Department of Mechanical Engineering

University of Management and Technology Lahore

Curriculum

For

BS Mechanical Engineering

Contents

UMT Vision

It defines UMT existence, inspires all stakeholders associated with UMT, creates a powerful momentum inside, and responds to the challenges outside. It continues to evolve as present captures new realities and foresight unfolds new possibilities.

This is a continuous attempt to help individuals and organizations to discover their God-gifted potentials to achieve Ultimate Success realizing the highest standards of efficiency, effectiveness, excellence, equity, trusteeship and sustainable development of global human society.

UMT Mission

Our Mission is.... Leading

We aspire to become a learning institution and evolve as the leading community for the purpose of integrated development of the society by actualizing strategic partnership with stakeholders, harnessing leadership, generating useful knowledge, fostering enduring values, and projecting sustainable technologies and practices.

Program Mission Statement

The mission of the Mechanical Engineering Department, in-line with the UMT mission, is to provide education that builds strong foundation of mechanical engineering knowledge and ethical values, expands reasoning, develops ability to solve complex engineering problems, and enhances communication skills for successful career in industry and academia to address the needs of society.

Curriculum for BS Mechanical Engineering

The curriculum for BS Mechanical Engineering is given following:

FIRST SEMESTER

Following courses are offered in first semester:

HM 103 - English Grammar and Comprehension

Contact Hours: **Credit Hours:**

Theory	**32**
Practical	**0**
Total	**32**

Theory	**2**
Practical	**0**
Total	**2**

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:

No	CLO Statement	Domain	Taxonomy Level	PLO
1	Distinguish main ideas and employ active reading strategies to understand texts	Cognitive	4	10
2	Construct grammatically correct sentences using sentence structures and appropriate vocabulary.	Cognitive	3	10
3	Apply English writing skills to organize ideas in paragraph.	Cognitive	3	10

Course Outline:

1. **Basics of grammar:**
   - Parts of speech and use of articles, Sentence structure, Active and passive voice, Practice in unified sentence, Analysis of phrase, clause and sentence structure, Transitive and intransitive verbs, Punctuation and spelling.

2. **Comprehension:**
   - Answers to questions on a given text.

3. **Discussion:**
   - General topics and every day conversation (topics for discussion to be at the discretion of the teacher keeping in view the level of students).

4. **Listening:**
   - To be improved by showing documentaries/films carefully selected by subject teachers.

5. **Translation skills:**
   - Urdu to English.

6. **Paragraph writing:**
   - Topics to be chosen at the discretion of the teacher.

7. **Presentation skills:**

- Introduction.

Recommended Books:

i. <u>Intermediate English grammar</u>, <u>Murphy, Raymond</u>, 1997
ii. <u>Navigating English grammar</u>, <u>Lobeck, Anne</u>, 2014, ISBN: 9781405159944
iii. <u>Applied English grammar and composition</u>, <u>Das, P. C.</u>, 2007, ISBN: 9788173815423
iv. Practical English Grammar by A. J. Thomson and A. V. Martinet. Exercises 1. Third edition. Oxford University Press. 1997. ISBN 0194313492
v. Practical English Grammar by A. J. Thomson and A. V. Martinet. Exercises 2. Third edition. Oxford University Press. 1997. ISBN 0194313506

HM 111 - Islamic Studies/Ethics

Contact Hours:		**Credit Hours:**	
Theory	**32**	Theory	**2**
Practical	**0**	Practical	**0**
Total	**32**	Total	**2**

Course Learning Outcomes:
Upon successful completion of the course, the student will be able to:

No	CLO Statement	Domain	Taxonomy Level	PLO
1	Explain the principles of Islam in light of the Holy Qur'an and Hadith.	Cognitive	2	6
2	Explain the rights of human beings in the light of Islam.	Cognitive	2	8
3	Explain the concepts of ethics in the light of the Holy Qur'an.	Cognitive	2	8
4	Explain the social and economic system of Islam.	Cognitive	2	6

Course Outline:

1. **Islamic Studies (For Muslims)**
   - Introduction to Islamic studies
   - Study of selected text of holly Quran
   - Seerat of Holy Prophet (P.B.U.H)
   - Introduction to Sunnah
   - Selected study from text of Hadith
   - Introduction to Islamic law & jurisprudence
   - Islamic culture and civilization
   - Islam and Science
   - Islamic economic system
   - Political system of Islam
   - Islamic historyand Social system of Islam.

2. **Ethics (For Non-Muslims):**
   - Ethical teachings: Ethical teachings of world religions with special reference to Hinduism, Buddhism
   - Judaism
   - Christianity and Islam.
   - Ethical philosophy: One hundred Ethical presentations from Quran and sayings of the Prophet
   - Islam's attitude towards minorities

- Promotion of moral values in the society anda brief review of ethical systems in philosophy.

Recommended Books:

i. Hameed ullah Muhammad, "Emergence of Islam", IRI, Islamabad, 1993, ISBN: 9694081378.
ii. Hameed ullah Muhammad, "Muslim Conduct of State", 1996.
iii. Hameed ullah Muhammad, 'Introduction to Islam', 1998,ISBN: 9694320305.
iv. Hussain Hamid Hassan, "An Introduction to the Study of Islamic Law", 2010, ISBN: 8174354158.
v. Ahmad Hasan, "Principles of Islamic Jurisprudence" Islamic Research Institute, International Islamic University, Islamabad,2007, ISBN: 9694081300

ME 101 - Engineering Drawing & Graphics

Contact Hours:		Credit Hours:	
Theory	**32**	Theory	**1**
Practical	**48**	Practical	**2**
Total	**80**	Total	**3**

Course Learning Outcomes:
Upon successful completion of the course, the student will be able to:

No	CLO Statement	Domain	Taxonomy Level	PLO
1	Students will be able to demonstrate the importance of basic concepts and principles of Engineering Drawing.	Cognitive	2	1
2	Understand the standards as well as dimensioning methods and tolerance in technical drawings development.	Cognitive	2	1
3	Ability to develop, surfaces, orthographic projections, isometric views and sectional views of different mechanical parts.	Cognitive	1	3

Course Outline:

1. **Orthographic Projection**
   - Principle and Methods of projection, Orthographic projection, Planes of projection, First and Third-angle projection, Reference line
2. **Projection of Points**
   - A point is situated in the first, second, third and fourth quadrant
3. **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.
4. **Projection of Planes (2D)**
   - Types and Traces of planes, Projections of planes, Projections of oblique planes
5. **Projections on Auxiliary Planes (2D)**
   - Types of auxiliary planes and views, Projection of a point on an auxiliary plane, Projections of lines and planes
6. **Projections of Solids (3D)**
   - Types of solids and their projections, Projections of solids with axes inclined
7. **Section of Solids (3D)**

- Section of planes, prisms, pyramids, cylinders, cones, spheres, Methods of development, Triangulation development, Developments of lateral surfaces of right solids

8. **Isometric Projections (3D)**
   - Isometric axes, lines, planes, and scale, Isometric drawing or isometric view, Isometric drawing of planes or plane figures, prisms and pyramids, cylinders, cones and sphere

Recommended Books:

  i.   Practical Engineering Drawing, Maitra, Gitin M., 2007, ISBN: 9788122426908
  ii. Fundamentals of Engineering Drawing , Luzadder, Warren J. , 11th edition 2012, ISBN: 9788120308855
  iii. A Textbook of Engineering Drawing, Dhawan, R. K., 2009, ISBN: 8121914310
  iv. Engineering Drawing by N.D Bhatt, 2002, 44th edition, ISBN: 9789380358833
  v.   A First Year Engineering Drawing by A.C. Parkinson, 1964

ME 122 - Engineering Mechanics (Statics)

Contact Hours:		Credit Hours:	
Theory	**32**	Theory	**3**
Practical	**48**	Practical	**1**
Total	**80**	Total	**4**

Course Learning Outcomes:
Upon successful completion of the course, the student will be able to:

No	CLO Statement	Domain	Taxonomy Level	PLO
1	Explain the concepts of scalars, vectors, forces, moments, couples and the resultant of forces in two and three dimensions.	Cognitive	2	1
2	Apply the concepts of forces, moments and couples to solve the problems of rigid bodies in two and three dimensions.	Cognitive	3	2
3	Analyze the plain trusses, frames and machines for forces and reaction.	Cognitive	4	2
4	Apply the concepts of mechanics for the solution of friction problems of contacting bodies.	Cognitive	3	2

Course Outline:

1. **Introduction to subject**
2. **Force System**
   - Introduction to Force System
   - Rectangular components, Moment, Couple and Resultants (Two dimensional Force systems)
3. **Equilibrium**
   - Mechanical system isolation and Equilibrium condition in two dimensions
   - Equilibrium Conditions-Equilibrium in three Dimensions
4. **Structures**
   - Plane Trusses
   - Method of joints
   - Method of Sections and Space Trusses
   - Frames and Machines
5. **Friction**
   - Types of Friction

Recommended Books:

i. Vector Mechanics for Engineers by Beer, Ferdinand, 2013, 10th edition, ISBN: 9781259062919
ii. Engineering Mechanics by J.L. Meriam, 2013, 7th edition,ISBN: 9781118164990
iii. Engineering Mechanics by R.C. Hibbler (14th Edition), 2016, ISBN: 9780133918922

EF 122 - Materials Engineering

Contact Hours:		Credit Hours:	
Theory	**32**	Theory	**2**
Practical	**48**	Practical	**1**
Total	**80**	Total	**0**

