and Gas Turbine Plants; Momentum Principal Applied to Flow Through Rotor, Euler Turbo Machinery Equation, Axial Thrust on the Rotor, Torque Exerted on the Rotor, Overall Efficiency, Stage Efficiency, Reheat Factor, Polytropic Efficiency, Centrifugal Compressors, Radial Flow and Mixed Flow Turbines.

Recommended books:

1. M. M. El-Wakil, Power Plant Technology, McGraw-Hill International Edition.
2. Eastop and McConkey, Applied Thermodynamics for Engineering Technologists, 5th Edition, Pearson.
3. Rogers and Mayhew, Engineering Thermodynamics – Work & Heat Transfer, 4th Edition, Pearson.
4. Rayner Joel, Basic Engineering Thermodynamics, 5th Edition, Pearson.
5. E. H. Lewitt, Thermodynamics Applied to Heat Engines, 2nd Edition, Sir Pitman & Sons.

COURSE LEARNING OUTCOMES (CLOs)

S. No.	CLO Statement	Domain	Mapping with Bloom's Taxonomy	Mapping with PLO
1.	Illustrate the working principle of Reciprocating IC Engines, the ideal Carnot cycle, Otto Cycle, Diesel Cycle; their criteria of performance and their various modifications	**Cognitive**	**3**	**PLO-1**
2.	Discuss Positive Displacement Machines	**Cognitive**	**1**	**PLO-2**
3.	Analysis of nozzles and its application in jet propulsion	**Cognitive**	**4**	**PLO-4**
4.	Discuss Turbo Machinery for Steam and Gas Turbine Power Plants	**Cognitive**	**1**	**PLO-2**

Course Title: Introduction to Mechatronics (3, 0)

Course Code: ME-332

Course Contents
Computing Numbering and coding systems, Logic Gates **Computer Architecture and Programming** Microprocessor and its operations, 8085 Microprocessor and its internal architecture, 8051 Microcontroller and its internal architecture, Assembly Language programming. **Interfacing** Ports, Input/Output, Analog to Digital Converters, Sampling Theory, Digital to Analog converters, Switches, LEDs, LCDs, Relay, Pulse Width Modulation, Stepper Motors, DC Motors.

Recommended books:

1. Goanikar, Microprocessor Architecture, Programming and Applications: Merril Publishing Co.
2. Muhammad Ali Mazidi, Janice G. Mazidi , Rolin D. McKinlay.Publisher, The 8051 Microcontroller and Embedded Systems, Pearson
3. A.K. Stiffler, Design with Microprocessors for Mechanical Engineers, McGraw-Hill.

COURSE LEARNING OUTCOMES (CLOs)				
S. No.	**CLO Statement**	**Domain**	**Mapping with Bloom's Taxonomy**	**Mapping with PLO**
1.	To explain microprocessor architecture and operations.	**Cognitive**	**2**	**PLO-1**
2.	To understand the assembly language programming for 8051 microcontroller.	**Cognitive**	**2**	**PLO-1**
3.	To apply the acquired knowledge to program microcontroller and interface with real world devices such as LEDs, LCDs, Relays,Stepper Motors and DC motors.	**Cognitive**	**3**	**PLO-2**

Course Title: Introduction to Mechatronics Lab (0,1)

Course Code: ME-332L

List of Experiments
1. Introduction to Mechatronics Lab: Overview of lab equipment (multimeter, bread board, Vero board etc.)
2. Introduction to basic electronic components
3. Introduction to transformer, voltage regulators, diode bridge
4. Introduction to Relay its function and uses
5. Introduction to micro controller development board and its use
6. Introduction to Keil software, loading program into microcontroller
7. Introduction to 8051 microcontroller pin-configuration and development a basic reset circuit
8. Interfacing LEDs to 8051and displaying Binary Patterns (Blinking LEDS)
9. DC motor interfacing with 8051– Microcontroller (Speed and Direction control)
10. Stepper motor interfacing with 8051– Microcontroller
11. Interfacing ADC and DAC with 8051 Microcontroller
12. Interfacing an LCD to the 8051 Microcontroller

Recommended books:

1. Goanikar, Microprocessor Architecture, Programming and Applications, 2nd edition ISBN-10: 0675206758, Merril Publishing Co., March 1989
2. Muhammad Ali Mazidi, The 8051 Microcontroller and Embedded Systems with Software, 2nd edition, ISBN-10: 8178085747, Pearson Education, 2000
3. Grob's Basic Electronics (Engineering Technologies & the Trades) 12th Edition, ISBN-10: 0073373877, McGraw-Hill Education, 2015.

COURSE LEARNING OUTCOMES (CLOs)

S. No.	CLO Statement	Domain	Mapping with Bloom's Taxonomy	Mapping with PLO
1.	Adopt ethical principles and necessary guidelines for students' health and safety while working in the laboratory	**Affective**	**3**	**PLO-8**
2.	Analyze experimental data and document findings of the experiment through writing technical report	**Cognitive**	**4**	**PLO-10**
3.	To Recognize and understand the function of Mechatronics system components	**Psychomotor**	**1**	**PLO-1**
4.	To be able to control mechanical components using micro controller	**Psychomotor**	**7**	**PLO-3**

Course Title: CAD-II (0, 2)

Course Code: ME-313L

Course Contents
Introduction to Creo. 3D Part Modeling, Assembling and Documentation of Mechanical components using Creo Software. Introduction to sheet metal modeling and analysis of parts and assemblies. Analysis of Parts and Assemblies in Creo Simulate.

Recommended books:

1. Sham Tickoo, Creo Parametric 5.0 for Designers, 5th Edition, ISBN 978-1-64057-032-0, CADCIM Technologies, 2019.

COURSE LEARNING OUTCOMES (CLOs)

S. No.	CLO Statement	Domain	Mapping with Bloom's Taxonomy	Mapping with PLO
1.	Adopt ethical principles and necessary guidelines for students health and safety during lab work	**Affective**	**3**	**PLO-8**
2.	Understand the concepts of part modeling using Creo software	**Psychomotor**	**4**	**PLO-1**
3.	Assemble the components created in the part module using assembly constraints	**Psychomotor**	**4**	**PLO-5**
4.	Documentation of parts and assemblies, including standard views generation and report writing	**Cognitive**	**4**	**PLO-5**
5.	Analyzing the parts and assemblies using Creo Simulate module	**Psychomotor**	**4**	**PLO-2**

Course Title: Technical Report writing (2, 0)

Course Code: ME-303

Course Contents
Introduction to Technical Report Writing, 7C's of communication and Resume Writing, Technical Writing Process (Pre-writing stage, writing stage, post-writing stage), Writing Style, Memos, Technical Report (structure and writing), Research Proposal, Research/ Term Paper, Feasibility Report. Plagiarism, use of citation management software.

Recommended books:

1. Technical Report Writing Today by Daniel G. Riordan, Wadsworth Publishing, 10th Edition, ISBN 9781133607380
2. Scenarios for Technical Communication by Teresa C. Kynell and Wendy Krieg Stone. ISBN 978-0205275243
3. Communication for Engineering Students by J. W. Davies, ISBN 978-0582256484
4. Science Research Writing for Non-Native Speakers of English by Hilary Glasman-Deal, Imperial College Press. ISBN 978 1 84816 309 6

COURSE LEARNING OUTCOMES (CLOs)				
S. No.	**CLO Statement**	**Domain**	**Mapping with Bloom's Taxonomy**	**Mapping with PLO**
1.	Demonstrate proficiency in writing memos, proposals, covering letter, enquiry letter, job application letter, acceptance letter, business letter, short report, long report etc.	**Cognitive**	**3**	**PLO-10**
2.	Prepare a technical report/ Research Proposal/ Research Paper	**Cognitive**	**3**	**PLO-10**
3.	Use a standard word processing software along with a referencing tool for report writing	**Cognitive**	**3**	**PLO-5**

SEVENTH SEMESTER MECHANICAL ENGINEERING

Semester 7		Contact hours		Credit hours
No.	**Course**	**Lecture**	**Lab.**	**Total**
ME-441	Production Automation	3	0	3
ME-441L	Production Automation Lab	0	3	1
ME-421	Power Plants-II	3	0	3
ME-421L	Power Plants Lab	0	3	1
ME-422	Heat and Mass Transfer	3	0	3
ME-423	Heating, Ventilating and Air Conditioning	3	0	3
ME-411	Project	0	9	3
	Total Contact Hours	12	15	
	Total Credit Hours	12	5	17

SEMESTER 7

Course Title: Production Automation (3, 0)

Course Code: ME-441

Course Contents
Introduction, Economics of Automation, Flow Lines, Mathematical Models, Storage Buffers, Partial Automation, Line Balancing, and Flexible Manufacturing. Building Blocks of Automation, Robotics Geometry, kinematics, Drives and Motion Control. Uses of CNC Machining. Advantages, Machine Code, Machine Control, Programming, DNC, CNC. Introduction to PLC and its applications.