Course Learning Outcomes:
Upon successful completion of the course, the student will be able to:

No	CLO Statement	Domain	Taxonomy Level	PLO
1	Interpret the basic properties and characteristics of metal.	Cognitive	2	4
2	Define the structural defects and their effects on material properties.	Cognitive	1	2
3	Demonstrate the production and properties of iron, ferrous and non-ferrous alloys.	Cognitive	2	4
4	Identify the effects of processes like corrosion and heat treatment in materials.	Cognitive	3	2

Course Outline:

1. **Introduction to Materials Science and Engineering**
2. **Atomic Bonding**
3. **Structure of Crystalline Solids**
4. **Imperfections in Solids**
5. **Phase Diagrams**
6. **Phase Transformation and Development of Microstructures**
7. **Applications and Processing of Metallic Materials**
8. **Structure, Properties and Applications of Polymer Materials**
9. **Composite Materials**
10. **Corrosion and degradation of Materials**

Recommended Books:

i. Fundamentals of Materials Science and Engineering by Callister, William D., 2013, 4th edition,ISBN: 9781118322697
ii. Engineering Materials by Budinski, Kenneth G., 2013,9th edition, ISBN: 9788120338340
iii. DeGarmo's Materials and Processes in Manufacturing by Black, J. T. 2013, 11th edition, ISBN: 9780470873755

NS 128 - Applied Calculus

Contact Hours:		Credit Hours:	
Theory	**48**	Theory	**3**
Practical	**0**	Practical	**0**
Total	**48**	Total	**3**

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:

No	CLO Statement	Domain	Taxonomy Level	PLO
1	Recall the concepts of calculus like limits, continuity, rates of change and integration.	Cognitive	1	1
2	Apply differential and integral calculus for the basic and complex functions.	Cognitive	3	2
3	Apply mathematical concepts for the solution of engineering problems.	Cognitive	3	2

Course Outline:

1. **Functions of one variable**
2. **Limits and continuity**
3. **Differentiation of functions of one variable**
4. **Properties of differentiable functions**
5. **Differentials and linear approximation**
6. **Maxima minima & curvature**
7. **Applied optimization problems of functions of one variable**
8. **Indefinite integrals and techniques of integration**
9. **Definite integrals and fundamental theorem of calculus**
10. **Applications of definite integrals**
11. **Polar coordinates and polar curves**
12. **Parametric functions and curves**
13. **Conic sections and their parametric representations**
14. **Properties of famous plane curves**
15. **Algebra of complex numbers and some applications of complex numbers.**

Recommended Books:

i. [Fundamentals Concepts of Algebra and Trigonometry](), [Earl W.Swokowski](), 1989, 7th edition, ISBN: 534917038

ii. Advanced Engineering Mathematics by E Kreyszig, 2011, 10th edition, ISBN: 9780470646137

iii. Engineering Mathematics by [Stroud, K. A.](), 2011, 5th edition, ISBN: 9780230275485

SECOND SEMESTER

Following courses are offered in second semester:

HM 106 - Composition & Communication

Contact Hours:		Credit Hours:	
Theory	**32**	Theory	**2**
Practical	**0**	Practical	**0**
Total	**32**	Total	**2**

Course Learning Outcomes:
Upon successful completion of the course, the student will be able to:

No	CLO Statement	Domain	Taxonomy Level	PLO
1	Distinguish main ideas from specific details and employ active reading strategies to understand texts.	Cognitive	4	10
2	Develop the effective communication skills and presentation skills for written and oral communication.	Cognitive	6	10
3	Construct grammatically correct sentences using a variety of sentence structures.	Cognitive	6	10
4	Organize ideas in cohesive and coherent paragraphs and essay.	Cognitive	3	10

Course Outline:

1. **Basics of Grammar:**
   - Parts of speech and use of articles, sentence structure, active and passive voice, practice in unified sentence, analysis of phrase, clause and sentence structure, transitive, intransitive verbs, punctuation and spelling.
2. **Comprehension:**
   - Answers to questions on a given text.
3. **Discussion:**
   - General topics and every day conversation (topics for discussion to be at the discretion of the teacher keeping in view the level of students).
4. **Listening:**
   - To be improved by showing documentaries/films carefully selected by subject teachers).
5. **Translation skills:**
   - Urdu to English.
6. **Paragraph writing:**
   - Topics to be chosen at the discretion of the teacher.
7. **Paragraph writing:**

- Practice in writing a good, unified and coherent paragraph.

8. Essay writing:
- Introduction.

9. CV and job application.

10. Study skills:
- Skimming and scanning
- Intensive and extensive
- Speed reading
- Summary and précis writing and comprehension

11. Academic skills:
- Letter / memo writing and minutes of the meeting
- Use of library and internet recourses.

12. Presentation skills:
- Introduction
- Personality development (emphasis on content
- Style and pronunciation.

Recommended Books:

Grammar

i. Practical English Grammar by A. J. Thomson and A. V. Martinet. Exercises 1. Third edition. Oxford University Press. 1997. ISBN 0194313492

ii. Practical English Grammar by A. J. Thomson and A. V. Martinet. Exercises 2. Third edition. Oxford University Press. 1997. ISBN 0194313506

Writing

i. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Francoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 0 19 435405 7 Pages 20-27 and 35-41.

Reading/Comprehension

i. Reading. Upper Intermediate. Brain Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 453402 2

NS 129 - Differential Equations

Contact Hours: **Credit Hours:**
Theory   **48**   Theory   **3**
Practical   **0**   Practical   **0**
Total   **48**   Total   **3**

Course Learning Outcomes:
Upon successful completion of the course, the student will be able to:

No	CLO Statement	Domain	Taxonomy Level	PLO
1	Explain the concept of differential equation.	Cognitive	2	1
2	Solve first order ordinary differential equations and higher-order linear differential equations in engineering application.	Cognitive	3	2
3	Apply Laplace transformation for the solution of linear differential equations.	Cognitive	3	2
4	Apply the learned concepts to solve engineering problems.	Cognitive	3	2

Course Outline:

1. **First Order Ordinary Differential Equations:**
   - Basic concepts, practical approach, formation and geometrical meaning of differential equation. solution of differential equation, variables separable methods, homogeneous equations, linear equations and Bernoulli's equation, exact differential equation, application-simple electric circuits, Newton's law of cooling and heat flow.
2. **Second and Higher Order Linear Differential Equations and their Applications:**
   - Homogeneous linear equations, homogeneous equations with constant coefficients, case of complex roots, complex exponential functions, differential operators, non-homogeneous equations solutions by undetermined coefficients, solution by variation of parameter, applications-simple harmonic motion, oscillatory electrical circuit.
3. **Series Solution of Differential Equations:**
   - Theory of power series method, Frobenius method, Legendre's equation and Legendre's polynomials, Bessel's equation and Bessel's functions with properties.
4. **Laplace Transformation:**
   - Laplace transformation, inverse Laplace and its linearity, transforms of derivatives and integrals, s-shifting, t-shifting and unit step function, differentiation and integration of transform, convolution-Integral equation, partial fractions-system of differential equations, periodic functions with applications, Laplace transformation as a method for solving differential equations.

Recommended Books:

i. Advanced Engineering Mathematics by E Kreyszig, 2011, 10th edition,
   ISBN: 9780470646137
ii. Differential Equations by D. G. Zill& M. R. Cullen, 2009, ISBN: 9788131509241
iii. Elementary Linear Algebra by Howard Anton, 2011, 10th edition, ISBN: 9780470561577
iv. Elementary Differential Equations with Boundary Value Problems by <u>Boyce, William E.</u>,
   2013, 10Th edition, ISBN: 9781118323618
v. A First course in the Numerical Analysis of Differential Equations by Iserles, Arieh,
   2010, 2nd edition, ISBN: 9781107612396

ME 131 - Thermodynamics-I

Contact Hours:	
Theory	**48**
Practical	**48**
Total	**96**

Credit Hours:	
Theory	**3**
Practical	**1**
Total	**4**

Course Learning Outcomes:
Upon successful completion of the course, the student will be able to:

No	CLO Statement	Domain	Taxonomy Level	PLO
1	Explain basic concepts, properties of pure substances and thermodynamic processes relationships.	Cognitive	2	1
2	Interpret Thermodynamic processes relationships.	Cognitive	2	1
3	Explain and apply Second law of thermodynamics.	Cognitive	2	1
4	Extend Second law of thermodynamics to the Entropy.	Cognitive	2	1

Course Outline:

1. **Introduction and Basic Concepts**
   - First law of thermodynamics and its applications
   - System and boundary
   - Specific volume, pressure and temperature
2. **Energy, Energy Transfer, and General Energy Analysis**
   - Equilibrium state, processes
   - Methods to solve thermodynamics problems
3. **Properties of Pure Substances**
   - Phase change processes, P-v-T relation
   - Property diagrams
   - Equation of state, specific heats
   - Compressibility polytropic process relation.
4. **Energy Analysis of Closed Systems**
   - Energy balance of closed system
5. **Mass and Energy Analysis of Control Volumes**
   - Energy analysis of power, refrigeration and heat pump cycles
6. **The Second Law of Thermodynamics**
   - Spontaneous and non-spontaneous processes
   - Thermodynamic cycles, irreversible and reversible process, and Carnot cycle
   - Clausius inequality.
7. **Entropy**

- Entropy change, T-s diagram, entropy generation
- Increase of entropy principle, entropy rate balance of closed systems and control volumes
- Isentropic efficiencies

Recommended Books:

i. Thermodynamics, An Engineering Approach, By Yunus A. Cengel,Michael A., Boles McGraw-Hill, 2011, 7th edition, ISBN: 9780071072540

ii. Fundamentals of Engineering Thermodynamics, By M.J. Moran, 4th edition, 2005,ISBN: 9971512998

iii. Modern Engineering Thermodynamics, Balmer, Robert T., 2011, ISBN: 9789381269411

iv. Applied Thermodynamics for Engineering Technologists, By T.D. Eastop and A. McConkey, 5th edition, 1993, ISBN: 0-582-23114-0

CS 143 - Programming Fundamentals

Contact Hours:		Credit Hours:	
Theory	**32**	Theory	**2**
Practical	**48**	Practical	**1**
Total	**80**	Total	**3**

Course Learning Outcomes:
Upon successful completion of the course, the student will be able to:

No	CLO Statement	Domain	Taxonomy Level	PLO
1	Define computer basic components, vital rules and algorithms of C++ programs.	Cognitive	1	1
2	Make use of different types of conditional statements and functions.	Cognitive	3	5
3	Classify different types of loops and arrays; and compare their results.	Cognitive	4	5

Course Outline:

1. **Introduction to Computers**
   - Computer components and systems
   - Operating systems
   - Input/output devices
   - Primary and secondary storage devices
2. **Introduction to software**
   - Word Processing
   - Spreadsheets
   - Presentation software
   - Internet browsers & E-mail
3. **Introduction to C++ Language**
   - Structure of C++ Programs
   - Preprocessor Directives
   - C++ Statements
   - Compilation of C++ programs
4. **Programming Introduction**
   - Logic gates and applications
   - Flowcharts
   - Pseudo codes
5. **Variables and Data types in C++**
   - Introduction to variables and data types
   - Use of variables in C++

- Use of different data types in C++
- Declaration of variables
- Arithmetic Operators
- Boolean Expressions and Operators

6. **Branch and Loop Statements**
   - Looping
   - Loop types
   - Loop Control Statements
   - For Loop and its structure
   - While Loop and its structure
   - Do-While Loop and its structure

7. **Arrays**
   - Introduction to Arrays
   - Declaring Arrays
   - Array Initialization
   - Accessing Array Elements
   - Two Dimensional Arrays
   - Three Dimensional Arrays

Recommended Books:

  i. Computer Fundamentals by P.K Sinha
 ii. The C++ Programming Languageby Stroustrup, Bjarne , 4th edition, 2014, ISBN: 9780321958327
iii. Programming with C++, Schaum's Series, 3rd edition, 2009, ISBN: 9780070144811
 iv. Programming and Problem Solving with C++ by Dale, Nell, 6th edition, 2014, ISBN: 9781284026283

ME 123 - Engineering Mechanics-II (Dynamics)

Contact Hours:		**Credit Hours:**	
Theory	**48**	Theory	**3**
Practical	**48**	Practical	**1**
Total	**96**	Total	**4**

Course Learning Outcomes:
Upon successful completion of the course, the student will be able to:

No	CLO Statement	Domain	Taxonomy Level	PLO
1	Explain key concepts related to position, velocity, force and acceleration and the corresponding angular terms for rigid bodies.	Cognitive	2	1
2	Explain concepts related to kinetics, work and energy for particles and rigid bodies.	Cognitive	2	1
3	Analyze problems related to kinematics and kinetics of particles using different coordinate systems.	Cognitive	4	2
4	Analyze problems related to Kinetics of rigid bodies using various techniques.	Cognitive	4	2

Course Outline:

1. **Introduction to subject and Basic Concepts**
2. **Kinematics of Particles**
   - Rectilinear Motion
   - Plane Curvilinear Motion
   - Space Curvilinear Motion
   - Motion Relative to Trans Axes
   - Constrained Motion of Connected Particles
3. **Kinetics of Particles**
   - Second Law & Equation of Motion
   - Work and Energy
   - Linear Impulse and Momentum
   - Impact
   - Angular Momentum
4. **Kinematics of Rigid Bodies**
   - Plane Motion
   - Relative Velocity
   - Relative Acceleration
5. **Kinetics of Rigid Bodies**
   - Kinetics of Rigid Bodies

Recommended Books:

i. Vector Mechanics for Engineers by Beer, Ferdinand, 2013, 10th edition,ISBN: 9781259062919
ii. Engineering Mechanics Dynamics by J.L. Meriam, 2013, 7th edition, ISBN: 9788126543953
iii. Engineering Mechanics Dynamics by R.C. Hibbler (14th Edition), 2016, ISBN: 9780133915389

THIRD SEMESTER

Following courses are offered in third semester:

ME 221 - Mechanics of Materials-I

Contact Hours:		Credit Hours:	
Theory	**48**	Theory	**3**
Practical	**48**	Practical	**1**
Total	**96**	Total	**4**

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:

No	CLO Statement	Domain	Taxonomy Level	PLO
1	Explain stress-strain behavior of materials and their mechanical properties.	Cognitive	2	1
2	Analyze statically determinate and indeterminate structures under axial loading.	Cognitive	4	2
3	Analyze mechanical structures for stresses and deflection in bending application and circular shaft for stresses and angle of twist in torsion applications	Cognitive	4	2

Course Outline:

1. **Mechanical properties of materials; tensile, compressive and shear stress & strain**
2. **Moment of inertia**
3. **Axial loading, Hooke's law, stress strain relationship**
4. **Thermal stresses**
5. **Torsion of circular bars,**
6. **Pure bending of beams, shear stresses in beams**
7. **Shearing force and bending moment**
8. **Beam deflection using various methods**
9. **Residual stresses and stress concentration in various engineering applications**
10. **Analysis of statically indeterminate problems,**
11. **Thin and thick curved bars,**
12. **Thin walled pressure vessels.**

Recommended Books:

i.   Mechanics of Materials by Ferdinand P. Beer, McGraw-Hill.
ii. Mechanics of Materials by R.C. Hibbler.

iii.   Mechanics of Engineering Materials by P.P. Benham & R.J. Crawford Longman Sc & Tech.

iv.   Mechanics of Materials by Gere, James M

ME 231 - Fluid Mechanics-I

Contact Hours:		Credit Hours:	
Theory	**48**	Theory	**3**
Practical	**48**	Practical	**1**
Total	**96**	Total	**4**

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:

No	CLO Statement	Domain	Taxonomy Level	PLO
1	Utilize the Fluid statics concepts to solve day to day engineering problems	Cognitive	3	3
2	Apply the Fluid dynamics concept to solve day to day engineering problems.	Cognitive	3	3
3	Apply the Fluid dynamics concepts relevant to momentum analysis to solve day to day engineering problems.	Cognitive	3	3
4	Make use of dimensionless analysis to model fluids mechanics scenarios	Cognitive	4	2

Course Outline:

1. **Fluid Properties**
   - Definition of fluid and its classification
   - Concept of continuum.
   - Properties of the fluid.
2. **Fluid Statics**
   - Concept of Pressure and basic equations for compressible and incompressible
   - Pressure measurements and devices.
   - Hydrostatics forces on plane and curved surfaces.
   - Buoyancy and Stability.
   - Pressure variation in fluid with rigid body motion.
3. **Fluid Kinematics**
   - Flow characteristics, Descriptions of Velocity and acceleration field (Streamlines, streak lines and path lines).
   - Control volume and representation of system.
   - Reynolds transport theorem (RTT).
4. **Fluid Dynamics**
   - Application of Newton's 2nd law in fluids.
   - Total, stagnation and dynamic pressure.

- Deriving Bernoulli equation and its applications.

5. **Integral Analysis of Fluid Flow**
   - Continuity equation using RTT.
   - Linear momentum equation using RTT.
   - Moment of momentum equation using RTT.

6. **Dimensional Analysis, Similitude and Modeling**
   - Dimensional analysis
   - Buckingham Pi theorem and determination of Pi terms

7. **Flow in Pipes**
   - Characteristics of pipe flow laminar and turbulent.
   - Calculating friction factor and wall shear stresses.
   - Solving pipe flow network problems

Recommended Books:

i.   Fundamentals of Fluid Mechanics, By Munson, Young and Okiishi, John Wiley & Sons.
ii. Fluid Mechanics, By Frank M. White McGraw Hill.
iii. Fluid Mechanics, By Douglas, John F.
iv. Fluid MechanicsFundamentals and Applications by Cengel, Yunus A.
v.   Fundamentals of Fluid Mechanics by Evett, Jack B.