Recommended books:

1. Mikell P. Groover, Automation, Production Systems, and CIM, 4th Edition, ISBN 978-0133499612, Pearson, 2016.
2. Szewczyk, Roman, Zieliński, Advances in Automation, Robotics and Measurement Techniques, 1st Edition, ISBN 978-3-319-77179-3, Springer, 2018.
3. R. Thomas Wright, Manufacturing and Automation Technology, 2nd Edition, ISBN 978-1590704844, Goodheart-Willcox, 2006.

COURSE LEARNING OUTCOMES (CLOs)				
S. No.	**CLO Statement**	**Domain**	**Mapping with Bloom's Taxonomy**	**Mapping with PLO**
1.	Identify the types of Production and Automation	**Cognitive**	**1**	**PLO-1**
2.	Explain the types of Philosophies of Production and Automation	**Cognitive**	**2**	**PLO-1**
3.	Describe the tools used to automate the Systems	**Cognitive**	**3**	**PLO-2**
4.	Application of Tools	**Cognitive**	**4**	**PLO-5**

Course Title: Production Automation Lab (0, 1)

Course Code: ME-441L

List of Experiments
1. Layout of Production Automation Lab.
2. Introduction to CNC Boxford machine and its conversion between lathe and mill modes.
3. Use of Boxford software in lath mode and practice of basic G and M codes.
4. Performing different turning operations on CNC lathe using the built in software.
5. Milling pockets and contours using Boxford mill software.
6. Performing different operations on CNC Boxford machine in mill mode using the built in software.
7. Performing various milling operations on vertical milling center using the built in software.
8. Making different jobs on CNC engraving machine.
9. Introduction to part programming using G and M codes.
10. Introduction to Rapid Prototyping Machine.

Recommended books:

1. Mikell P. Groover, Automation, Production Systems, and CIM, 4th Edition, ISBN 978-0133499612, Pearson, 2016.

COURSE LEARNING OUTCOMES (CLOs)

S. No.	CLO Statement	Domain	Mapping with Bloom's Taxonomy	Mapping with PLO
1.	Apply ethical principles while working in the laboratory and adopt necessary guidelines for student's health and safety	**Affective**	**3**	**PLO-8**
2.	Analyze experimental data and document findings of the experiment through writing technical report	**Cognitive**	**4**	**PLO-10**
3.	Practice some basic G and M codes.	**Psychomotor**	**3**	**PLO-5**
4.	Operate under supervision a CNC machine for making a job.	**Psychomotor**	**3**	**PLO-5**

Course Title: Power Plants II (3,0)

Course Code: ME-406

Course Contents
The Gas Power Cycle: The Gas Power Cycle, Regenerative Gas Turbine Cycle, Regenerative Gas Turbine Cycle with reheat and intercooling ***The Vapor Power Cycles:*** The Rankine Cycle, Rankine Cycle with Superheat, The Enthalpy-Entropy Chart, The Reheat Cycle, The Regenerative Cycle, Further Considerations of Plant Efficiency Steam for Heating and Process, Exergy Accounting of a Rankine cycle. ***Combined Cycle Power Plants*****:** General Gas Turbine-Based Combined Cycle, Combined Cycle with Heat-Recovery Boiler. Combined Cycle with Multi Pressure Steam. Steam Cycles for Nuclear Power Plant, Combined Cycle for Nuclear Power Plants ***Nuclear Power Plant: Introduction*****:** Power from Nuclear Energy and world experience; Structure of an Atom; Nuclear Fusion and Fission; Radioactivity; Decay Rates and Half-Lives; Basic design of NPP, The Reactor; Core; Control Rods; Moderator; Coolant, Thermal-Fission Reactors and Power Plants. Fast Breeder Reactors, Burner, Converter and Breeder, Economic and Environmental Aspect of Nuclear Power. ***Alternative Energy Resources:*** Solar Energy Power Plants, Solar Thermal, Cooking and Photovoltaic, Wind Energy Power Plants and its Global Trends, Fuel Cells (PEMFCs and SOFCs), Energy Storage, Energy Management and Energy Audit, Environmental Aspects of Power Generation