NS 221 - Linear Algebra

Contact Hours:			Credit Hours:	
Theory	**48**		Theory	**3**
Practical	**0**		Practical	**0**
Total	**48**		Total	**3**

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:

No	CLO Statement	Domain	Taxonomy Level	PLO
1	Recall the basic formulas of linear algebra, differentiation and integration.	Cognitive	1	1
2	Apply the concepts of matrices, determinant, linear transformations, linear systems, vector spaces and ODEs for the solution of problems.	Cognitive	3	2
3	Apply the learned concepts for the solution of engineering problems.	Cognitive	3	2

Course Outline:

1. **Matrix algebra and general properties of matrices**
2. **Elementary row operations reduction of matrices into echelon and reduced echelon form**
3. **Rank of a matrix**
4. **Determinants and their properties**
5. **Solution of system of linear algebraic equations**
6. **Gaussian elimination and Gauss-Jordan method**
7. **Vector spaces**
8. **Linear dependent and independent vectors basis, eigenvalue and eigenvectors**
9. **First and second differential equations and their solution techniques**
10. **Higher order linear differential equations**
11. **Applications of differential equations`**
12. **Study of power series solution and system of linear differential equations.**

Recommended Books:

i. Linear Algebra and its Applications by David C Lay, Addison-Wesley.
ii. Advanced Engineering Mathematics by E Kreyszig.

iii.   Elementary Linear Algebra by Howard Anton, 2011.
iv.   Elementary Differential Equations with Boundary Value Problems by <u>Boyce, William E.</u>

ME 241 - Manufacturing Processes

Contact Hours:		Credit Hours:	
Theory	**48**	Theory	**3**
Practical	**48**	Practical	**1**
Total	**96**	Total	**4**

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:

No	CLO Statement	Domain	Taxonomy Level	PLO
1	Identify the fundamentals and applications of a variety of manufacturing processes involving different formation physics, including injection: molding, additive manufacturing, bulk and sheet forming, welding and casting.	Cognitive	3	1
2	Explain the causes of various defects in an injection molding process, casting, welding and forming processes and how these defects can be avoided by control of the process conditions (e.g. pressure, temperature) and mold design.	Cognitive	3	4
3	Demonstrate additive manufacturing (AM) as an emerging technology and know the operating principles of the most prominent AM processes: fused deposition modeling (FDM), stereolithography (SLA), and selective laser melting (SLM).	Cognitive	2	1

Course Outline:

1. **Introduction:**
    -   Basic concepts of manufacturing processes
    -   Casting and Molding:
    -   Metal casting processes and equipment, Powder metallurgy, Plastics
2. **Forming:**
    -   Extrusion and drawing
    -   Sheet metal forming
    -   Forming and shaping plastics and composite materials
3. **Machining:**
    -   Conventional and non-conventional machining processes
4. **Joining:**
    -   Welding

- Brazing
- Soldering
- Sintering
- Adhesive bonding
- Fastening, Press fitting

5. **Additive Manufacturing:**
    - 3D Printing

Recommended Books:

i. Manufacturing Engineering and Technology by Kalpakjian Prentice Hall.
ii. Materials and Processes in Manufacturing by E.P Degarmo Prentice Hall.
iii. Manufacturing Process by P.F Ostwald.

HM 211 - Pakistan Studies

Contact Hours:		Credit Hours:	
Theory	**32**	Theory	**2**
Practical	**0**	Practical	**0**
Total	**32**	Total	**0**

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:

No	CLO Statement	Domain	Taxonomy Level	PLO
1	Explain the ideology of Pakistan with reference to speeches of Muhammad Ali Jinnah and Muhammad Iqbal.	Cognitive	2	6
2	Explain the history of Muslim nation ideology, leading to the creation of Pakistan.	Cognitive	2	6
3	Explain the political and constitutional process, and current prevailing issues in Pakistan.	Cognitive	2	6
4	Explain the foreign policy of Pakistan.	Cognitive	2	6

Course Outline:

1. **Historical Perspective**
   - Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-e-Azam Muhammad Ali Jinnah.
   - Factors leading to Muslim separatism
   - People and Land
   - Indus Civilization
   - Muslim advent
   - Location and geo-physical features.
2. **Government and Politics in Pakistan**
   - Political and constitutional phases:
     - a. 1947-58
     - b. 1958-71
     - c. 1971-77
     - d. 1977-88
     - e. 1988-99
     - f. 1999 onward
3. **Contemporary Pakistan**
   - Economic institutions and issues
   - Society and social structure

- Ethnicity
- Foreign policy of Pakistan and challenges
- Futuristic outlook of Pakistan

Recommended Books:

i. Burki, Shahid Javed, State & Society in Pakistan, the Macmillan Press Ltd
ii. Akbar, S. Zaidi, Issue in Pakistan's Economy, Karachi: Oxford University Press.
iii. S.M. Burke and Lawrence Ziring, Pakistan's Foreign Policy: An Historical Analysis, Karachi: Oxford University Press.
iv. Mehmood, Safdar, Pakistan Political Roots & Development, Lahore.
v. Badruddin Umar, The Emergence of Bangladesh.

FOURTH SEMESTER

Following courses are offered in forth semester:

EE 205 - Basic Electrical Engineering

Contact Hours:		**Credit Hours:**	
Theory	**32**	Theory	**2**
Practical	**48**	Practical	**1**
Total	**80**	Total	**3**

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:

No	CLO Statement	Domain	Taxonomy Level	PLO
1	Explain the basic construction, operation and characteristics of electrical components.	Cognitive	2	1
2	Apply the acquired knowledge in electrical engineering to solve small scale circuits	Cognitive	2	2
3	Apply the acquired knowledge to analyze the electrical machines.	Cognitive	2	2
4	Describe the practical application of electrical devices	Cognitive	3	1

Course Outline:

1. **Basic concepts and circuit elements,**
2. **System of units, electric charge, current, electromotive force and potential difference,**
3. **Ohm's law, resistors, conductors and insulators,**
4. **Active and passive circuit elements dependent and independent current and voltage sources,**
5. **Simple DC circuits, series circuits, parallel networks,**
6. **Kirchhoff's laws, power and energy, resistivity,**
7. **Temperature, co-efficient of resistance, capacitance and capacitors,**
8. **Hydraulics analogy, charging and discharging, series and parallel connection of capacitors, relative permittivity dielectric strength,**
9. **Electromagnetism & magnetic circuits,**
10. **Magnetic field and flux due to and electric current, solenoid,**
11. **Force on current carrying conductor,**

12. **Magnitude and direction of induced emf, magneto motive force, field strength and reluctance, comparison of electric and magnetic circuits, determination of B/H characteristic,**

13. **Inductance in a DC circuit, inductive and non-inductive circuit, inductance of air-cored & iron-cored coil,**

14. **Growth and decay of current in LR circuit, energy storage, mutual inductance and coupling co-efficient,**

15. **AC fundamentals,**

16. **generation of single phase and three phase alternating emf, relationship between frequency, speed and number poles, RMS, average, instantaneous and peak values of sinusoidal waveform,**

17. **Voltages and currents in star and delta circuits, inductive reactance and impedance of RL load, phasor representation of alternating quantity,**

18. **Active, reactive and apparent powers, power factor and power triangle and working principle of transformer.**

Recommended Books:

i.   Basic Electrical Engineering, 2nd Edition by J J Cathey & A Nasar, Schaum's outline series.
ii. Electric Machines and Automatic Control by J. B Gupta.
iii. Basic Concepts of Electrical Engineering by Subramanyam, P.S.

ME 232 - Thermodynamics-II

Contact Hours:		Credit Hours:	
Theory	**48**	Theory	**3**
Practical	**48**	Practical	**1**
Total	**96**	Total	**2**

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:

No	CLO Statement	Domain	Taxonomy Level	PLO
1	Make use of knowledge of gas power cycles and working of associated equipment to solve engineering problems.	Cognitive	3	2
2	Make use of knowledge of vapor power cycles and working of associated equipment to solve engineering problems	Cognitive	3	2
3	Illustrate the construction of internal combustion engines	Cognitive	2	1
4	Explain Combustion reactions and relevant terms	Cognitive	2	1

Course Outline:

1. **Review of Thermodynamics I**
   - Energetics
   - Efficiency
2. **Exergy**
   - Exergy balance
   - Exergetic efficiency
3. **Gas Power Cycles**
   - Air-Standard-Otto cycle
   - Diesel cycle,
   - Dual and Brayton cycle
   - Regenerative gas turbines with reheat & inter cooling
   - Combined cycles
4. **Vapor and Combined Power Cycles**
   - Modeling and analyzing
   - Superheat and Reheat vapor power cycles
   - Regenerative vapor power cycles

- Other vapor cycle aspects

5. **Refrigeration Cycles**
   - Vapor compression refrigeration systems
   - Cascade and Multistage systems
   - Absorption refrigeration, Heat pump, and Gas refrigeration systems

6. **Thermodynamic Property Relations and Gas Mixtures**
   - Mixture composition
   - P-v-T relations for gas mixtures
   - U, H, S and specific heats for gas mixtures.

7. **Chemical Reactions**
   - Combustion process and conservation of energy in reacting systems
   - Importance of mathematical relations

8. **Chemical and Phase Equilibrium**
   - Equilibrium fundamentals
   - Chemical potential and equilibrium.

Recommended Books:

i. Thermodynamics, An Engineering Approach, By Yunus A. Cengel, Michael A., Boles McGraw-Hill.
ii. Fundamentals of Engineering Thermodynamics, By M.J. Moran.
iii. Modern Engineering Thermodynamics, Balmer, Robert T.
iv. Applied Thermodynamics for Engineering Technologists, By T.D. Eastop and A. McConkey.

ME 242 - Mechanical Measurements & Metrology

Contact Hours:		Credit Hours:	
Theory	**32**	Theory	**2**
Practical	**48**	Practical	**1**
Total	**80**	Total	**3**

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:

No	CLO Statement	Domain	Taxonomy Level	PLO
1	Analyze general measurement principles with respect to gauges and comparators	Cognitive	4	1
2	Identify basic characteristics and working principles of instruments for measuring length, force, torque, temperature, pressure and flow.	Cognitive	3	5
3	Explain different methods and techniques being used for data acquisition systems, A/D and D/A converters and measurement system analysis.	Cognitive	2	1

Course Outline:

1. **General principles of measurement**
2. **Geometric dimensioning and tolerances, gauges and comparators**
3. **Interferometers and associated devices, surface texture measurement**
4. **Significance of measurement**
5. **Planning of experiments**
6. **General measurement system**
7. **Calibration, static and dynamic measurement sensitivity**
8. **Range, accuracy precision and uncertainty of instruments**
9. **Measurement errors**
10. **Instruments for measurement of length, force, torque, strain, frequency, pressure, flow, and temperature**
11. **Introduction to data acquisition systems, A/D and D/A converters**
12. **Standards of linear measurements, angular measurements and comparators**
13. **Limits, tolerances and fits, repeatability and reproducibility**
14. **Machine tool metrology**
15. **Computers in Metrology**
16. **Measurement system analysis**

Recommended Books:

i. Theory and Design for Mechanical Measurements, by R. Figliola, And D. Beasley, John Wiley.
ii. Mechanical Measurement by Thomas G Beckwith.
iii. Measurement and Instrumentation by Alan S. Morris.
iv. The Metrology and Handbook by Jay L. Bucher.

ME 222 - Mechanics of Machines

Contact Hours:		Credit Hours:	
Theory	**48**	Theory	**3**
Practical	**48**	Practical	**1**
Total	**96**	Total	**4**

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:

No	CLO Statement	Domain	Taxonomy Level	PLO
1	Define various mechanisms, their geometry and motion of the machine parts	Cognitive	1	1
2	Explain the working of different engineering mechanisms and their industrial applications	Cognitive	2	2
3	Solve different mechanisms by using graphical and analytical techniques to find the performance parameters	Cognitive	3	3

Course Outline:

1. **Introduction to Mechanisms**
   - Machine & mechanisms, mechanism terminology
   - Kinematic diagram
   - Kinematic inversion, four bar mechanism
   - Slider crank mechanism,
   - Techniques of mechanism analysis
2. **Vector, Position and Displacement Analysis**
   - Motion
   - Vectors
   - Analytical vector methods applied to the displacement analysis of planar linkages
   - Graphical analysis
   - Complex-number methods applied to the displacement analysis of linkages
   - Spatial (three-dimensional) linkages
   - Computer-implemented numerical methods of position analysis
3. **Velocity Analysis of Mechanisms**
   - Average speed in mechanize mechanism
   - Velocity of a point in mechanize mechanism
   - Angular velocity in mechanize mechanism, motion of a rigid body about a fixed axis (without translation)

- Moving coordinate systems and relative velocity
- Application of analytical vector and Matrix Methods to Linkages
- Four-Bar Linkage
- Complex-Number Methods Applied to Velocity Analysis

4. **Acceleration Analysis of Mechanisms**
   - Planar motion
   - Spatial motion
   - Relative acceleration
   - Analysis of a four-bar linkage by analytical vector methods
   - Acceleration analysis
   - Position analysis, the acceleration polygon
   - Graphical analysis of the four-bar linkage
   - An analytical solution based on the acceleration polygon
   - Graphical analysis of sliding contact linkages
   - Trial solution method applied to linkage acceleration analysis
   - Spatial linkages
   - Acceleration analysis of an rssr

5. **Design & development**

6. **Mechanism Design**
   - Time Ratio, Timing Charts
   - Design of Slider Crank Mechanism
   - Design of Crank Shaper Mechanism
   - Mechanism to Move a Link between Two Positions

7. **Cams**
   - Types of Cams & Followers
   - Follower Motion Schemes
   - Graphical Disk Cam Profile Design
   - Pressure Angle
   - Design Limitations

8. **Governors**
   - Types of Governors
   - Centrifugal Governors
   - Porter Governors
   - Parallel Governors
   - Spring Loaded Governors

9. **Gears**
   - Toothed Gearing
   - Gear Trains

Recommended Books:

   i. Theory of Machines and Mechanisms, by J.E. Shigley &Uicker, McGraw-Hill.
  ii. Theory of Machinesby Bevan, Thomas.
 iii. Machines and Mechanism by Myszka, David H.
  iv. Theory of Machines, Kinematics and Dynamics by Singh, Sadhu.

ME 223 - Machine Design & CAD-I

Contact Hours:		Credit Hours:	
Theory	**32**	Theory	**2**
Practical	**48**	Practical	**1**
Total	**80**	Total	**3**

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:

No	CLO Statement	Domain	Taxonomy Level	PLO
1	Demonstrate the basics of machine design	Cognitive	2	1
2	Make use of mathematical skills to solve problems in the designing of machine element	Cognitive	3	3
3	Analyze the behavior of machine elements under different loading conditions	Cognitive	4	2

Course Outline:

1. **Basic criteria of design of machine parts**
2. **Determination of permissible and actual stresses**
3. **Factor of safety**
4. **Design of keys, cotters, and couplings**
5. **Design of brakes and clutches**
6. **Flywheel**
7. **Design of welded, riveted and bolted joints**
8. **Design of translation screws**
9. **Design codes and standards**
10. **Tolerances**
11. **Standards of fits & tolerances**
12. **Fundamentals of CAD**

Recommended Books:

i. Shigley's Mechanical Engineering Design, by Budynas, Richard G., McGraw Hill.
ii. Machine Design, An Integrated Approach, by R L Norton.
iii. Design of Machine Elements, by M.F. Spotts.
iv. Fundamentals of Machine Component Design, by R. C. Juvinall & K. M. Marshek, John Wiley.
v. Related CAD software user's guide.

FIFTH SEMESTER

Following courses are offered in fifth semester:

ME 341 - Machine Tools & Machining

Contact Hours:

Theory:	32
Practical:	48
Total:	80

Credit Hours:

Theory:	2
Practical:	1
Total:	3

Prerequisite: --

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:

Sr. No.	CLO	Domain	Taxonomy Level	PLO
1	Compare different traditional and modern cutting tools, explain their geometry and the basic functions.	Cognitive	1	1
2	Determine different cutting parameters involved in machining operation.	Cognitive	2	2
3	Analyze different machine tools and (Lathe, Drill, Milling, shaper, broaching etc.) and their performance.	Cognitive	3	3

Course Contents:

1. Objectives of metal cutting processes
2. Classification of machining
3. Evaluation of machining performance and its optimization
4. Cutting mechanisms
5. Material removal operations
6. Cutting tool materials and geometry
7. Effects of different cutting parameters on tool life and cutting forces, tool design, jigs and fixtures design.

Recommended Books:

i. Manufacturing Engineering & Technology by Kalpakjian & Schmid, 7th edition, 2014, ISBN: 9789810694067
ii. Technology of Machine Tools by Krar, Steve F., 7th edition, 2011, ISBN: 9780073510835

iii.   Machine Tools by Kesavan, R., 2013, ISBN: 9788190856584

iv.   Machining and Machine Tools by Chattopadhyay, A. B., 2011, ISBN: 9788126530984

NS 321 - Numerical Analysis

Contact Hours:

Theory:	32
Practical:	48
Total:	80

Credit Hours:

Theory:	2
Practical:	1
Total:	3

Prerequisite: --

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:

Sr. No.	CLO	Domain	Taxonomy Level	PLO
1	Identify importance of numerical methods with the help of engineering problems solving techniques, significant figures, accuracy and precision.	Cognitive	1	1
2	Distinguish in truncation errors, round off errors, error propagation, total numerical error using error definition.	Cognitive	2	2
3	Solve Non-Linear algebraic and ordinary and partial differential equation.	Cognitive	3	4
	Simplify numerical methods in Linear algebra through Matrix transformation and iteration.	Cognitive	3	5

Course Contents:

1. **Introduction:**
    *   Introduction and importance of numerical methods motivation with the help of engineering problems solving, significant figures, accuracy and precision, error definitions, truncation errors, round off errors, error propagation, total numerical error.

2. **Solution of Non-Linear Algebraic Equation:**
    *   Bisection methods, fixed point iteration method, method of false position, the Newton–Raphson's method, error analysis for iterative methods andmullers's method.

3. **Interpolation and Numerical Differentiation**:
    *   Divided difference interpolations formulas, Hermit interpolations, Differential of interpolating polynomials, method of undetermined co-efficient and extra-polation methods.

4. **Numerical Integration and Integral Equations:**
    *   Trapezoidal Rule, Sampson's 1/3 Rule, integrals, improper integral, numerical solution of integral equations.

5. **Numerical Solution of Ordinary & Partial Differential Equations:**
   - Euler's method, Euler's modified methods, higher order–Taylor's method, RungeKutta method, higher order equations & system of differential equations, elliptic partial differential equations.

6. **Numerical Methods in Linear Algebra:**
   - Matrix transformation, linear system-Gauss elimination, matrix inversion, linear systems – solution by iteration, linear system – conditioning norms, matrix Eigen value problems, inclusion of matrix Eigen values.