Recommended books:

1. M. M. El-Wakil, Power Plant Technology, McGraw-Hill International Edition.
2. Moran, Shapiro Boettner and Bailey, Principle of Engineering Thermodynamics, 8th Edition, Wiley
3. Eastop and McConkey, Applied Thermodynamics for Engineering Technologists, 5th Edition, Pearson.
4. Rayner Joel, Basic Engineering Thermodynamics, 5th Edition, Pearson.
5. E. H. Lewitt, Thermodynamics Applied to Heat Engines, 2nd Edition, Sir Pitman & Sons.
6. W. J. Kearlon, Steam Turbine Theory and Practice, 8th Edition, Aristophanes Press.

COURSE LEARNING OUTCOMES (CLOs)

S. No.	CLO Statement	Domain	Mapping with Bloom's Taxonomy	Mapping with PLO
1.	Explain and analyze the basic and modified Gas Cycle, the Rankine Cycle with Superheat, Reheat, Regeneration, Feedwater heaters, Efficiency and Heat Rate, Cogeneration	**Cognitive**	**4**	**PLO-4**
2.	Explain and analyze Combined Cycle with Heat Recovery	**Cognitive**	**4**	**PLO-4**
3.	Discuss Nuclear Power Plant, Nuclear Fusion and Fission, Radioactivity, Alternative Energies (Solar, Wind) Fuel Cell, Energy Storage, Energy Management and Energy Audit, Environmental Aspects of Power Generation	**Cognitive**	**2**	**PLO-1**

Course Title: Power Plants Lab (0, 1)

Course Code: ME-322L

List of Experiments
1. Safety precautions and layout of power plants lab
2. Usage of different gadgetries and components of steam boiler
3. Demonstration of distilled water unit
4. Brake power measurement and demonstration of steam engine
5. Demonstration of steam turbine
6. Demonstration of steam condenser
7. Obtain indicated diagram of Single-stage and Two-stages reciprocating air compressor
8. Determine mechanical efficiency and Mean effective pressure of reciprocating air compressor

Recommended books:

1. M.M. El Wakil, Power Plant technology.

COURSE LEARNING OUTCOMES (CLOs)

S. No.	CLO Statement	Domain	Mapping with Bloom's Taxonomy	Mapping with PLO
1.	Apply ethical principles while working in the laboratory and adopt necessary guidelines for student's health and safety	**Affective**	**3**	**PLO-8**
2.	Analyze experimental data and document findings of the experiment through writing technical report	**Cognitive**	**4**	**PLO-10**
3.	Demonstrate different components of Steam Power Plant.	**Cognitive**	**3**	**PLO-1**
4.	Conduct experiment to find the efficiency of Reciprocating air compressor	**Psychomotor**	**4**	**PLO-2**

Course Title: Heat and Mass Transfer (3,0)

Course Code: ME-422

Course Contents
Introduction: Review of the concepts of equilibrium, steady state, heat and thermodynamics. Basic modes of heat transfer and their mechanisms. **Conduction:** Heat conduction equation, Solving heat conduction equation plane walls, cylinders and spheres, Electrical analogies and thermal circuits for homogeneous and composite structures, Systems with internal energy generation, combined conduction and convection heat transfer, Extended surfaces and their performance parameters. **Convection:** Evaluation of Hydrodynamic and Thermal Boundary Layers thickness and heat Transfer Coefficient, Introduction to Free and Forced Convection, Heat transfer rate for laminar, turbulent and mixed boundary layers for external flow and internal flow problems. Buoyancy driven flows and their heat transfer rate for external flow problems. **Radiation:** Fundamental characteristics of thermal radiation and surfaces, The Concepts of Black Body and Gray Body, Laws of Radiation, Radiation Properties, Radiation Shape Factor, Radiation Exchange between Black and Gray Bodies. Radiation Network, Radiation Shields **Heat Exchangers:** Classification and types of Heat Exchangers, Log Mean Temperature Difference (LMTD), NTU-effectiveness method **Mass Transfer:** Introduction to Mass Transfer, Fick's Law of Diffusion. Concept of concentration boundary layer.

Recommended books:

1. Theodore L.Bergman, Adrienne S. Lavine, Frank P. Incropera and David. P. Dewitt., Principles of Heat and Mass Transfer, Wiley, 7th Edition, 2016
2. J. P. Holman., Heat Transfer, McGraw-Hill. 10th Edition, 2009
3. Yunus Cengel and Afshin Ghajjar, Heat and Mass transfer: Fundamentals and Applications, McGraw-Hill 5th Edition, 2014
4. Allan J. Chapman, Heat Transfer, Pesarson 4th Edition, 2014.

COURSE LEARNING OUTCOMES (CLOs)

S. No.	CLO Statement	Domain	Mapping with Bloom's Taxonomy	Mapping with PLO
1.	Understand the physical laws and mechanisms of heat and mass transfer and related properties	**Cognitive**	**2**	**PLO-1**
2.	Analyze heat conduction and convection problems	**Cognitive**	**4**	**PLO-2**
3.	Analyze radiation heat transfer problems involving black and non-black bodies	**Cognitive**	**4**	**PLO-2**
4.	Design and analyze common types of heat exchangers	**Cognitive**	**6**	**PLO-3**

Course Title: Heating, Ventilating and Air Conditioning (3, 0)

Course Code: ME-423

Course Contents
Vapor Compression System: Vapor compression cycle and effects of operating conditions on its C.O.P, Heat pump, Refrigerants, H-S and P-H charts. **Refrigeration System Analysis:** Types and properties of Refrigerants, Condensers and Evaporators, Refrigerant flow control devices **Vapor Absorption System:** Simple vapor-absorption system, Common refrigerant-absorbent systems, Actual Vapor-absorption cycle. Psychometry of Air-conditioning processes, Psychometric chart, mixing processes, sensible heat, latent heat, humidification, dehumidification, cooling and adiabatic processes on psychometric chart, by-pass factor, apparatus dew point, summer air-conditioning. **HVAC Systems:** Essential Components design of Central Air-Conditioning plant, Water Chillers and water heater Air Handling Units. Chilled water and hot water recirculation system, All Air system basics, Single zone and reheat system, Variable volume, Dual duct and multi zone system, VCDs and VAVs etc. CFM calculations. **Solar Radiations:** Direct and diffuse radiations, Earth-sun angles, Heat gain through glass, External shading, Internal shading. **Heat Transfer Through Building Structures:** Fabric heat gain, Overall heat transmission coefficient, Evaluation of heat transfer through walls and roofs using equivalent temperature differential (ETD) method, ventilation, Infiltration. **Load Calculations and Applied Psychometry** **Cooling Load:** Occupancy load, lighting load, appliances load etc. Product load, process load, heat gain through ducts, leakage etc, Ventilation load, Infiltration load, Grand total load on air-conditioning apparatus, Calculation of state and rate of supply air.

Recommended books:

1. C.P. Arora, Refrigeration and Air-conditioning
2. Dossat, Principles of Refrigeration
3. Ed. Kreider, Curtiss and Rabl, Heating and Cooling of Buildings, McGraw Hill
4. Haines, Roger W. Wilson, Lewis, HVAC Systems Design Handbook, McGraw Hill Companies.

COURSE LEARNING OUTCOMES (CLOs)

S. No.	CLO Statement	Domain	Mapping with Bloom's Taxonomy	Mapping with PLO
1.	Describe the vapor compression and vapor absorption cycles and the concepts of producing refrigeration and air conditioning with these cycles	**Cognitive**	**2**	**PLO-1**
2.	Analyze the effect of various air conditioning processes on the psychometric properties of air	**Cognitive**	**4**	**PLO-4**
3.	Evaluating the (load calculation) for both summer and winter air conditioning and Design of HVAC Systems	**Cognitive**	**6**	**PLO-4**