Recommended Books:

   i.   Numerical Methods by H M Kandasamy, P., 2010, ISBN: 8121914388
  ii.   Applied Numerical Methods with MATLAB by Chapra, Steven C., 2012,ISBN: 9780073401102
 iii.   Applied Numerical Analysis by Curtis F., 7ISBN: 9788131717400 [th] edition, 2004

ME 331 - Fluid Mechanics – II

Contact Hours:

		Credit Hours:	
Theory:	48	**Theory:**	3
Practical:	48	**Practical:**	1
Total:	96	**Total:**	4

Prerequisite: Fluid Mechanics – I

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:

Sr. No.	CLO	Domain	Taxonomy Level	PLO
1	Apply the differential and integral form of governing equations to viscous and non-viscous flows to estimate the solution of real engineering problems.	Cognitive	3	2
2	Estimate the design of piping system by using internal fluid flow concept.	Cognitive	5	3
3	Analyze the flow characteristics of fluid over a solid body by using boundary layer theory.	Cognitive	4	4
4	Apply the CFD techniques for the analysis of elementary fluid mechanics problems.	Cognitive	3	5

Course Contents:

1. **Integral Analysis of Fluid Flow**

   - Review of Fundamental Concepts
   - Conservation of Mass
   - Mechanical Energy and Efficiency
   - The Bernoulli Equation
   - Energy Analysis of Steady Flows Advantages

2. **Differential Analysis of Fluid Flow**

   - Conservation of Mass—The Continuity Equation
   - The Stream Function
   - Conservation of Linear Momentum
   - The Navier–Stokes Equation
   - Differential Analysis of Fluid Flow Problems

3. **Internal Flows**

   - Laminar and Turbulent Flows
   - The Entrance Region
   - Laminar Flow in Pipes

- Turbulent Flow in Pipes
- The Moody Chart
- Types of Fluid Flow Problems
- Minor Losses
- Piping Networks and Pump Selection

4. **The Boundary Layer Approximation**

- The Boundary Layer Equations
- The Boundary Layer Procedure
- Displacement Thickness
- Momentum Thickness
- Turbulent Flat Plate Boundary Layer
- Boundary Layers with Pressure Gradients

5. **Flow Over Bodies: Drag and Lift**

- Drag and Lift
- Friction and Pressure Drag
- Drag Coefficients of Common Geometries
- Parallel Flow over Flat Plates
- Flow over Cylinders and Spheres
- Lift Force

6. **Turbomachinery**
- Fans, Pumps, turbines and other flow devices.
- Deriving Euler's equation and solving of turbo-machine problems using velocity triangle
- Pump and turbine performance characteristic curves.

Recommended Books:

  i. Fluid Mechanics, Fundamentals and application By Younus Cengel
 ii. Fundamentals of Fluid Mechanics, By Munson, Young and Okiishi, John Wiley & Sons
iii. Fluid Mechanics, By Frank M. White McGraw-Hill
 iv. Fluid Mechanics by Shames McGraw-Hill. McGraw-Hill Science/Engineering/Math
  v. Engineering Fluid Mechanics, By Clayton T. Crowe, Donald F. Elger, John A. Roberson, John Wiley & Sons

ME 321 - Machine Design & CAD-II

Contact Hours:

Theory:	32
Practical:	48
Total:	80

Credit Hours:

Theory:	2
Practical:	1
Total:	3

Prerequisite: Machine Design & CAD-I

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:

Sr. No.	CLO	Domain	Taxonomy Level	PLO
1	Identify the nomenclature and processes involved in the design of different machine elements.	Cognitive	3	1
2	Examine the mechanics of machine element to develop relationship between design parameters.	Cognitive	4	2
3	Determine the different design parameters of machine elements.	Cognitive	5	3
4	Design the machine element for application based on the customer requirement.	Cognitive	6	4

Course Contents:

1. **Spur, Helical, Bevel and Worm Gears**
   - Stress analysis on gear teeth
   - Power transmission by the gears
2. **Design of Flywheels**
   - Concepts of designing flywheels for different requirements

3. **Selection of bearings**
   - Selection procedures of sliding contact bearings and rolling contact bearings
4. **Design of Brake / Clutches**
   - Different types of clutches and designing concepts
   - Different types of brakes and designing concepts

5. **Design of Power Screws / Translation Screws**
   - Introduction to power / translational screws
   - Stresses in power / translational screws
   - Efficiency of power / translational screws
   - Applications of power / translational screws

6. **Selection of Standard Machine Elements**

- Selection of flat belts, V belts, chain drive and rope drives

Recommended Books:

i. Shigley's Mechanical Engineering Design, by Budynas, Richard G., McGraw Hill, 9th edition, 2011, ISBN: 9780071077835
ii. Machine Design, An Integrated Approach, by R L Norton, 2nd edition, 2000, ISBN: 9788131705339
iii. Design of Machine Elements, by M.F. Spotts, 8th edition, 2006, ISBN: 8177584219
iv. Fundamentals of Machine Component Design, by R. C. Juvinall & K. M. Marshek, John Wiley, 3rd edition, 2000, ISBN: 9788126513673
v. Related CAD and FEA software user's guide

SIXTH SEMESTER

Following courses are offered in sixth semester:

HM 302 - Technical Report Writing & Presentation Skills

Contact Hours:

Theory:	32
Practical:	0
Total:	32

Credit Hours:

Theory:	2
Practical:	0
Total:	2

Prerequisite: ---

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:

Sr. No.	CLO	Domain	Taxonomy Level	PLO
1	Demonstrate the ability to use modern presentation skills.	Cognitive	2	10
2	Illustrate the technicalities of academic writing.	Cognitive	2	10
3	Utilize basics of technical report writing skills to write project reports.	Cognitive	3	10
4	Deduce the idea presented in a written article.	Cognitive	4	12

Course Contents:

1. **Essay writing:**
   - Descriptive, narrative, discursive, argumentative academic writing. How to write a proposal for research paper/term paper? How to write a research paper/term paper (emphasis on style, content, language, form, clarity, consistency)? Technical report writing, progress report writing.

   Note: Extensive reading is required for vocabulary building

2. **Interviewing skills:**
   - Preparation of interview
   - Characteristics of interviews
3. **Presentation skills:**
   - Presentation defined.
   - Delivery of presentations
4. **Audio-visual aids:**
   - Use of audio-visual laboratory to improve pronunciation and delivery.

Recommended Books:

i. Ron White, Writing, Advanced Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 435407 3 (particularly suitable for discursive, descriptive, argumentative and report writing).

ii. John Langan, College Writing Skills with Readings, McGraw-Hill Higher Education, 9th edition, 2014,ISBN: 9781259060632

iii. The Presentation Skills Workshop by Bienvenu, Sherron, 2008, ISBN: 9788120334700

iv. Patterns of College Writing (4th edition) by Laurie G. Kirszner and Stephen R. Mandell, 1989, ISBN: 0-312-01231-4

v. The Mercury Reader, A Custom Publication by Janice Neulib, 2005, ISBN: 0536937435

ME 323 - Mechanics of Materials –II

Contact Hours:

Theory:	48
Practical:	48
Total:	96

Credit Hours:

Theory:	3
Practical:	1
Total:	4

Prerequisite: Mechanics of Materials –I

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:

Sr. No.	CLO	Domain	Taxonomy Level	PLO
1	Explain the concepts of strain energy, virtual work, fatigue and creep.	Cognitive	2	1
2	Explain theories of failure of materiel.	Cognitive	2	1
3	Analyze principal stresses and strains for combined loading problems in two- and three-dimensional stress systems.	Cognitive	4	2
4	Analyze thick walled cylinder for radial and hoop stresses.	Cognitive	4	2

Course Contents:

1. Analysis of stress and strain in two and three dimensions
2. Principal stresses and strains
3. Mohr's circle for stress and strain
4. Thick walled pressure vessels
5. Symmetrical and asymmetrical loading
6. Introduction to fracture mechanics
7. Impact loading
8. Fatigue and creep
9. Virtual work
10. Theories of elastic failure
11. Theory of columns

Recommended Books:

i. E J Hearn, *Mechanics of Materials Volume 1 & 2*
ii. Ferdinand P. Beer & Russel Johnston Jr., *Mechanics of Materials*, McGraw-Hill
iii. Popov, *Mechanics of Materials*

iv.   P. P. Benham & R. J. Crawford, *Mechanics of Engineering Materials*, Longman Sci & Tech

v.   Boresi, Arthur P., Schmidt, Richard J. Sidebottom, Omar M., *Advanced Mechanics of Materials*

vi.   R. C. Hibbeler, Mechanics of Materials

vii.   Andrew Pytel and F. L. Singer, *Strength of Materials*

viii.   W. F. Riley, L. D. Sturges and D. H. Morris, *Mechanics of Materials*.

ix.   W. A. Nashi, *Statics and Mechanics of Materials*, Schaum's outline series New York.

ME 332 - Heat & Mass Transfer

Contact Hours:

Theory:	48
Practical:	0
Total:	48

Credit Hours:

Theory:	3
Practical:	0
Total:	3

Prerequisite: Thermodynamics and Fluid Mechanics

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:

Sr. No.	CLO	Domain	Taxonomy Level	PLO
1	Apply the governing equations of conduction, convection and radiation heat transfer modes to basic thermal systems.	Cognitive	3	2
2	Analyze the thermal performance of finned surfaces.	Cognitive	4	2
3	Analyze the thermal performance of heat exchanger under various operating conditions.	Cognitive	4	3

Course Contents:

1. **Introduction to Heat Transfer**
   - Conduction
   - Convection
   - Radiation
2. **Conduction Heat Transfer**
   - Heat equation
   - Fourier's Law
   - One dimensional steady state heat conduction through plane and composite wall
   - One dimensional steady state heat conduction through plane and composite cylinders
   - One dimensional steady state heat conduction through plane and composite spheres
   - Overall heat transfer coefficient
   - Critical thickness of insulation
3. **Heat Transfer through Extended surfaces**
   - Introduction
   - Various cases of fin heat transfer
   - Temperature distribution and heat transfer derivation for each cases
   - Efficiency and effectiveness of fin
4. **Convection Heat Transfer**

- Introduction
- Newton law of cooling
- Solution of Differential Convection Equations
- Drag and Heat Transfer in external flow
- Parallel flow over Flat plate
- Flow across cylinders and spheres
- Laminar Flow in tubes
- Thermal analysis in circular tubes
- Turbulent flow in tubes

5. **Heat Exchanger**
   - Introduction
   - Types of heat exchanger
   - LMTD Method
   - NTU Method
   - Efficiency and effectiveness of heat exchanger

6. **Radiation**
   - Introduction
   - Stefan Boltzmann's Law
   - Black body radiation
   - Absorptivity, reflectivity and transmissivity
   - Kirchhoff's Law
   - Grey body radiation
   - Radiation shape factor and its application

7. **Mass transfer**
   - Fick's law of diffusion and mass diffusivity.
   - Concept of concentration boundary layer.
   - Solving mass transfer problems using convective heat transfer analogy.