EIGHTH SEMESTER MECHANICAL ENGINEERING

Semester 8		Contact hours		Credit hours
No.	**Course**	**Lecture**	**Lab.**	**Total**
ME-401	Health, Safety and Environment	2	0	2
ME-431	Measurement and Instrumentation	2	0	2
ME-432	Control Engineering	3	0	3
ME-433L	Measurement, Instrumentation & Control Lab	0	3	1
ME-424L	Heat Transfer and HVAC Lab	0	3	1
ME-442	Industrial Management	3	0	3
ME-411	Final Year Project	0	9	3
	Total Contact Hours	10	15	
	Total Credit Hours	10	5	15

SEMESTER 8

Course Title: Health, Safety, and Environment (2, 0)

Course Code: ME-401

Course Contents
Introduction to Health and Safety: Introduction to Objectives and Importance of Safety in an industry. **Industrial accidents:** Risks, Hazards, Effects, Consequences and Types of accidents. **Operation of consultative processes in the management of workplace health and safety.** **Duty of Care for a specific industry** **Techniques of Safety Management:** Principles of accident prevention, Legal, humanitarian and economic reason for action. **Safety inspection procedures, Training, First aid and Emergency Procedures:** Development of Safe Operation Procedures of a piece of machinery., Factors and hazards that contribute towards problems with manual handling, in a specific industry, Distinguishing between different classes of dangerous goods, for a specific industry. **Environment and Health:** Introduction: importance of clean environment, Scale of Environmental Pollution, Environmental Act. Health and Safety Act. **Hazard Assessment, Prevention, And Control:** Hazard analysis, Different types of Hazards (Mechanical hazards and Machine Safeguarding, Falling, Impact, Acceleration, Lifting, and Vision hazards, Hazards of Temperature extremes, Pressure hazards, Electrical hazards, Fire hazards, Radiation hazards, Noise and Vibration hazards), Fire prevention and control. **ISO Standards for Safety and Health and Environment** **Case studies for analyzing various types of hazards in varying industries.**

Recommended books:

1. David L. Geotsch Pearson Education. Inc, Occupational Safety and Health for Technologists, Engineers and Managers, 8th edition, ISBN-10: 0133484173, 2014
2. J. Ridley and J. Channing, Safety at Works, ISBN: 9780415656962, 2013.
3. K. G. Lockyer, Factory & Production Management, Pitman Publishing, ISBN-13: 978-0273004653, 1974.

COURSE LEARNING OUTCOMES (CLOs)

S. No.	CLO Statement	Domain	Mapping with Bloom's Taxonomy	Mapping with PLO
1.	Identifying and Explaining the common workplace hazards, their causes, types and Safe Operating Procedures for various mechanical systems	**Cognitive**	**2**	**PLO-6**
2.	Demonstrate knowledge of Safety Health and Environment	**Cognitive**	**3**	**PLO-7**
3.	Analyze various types of hazards at different workplaces	**Cognitive**	**4**	**PLO-9**

Course Title: Measurement and Instrumentation (2,0)

Course Code: ME-431

Course Contents
Introduction Significance of measurement, planning of experiments, general measurement system, calibration. **Characteristics of instruments** Sensitivity, range, accuracy, precision, repeatability, and uncertainty of instruments, measurement errors including loading error. **Applied Statistics and Uncertainty Analysis** Histograms, PDFs, Gaussian Statistics, Regression Analysis, Uncertainty Analysis, Error Propagation **Analogue and Digital signal measurement** Alternating Current (AC) and Direct Current (DC) current and voltage measurement, resistance measurement, voltage divider circuit, Wheatstone bridge, Root Mean Square (RMS) value. Sampling, Alias signal, signal conditioning, Fourier expansion and introduction to data acquisition systems. **Measurement** of temperature, strain, force, torque, length, displacement, pressure and flow.

Recommended books:

1. Richard S. Figliola and Donald E. Beasley, Theory and Design for Mechanical Measurements, 5th edition, ISBN: 0470547413, John Wiley & Sons, 2011
2. Ernest O. Doebelin, Engineering Experimentation, Planning, Execution, Reporting, ISBN: 0070173397, McGraw-Hill, 1995
3. E. O. Doeblin, Measurement Systems Applications and Design, 5th edition, ISBN: 007292201X, McGraw-Hill, 2004
4. D. G. Alciatore, M. B. Histand, Introduction to Mechatronics and Measurement Systems, 4th edition, ISBN: 0073380237, McGraw-Hill, 2012.