Recommended Books:

i.   Heat and Mass Transfer Fundamentals & Applications by Y.A. Cengel, McGraw-Hill, 5th edition, 2016, ISBN: 9789339223199

ii. Fundamentals of Heat and Mass Transfer by Incropera &Frank P., 2013, ISBN:

     9788126536146

iii. Heat Transfer by J. P. Holman, McGraw-Hill, 10th edition, 2010, ISBN: 9780071267694

iv. Fundamentals of Heat and Mass Transfer by Venkanna, B. K., 2010, ISBN:

     9788120340312

v.   Fundamentals of Engineering Heat and Mass Transfer (SI units) by Sachdeva, R. C., 4th

     edition, 2010, ISBN: 9788122427851

ME 333 - Refrigeration & Air Conditioning

Contact Hours:		Credit Hours:	
Theory:	48	**Theory:**	3
Practical:	48	**Practical:**	1
Total:	96	**Total:**	4

Prerequisite: Thermodynamics

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:

Sr. No.	CLO	Domain	Taxonomy Level	PLO
1	Examine components and design principles used in Refrigeration systems.	Cognitive	4	1
2	Examine components and design principles used in air conditioning systems.	Cognitive	4	2
3	Demonstrate a proper load calculation of a structure.	Cognitive	3	4

Course Contents:

1. **Refrigeration cycles:**
   - Reversed Carnot and Joule cycles
   - Vapor compression and vapor absorption systems, COP, pressure-enthalpy chart
   - Types of refrigerants
   - Air cycle refrigeration, multiple effect compression, and multi-stage compression
   - Heat pumps
2. **Air conditioning:**
   - Indoor and outdoor air conditions
   - Comfort conditions and comfort zone
   - Indoor air quality
   - Psychometry.
3. **Central air-conditioning system:**
   - Essential components of central air-conditioning plant
   - Water chiller and water heater
   - Air handling unit, chilled water and hot water recirculation system
   - Return air supply system, fresh air supply system air mixture chamber, supply fan
   - Air dust cleaning and bacteria removal
   - Air supply and air return terminals, diffusers and grilles
   - CFM rating and tons of air-conditioning of a central air-conditioning plant.
4. **Load calculation and system design:**

- Cooling and heating load calculation procedures
- Duct sizing and piping design, pumps and fans selection.

5. **Air ventilation:**
   - Calculation of fresh air supply of a multi-story building
   - Air handling unit for untreated fresh air
   - Forced convection based air ventilator design.

Recommended Books:

i. Principles of Refrigeration, By Dossat, R. J., 4th edition, 1997, ISBN: 9788177588811
ii. A Textbook of Refrigeration and Air-conditioning, Rajput, R. K., 2nd edition, 2012, ISBN: 9789650142554
iii. Heating, Ventilating, and Air Conditioning by McQuiston, Faye C., 6th edition, 2005, ISBN: 9788126531875
iv. Refrigeration and Air Conditioning by Arora, Ramesh Chandra, 2012, ISBN: 9788120339156
v. Air conditioning principles and systems Pita, Edward G., 4th edition, 2009, ISBN: 9788120322110
vi. ASHRAE Handbook

HM 321 - Social and Ethical Aspects in Engineering

Contact Hours:		Credit Hours:	

Theory:	48	**Theory:**	3
Practical:	0	**Practical:**	0
Total:	48	**Total:**	3

Prerequisite: ---

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:

Sr. No.	CLO	Domain	Taxonomy Level	PLO
1	Discuss awareness of professional, social and ethical responsibility in engineering practice.	Cognitive	3	6
2	Distinguish between individual behavior and behavior in a group.	Cognitive	2	8
3	Choose different safety issues in engineering practice.	Cognitive	1	7
4	Explain the impact of personality and cultural norms on engineer's responsibilities in society.	Cognitive	3	6

Course Contents:

1. **Ethics and Scientific Method:**
   - What is Ethics? Social sciences and common sense, scientific observation, characteristics of scientific observation, the scientific method of investigation.
2. **Origin and Development of Human Society:**
   - Culture and society, social and cultural development, culture as a system of norms, real and ideal culture, ethnocentrism, xenocentrism.
3. **Personality and Moralization:**
   - The meaning of personality, factors in the development of personality, biological inheritance/physical environment and personality, culture and personality, moralization and the self.
4. **Social order and social control:**
   - Social control through moralization, though moral pressure, through force situational determinations of behavior, moral deviation, freedom and order.
5. **Social Institutions:**
   - Concept of Institution and associations, group and individual, group dynamics, voluntary associations, institutions and associations, basic institutions.
6. **The Family:**

- Structure of the family, functions of the family, the Pakistani family today.
7. **Religion:**
   - Religion and society, religion as a unifying force of society, Islamic concept.
8. **Education:**
   - Development of educational institutions, the school as a moral system.
9. **Contemporary Moral Issues.**
10. **Engineering Case Studies.**

Recommended Books:

  i.   Engineering Ethics Concepts and Cases by Harris, C.E. Pritchard, M.S.Rabins, M.J., 5th edition, 2014, ISBN: 9781133934684
  ii. Engineering Ethics by Fleddermann, Charles B., 4th edition, 2014, ISBN: 9781292012520
  iii. Contemporary Moral Issues Diversity and Consensus by Hinman, L.M., 4th edition, 2013, ISBN: 9780205633609

NS 331 - Probability and Statistics

Contact Hours:		Credit Hours:	
Theory:	48	Theory:	3
Practical:	0	Practical:	0
Total:	48	Total:	3

Prerequisite: ---

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:

Sr. No.	CLO	Domain	Taxonomy Level	PLO
1	Explain the fundamental concepts in probability and statistics and their need in engineering.	Cognitive	2	1
2	Analyze data for solving problems and decision-making using probability theory.	Cognitive	4	2
3	Apply the rules and algorithms of probability and statistics for the solution of relevant engineering problems.	Cognitive	3	4
4	Explain the fundamental concepts in probability and statistics and their need in engineering.	Cognitive	2	1

Course Contents:

1. **Treatment of Data:**
   - Frequency distribution, graphs of frequency distributions, measures of central tendency, measures of variance, standard deviation.
2. **Probability:**
   - Samples spaces and events, counting probability, some elementary theorems, conditional probability, Bay's theorem, mathematical expectation and decision making.
3. **Probability Distribution:**
   - Random variable binomials distributions, Poisson processes, probability densities, normal distribution, Statents "t" distribution, Chi-square distribution.
4. **Sampling Distribution:**
   - Populations and samples, the sampling distribution of the mean (Known), the sampling distribution of the mean (unknown), the sampling distribution of the variance.
5. **Curve Fitting:**

- Regression analysis by least square methods, correlation linear, polynomial, regression analysis by least square methods incorporating linear, polynomial, exponential or power function, correlation coefficient determination.

Recommended Books:

i.   Probability & Statistics for Engineers & Scientists, Walpole, Ronald E., 9th edition, 2014,ISBN: 9789332519084
ii.   Schaum's Outlines Probability and Statistics by Spiegel, Murray R., 3rd edition, 2010, ISBN: 9780070151543
iii.   Miller and Freund's Probability and Statistics for Engineers by Ross, Sheldon M., 4th edition, 2009, ISBN: 9780123704832
iv.   Fundamentals of Probability bySaeed Ghahramani, 1996 ,ISBN: 0-13-065798-0

SEVENTH SEMESTER

Following courses are offered in seventh semester:

ME431 - Internal Combustion Engines

Contact Hours:		**Credit Hours:**	
Theory	**48**	Theory	**3**
Practical	**48**	Practical	**1**
Total	**96**	Total	**4**

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:

No	CLO Statement	Domain	Taxonomy Level	PLO
1	Compare the different engine types based on their shapes and working principle.	Cognitive	4	1
2	Relate the Engine performance parameters by applying thermodynamic laws.	Cognitive	5	3
3	Discriminate the air fuel injection methods and ignition systems to improve the engine performance.	Cognitive	5	4
4	Interpret the combustion process and emissions of IC engines to improve the engine design by using emissions control methods.	Cognitive	5	2

Course Outline:

1. **Introduction to I.C engines:**
   - History of I.C engine development
   - Engine classifications
   - Engine components and terminologies
   - Working principle of turbo-charged, supercharged engine, its performance characteristics.