COURSE LEARNING OUTCOMES (CLOs)				
S. No.	**CLO Statement**	**Domain**	**Mapping with Bloom's Taxonomy**	**Mapping with PLO**
1.	Explain the basic concepts related to measurement	**Cognitive**	**2**	**PLO-1**
2.	Explain the construction, working and applications of various sensors	**Cognitive**	**2**	**PLO-1**
3.	Analyze the sensor data	**Cognitive**	**4**	**PLO-2**

Course Title: Control Engineering (3,0)

Course Code: ME-432

Course Contents
Introduction: Basics of control system, Open-loop and closed-loop control systems, Block diagram terminology, Examples of Control System. **Dynamic System modeling:** Mechanical translational & rotational systems, electrical systems, electromechanical systems, thermal system and fluid systems **Laplace Transforms and Transfer Function:** Review of Laplace transform, Impulse, Step and Ramp Functions, partial fractions. Concept of Transfer Functions, Block Diagram Algebra, Signal Flow Graphs and Mason Gain Formula to find transfer function. **Time Response of 1st and 2nd Order System:** Time response of the 1st and 2nd order systems (impulse, step, ramp etc.), Time response characteristics (Time Constant, Overshoot, Rise Time, Setting Time, Steady State Error, Etc.), Relation of System Response to Location of System Poles and Zeros. **Study of System Stability:** Introduction to stability, Ruth-Hurwitz stability criteria and its applications, Concept of Root-Locus, Construction of Root-Locus. **Root Locus Design:** Root Locus design, System stability by pole placement, Compensator Design (Lead and Lag Compensator), Design of PID Controller (P, PI and PID Controllers)

Recommended books:

1. Norman S Nise, Control Systems Engineering, 6th edition, ISBN: 9780470547564, John Wiley & Sons, 2011
2. Katsuhiko Ogata, Modern Control Engineering. 5th edition, ISBN: 136156738, Prentice Hall, 2010
3. Richard C. Dorf, Robert H. Bishop, Modern Control Systems, 13th edition, ISBN 0134407628, Pearson, 2017.

COURSE LEARNING OUTCOMES (CLOs)

S. No.	CLO Statement	Domain	Mapping with Bloom's Taxonomy	Mapping with PLO
1.	Develop mathematical models of different physical system	**Cognitive**	**5**	**PLO-3**
2.	Analyze complex engineering problems using mathematical models to examine different properties of the system	**Cognitive**	**4**	**PLO-2**
3.	Design a controller to achieve the desired response from the system	**Cognitive**	**5**	**PLO-3**

Course Title: Industrial Management (3, 0)

Course Code: ME-442

Course Contents
Project Management, PERT-CPM, Network Scheduling Production and Service Systems Inputs and Output, Basics of managing manufacturing and service organizations; strategic decision making; facility location and layout; Demand Forecasting, Common Forecasting Models; Inventory Models and Just in Time (JIT) Technique, Material Requirement Planning. Capacity Planning, Production Planning, Scheduling Problems and Models, Decision Making. job design, job evaluation and work compensation;

Recommended books:

1. Jay Heizer and Barry Render, Operations Management, Sustainability and Supply Chain Management, 10th Edition Pearson, 2016.
2. William J. Stevenson, Operations Management, 12th Edition, McGraw Hill, 2015.

COURSE LEARNING OUTCOMES (CLOs)				
S. No.	**CLO Statement**	**Domain**	**Mapping with Bloom's Taxonomy**	**Mapping with PLO**
1.	Analyze the parameters affecting plant location, layout and inventory decisions.	**Cognitive**	**4**	**PLO-6**
2.	Apply project management tools such as CPM and PERT in controlling projects.	**Cognitive**	**3**	**PLO-9**
3.	Select forecasting methods to develop aggregate plans and short-term schedules	**Cognitive**	**6**	**PLO-11**

Course Title: Heat Transfer and HVAC Lab (0, 1)

Course Code: ME-424L

List of Experiments
1. Introduction to Heat Transfer and HVAC Laboratory, its layout, and safety guidelines.
2. Determine the COP of cooling of Technovate vapor compression unit based on the following methods using thermostatic expansion valve and capillary tube as an expansion device: a. Carnot cycle b. Enthalpies c. Input Power to Compressor
3. Determine the COP of heating of Technovate vapor compression unit operating in heat pump mode based on the following methods and also demonstrate the equipment in heat pump mode: a. Carnot cycle b. Enthalpies
4. Analyze, demonstrate, and represent air sensible heating process on the psychometric chart.
5. Analyze, demonstrate, and represent steam injection process (Heating and humidification) on the psychometric chart.
6. Analyze, demonstrate, and represent cooling and dehumidification process on the psychometric chart.
7. Analyze, demonstrate, and represent mixing process of two different air streams on the psychometric chart.
8. Demonstrate the charging of the refrigerant in vapor compression based air conditioning unit.
9. Demonstrate of defrosting techniques on refrigeration defrost unit.
10. Determination of thermal conductivity of given specimen using thermal conductivity measuring apparatus.
11. Finding out the overall Heat transfer coefficient of double pipe heat exchanger with parallel flow and counter flow.
12. Investigating the effect of Reynolds's Number on heat transfer in parallel flow and counter flow for a double pipe heat exchanger.
13. Finding out the effectiveness of double pipe heat exchanger in parallel flow and counter flow.
14. Determining the emissivity of given specimen using emissivity measuring equipment.
15. Demonstration on shell and tube heat exchanger.

Recommended books:

1. C.P Arora, Refrigeration and Air conditioning, 2nd edition, ISBN:0-07-118848-7, McGraw-Hill, 2001.

COURSE LEARNING OUTCOMES (CLOs)

S. No.	CLO Statement	Domain	Mapping with Bloom's Taxonomy	Mapping with PLO
1.	Adopt ethical principles and necessary guidelines for students' health and safety while working in the laboratory	**Affective**	**3**	**PLO-8**
2.	Analyze experimental data and document findings of the experiment through writing technical report	**Cognitive**	**4**	**PLO-10**
3.	**Demonstrate** and **analyze** various air conditioning process on the recirculation and air conditioning unit	**Psychomotor**	**4**	**PLO-1**
4.	**Conduct** the experiments for the COP determination with different techniques using thermostatic and capillary tube as expansion devices	**Psychomotor**	**4**	**PLO-1**
5.	An ability to **perform** experiments on conduction and radiation heat transfer units.	**Psychomotor**	**5**	**PLO-1**
6.	An Ability to **alter** operating parameters of heat exchanger.	**Psychomotor**	**6**	**PLO-2**

Course Title: Measurement, Instrumentation and Control Lab (0, 1)

Course Code: ME-433L

List of Experiments
1. Basics of Instrumentation and control (Terminologies, Safety and Introductory materials of the course 2. Demonstration of working of sensors in mechanical systems a. Pressure measuring Sensors b. Level measuring Sensors c. Flow Rate Measuring Sensors d. Temperature measuring Sensors 3. An introduction to Level-Pressure-Flow rate Transducer Unit (Sensors, Circuits, PID Controller Section, Input Section) 4. To investigate the response of Piezo Resistive Type Pressure Sensor to be used as Level measuring apparatus 5. To investigate and control the Level Response of Level-Pressure-Flow rate Transducer Unit Using P-I, P-D and P-I-D Controller 6. To study the response of potentiometer to be used as set point (Input) for pressure and flow rate valu 7. To investigate the response of Flow rate of Level-Pressure-Flow rate Transducer Unit using Digital Multimeter 8. To investigate and control the Flow rate Response of Level-Pressure-Flow rate Transducer Unit Using P-I, P-D and P-I-D Controller 9. Problem Based Learning (PBL) OR Lab Project Submission

Recommended books:

1. E. Doeblin, E.N. Manik Measurement Systems Applications and Design, McGraw Hill. 2007
2. Norman S Nise, Modern Control Engineering, John Wiley & Sons. 2007.

COURSE LEARNING OUTCOMES (CLOs)

S. No.	CLO Statement	Domain	Mapping with Bloom's Taxonomy	Mapping with PLO
1.	Adopt ethical principles and necessary guidelines for students' health and safety while working in the laboratory	**Affective**	**3**	**PLO-8**
2.	Analyze experimental data and document findings of the experiment through writing technical report	**Cognitive**	**4**	**PLO-10**
3.	Demonstrates equipment operational skills and also should be able to recorded data	**Psychomotor**	**3**	**PLO-4**
4.	Work in a team by participating in a group project using Controllers, Sensors and Actuators.	**Affective**	**2**	**PLO-9**