2. **SI & CI engines systems:**
   - Basic engine cycle and operation
   - Two and four stroke engines
   - Engine operating characteristics (engine speed, compression ratio, sfc, A/F, F/A, etc)
   - Engine parameters (efficiency, MEP, Power, torque, etc)
   - Carburetors

- Fuel injectors
- Ignition system
- Electronic control unit, Engine management system
- Otto, Diesel and Dual cycle and their comparison

3. **Fuel and combustion:**
   - Hydrocarbon fuels and their properties
   - Thermo-chemistry and Chemical equilibrium
   - Self-ignition and engine knock
   - Ignition delay
   - Octane and Cetane Numbers

4. **Gas exchange processes and mixture preparation:**
   - Intake Manifold
   - Volumetric efficiency
   - Intake valves
   - Variable valve Control
   - Fuel injection, EFI systems (PFI, MPFI, GDI and Common
   - Super-charging and turbo-charging
   - Fluid Motion within combustion chamber
   - Turbulence, Swirl, Squish and Tumble
   - Crevice Flow and blow by

5. **Combustion in SI and CI engines:**
   - Ignition and flame development
   - Abnormal combustion and knock
   - Spark timing and maximum brake torque spark timing
   - Diesel Fuel injection and mixture preparation
   - Phases of combustion and ignition delay
   - Injection timing, injection pressure
   - Common rail fuel injection

6. **Exhaust Flow:**
   - Turbocharging
   - Exhaust manifold
   - Exhaust gas recirculation

7. **Pollution control**
   - Engine emissions
   - Pollutant formation
   - After treatment
   - Catalytic converters
   - Soot traps

8. **Heat Transfer in Engines and engine cooling system**
9. **Friction and Lubrication of engine, Lubrication systems**

Recommended Books:

  i.   Introduction to I. C. Engines By Richard Stone, 1985, ISBN: 0333375947
 ii.   Internal Combustion Engines By Singal, R. K., 2012, ISBN: 9789350142141
iii.   Internal Combustion Engines and Gas Turbines by Singh, Sadhu, 2011, ISBN: 9789350141892
 iv.   Internal Combustion Engines Applied Thermosciences by Ferguson, Colin R., 2nd edition, 2004, ISBN: 9788126530076
  v.   Applied Thermodynamics for Engineering Technologist, By T. D. Eastop& A McConkey, 5th edition, 1993, ISBN: 9788177582383

ME 421 - Mechanical Vibrations

Contact Hours:		Credit Hours:	
Theory	**48**	Theory	**3**
Practical	**48**	Practical	**1**
Total	**96**	Total	**4**

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:

No	CLO Statement	Domain	Taxonomy Level	PLO
1	Apply different techniques to model single and multi-degree of freedom vibrating systems.	Cognitive	3	1
2	Analyze for the natural frequency and system response of free and forced undamped/damped vibrating system with single degree of freedom.	Cognitive	4	2
3	Analyze for the dynamic response of free and forced vibrating systems with multi- degree of freedom.	Cognitive	4	2
4	Design a passive vibration absorber to minimize vibration in a forced system.	Cognitive	3	3

Course Outline:

1. **Introduction**
   - Fundamentals of Vibrations, Degrees of Freedom
   - Discrete and Continuous Systems, SHM, Vibration Analysis Procedure
2. **Single Degree of Freedom Systems - Free Vibratory Systems**
   - Newton's Method, Energy Method
   - Viscously Damped Free Vibration
   - Logarithmic Decrement, Springs and dampers in Combination
3. **Single Degree of Freedom Systems – Forced Vibratory Systems**
   - Forced Harmonic Vibration, Rotating Unbalance
   - Base Excitation, Vibration Isolation, Energy Dissipation by Damping
   - Whirling of Rotating shafts
4. **Transient Vibration**
   - Impulse Response Function, Response to an Arbitrary Input
5. **Systems with Two Degrees of Freedom**
   - The Normal Mode Analysis, Free Vibration Analysis of an Undamped Systems

- Coordinate Coupling, Free Vibration Analysis of Damped systems
- Forced Harmonic Vibration of an Undamped Systems
- Forced Harmonic Vibration of Damped Systems

6. **Multi Degree of Freedom Systems**
   - Eigen Values and Eigen Vectors, Dunkerley's Method, Rayleigh's Method
   - Influence co-efficients, Matrix Iteration Method
   - Stodola's Method, Holzer's Method

Recommended Books:

i. Mechanical Vibrations: Theory & Applications, By Singal R.K., 2011,ISBN: 9789350140383
ii. Solving Vibration Analysis Problems using MATLAB by Dukkipati, Rao V., 2007, ISBN: 9788122420647
iii. Mechanical Vibrations, By S. S. Rao, 5th edition, 2011, ISBN: 9780132128193
iv. Mechanical Vibrations by Kelly, S. Graham, 2007, ISBN: 9780070616790
v. Mechanical Vibrations Active and Passive Control by Krysinski, Tomasz, 2007, ISBN: 9781905209293

ME 433 - Energy Resources & Utilization

Contact Hours:		Credit Hours:	
Theory	**32**	Theory	**2**
Practical	**0**	Practical	**0**
Total	**32**	Total	**2**

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:

No	CLO Statement	Domain	Taxonomy Level	PLO
1	Discuss the various forms of conventional and non-conventional energy resources.	Cognitive	6	1
2	Assess the availability of current energy resources, energy demand and dependence.	Cognitive	5	1
3	Explain the effective utilization of energy resources.	Cognitive	5	1
4	Design cost effective and optimum solution in the renewable energy and green building sectors.	Cognitive	6	2
5	Examine the impacts on the environment and climate, and the social and economic impacts of our present.	Cognitive	4	1

Course Outline:

1. **Sources of energy and forms of energy (mechanical, electrical, chemical, nuclear and thermal energy)**
2. **Alternate and renewable energy resources (hydel, wind, geothermal, tidal, solar, geomagnetic, etc.)**
3. **Perspectives of world & local energy production and consumption,**
4. **Availability of energy resources (renewable &non renewable, conventional &non conventional) to masses, losses, cost, infrastructure required,**
5. **Principles of efficient utilization of resources, cost effective design and solution optimization for energy considerations in environmental projects**
6. **Economic incentives of energy resources**
7. **Theory and application of different energy resources**
   - Direct combustion of biomass
   - Solar energy
   - Wind energy technology
   - Energy from hydropower,
   - Geothermal, tidal and other natural sources,

- Fossil fuels

8. **Environmental impacts of energy production and consumption**
9. **Importance of energy conservation**
10. **Energy conservation, principles and techniques**
11. **Electric power conservation in buildings**
12. **Reducing heat losses-thermal insulation (materials and methods)**

Recommended Books:

i. Energy Resources, Utilization and Technologies by Yerramilli, Anjaneyulu, 2012, ISBN: 789381075869
ii. Handbook of Energy Conservation by Robert, H. M., 2007, ISBN: 8123912072
iii. Energy Management by UmeshRathore, 2011, ISBN: 9789350141014
iv. Sustainable Energy Management by Popov, Stevan, 2013, ISBN: 9780124159785
v. Energy, Environment and Climate by Richard Wolfson, W. W. Norton, 2nd edition, 2012,ISBN: 9780393912746
vi. Renewable Energy Resources by John Twidell and Tony Weir,3rd edition, 2015, ISBN: 9780415584388.

ME 441 - Instrumentation & Control

Contact Hours:		Credit Hours:	
Theory	**48**	Theory	**3**
Practical	**48**	Practical	**1**
Total	**96**	Total	**4**

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:

No	CLO Statement	Domain	Taxonomy Level	PLO
1	Explain the working of different measuring instruments and their interface with the control system.	Cognitive	1	1
2	Explain the control system along its main components and system representation.	Cognitive	2	1
3	Analyze the stability and response of the control system along with PID controller design.	Cognitive	3	2

Course Outline:

1. **Introduction to measurement and instrumentation:**
   - Significance of measurement, planning of experiments, general measurement system, calibration
2. **Static and dynamic characteristics of instruments:**
   - Measurement sensitivity, range, accuracy, precision, repeatability, and uncertainty of instruments, measurement errors
3. **Measurement:**
   - Measurement of length, displacement, force, torque, strain, frequency, pressure, flow, and temperature.
4. **Introduction to data acquisition systems:**
   - Signal conditioning
   - Display elements

Recommended Books:

   i. Introduction to Instrumentation and Measurements by Northrop, Robert B., 2nd edition, 2005, ISBN: 0849337739

ii.   Fundamentals of Industrial Instrumentation and Process Control by Dunn, William C.,
         2005, ISBN: 9780070677494

iii.   Electronic Instrumentation and Measurements by Bell, David A., 2nd edition, 1997,
         ISBN: 0198065558

iv.   Industrial Instrumentation and Control by Singh, S. K., 3rd, 2009, ISBN: 9780070262225

HM 421 - Engineering Economics

Contact Hours:		Credit Hours:	
Theory	**48**	Theory	**3**
Practical	**0**	Practical	**0**
Total	**48**	Total	**3**

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:

No	CLO Statement	Domain	Taxonomy Level	PLO
1	Assess the economic and financial considerations involved in engineering projects.	Cognitive	5	3
2	Analyze the economic matters like; Present worth, Annual worth, Rate of return and payback period etc.	Cognitive	4	4
3	Interpret balance sheet, financial statements and cost benefit ratios with reference to accounting.	Cognitive	5	5
4	Elaborate forecasting methods and industrial organization.	Cognitive	6	1

Course Outline:

1. **Introduction**
   - Engineering Costs
   - Estimation Models & Cash Flow Diagram
   - Life cycle cost
2. **Time value of Money**
   - Time value of money, equivalence, use of spread sheet, simple and compound interest
   - Uniform series & Arithmetic & geometric gradient
   - Nominal & effective, continuous compounding Economic criteria,
   - Present Worth, future worth and annuity
3. **Rate of Return**
   - Minimum acceptable rate of return (MARR),
   - Internal rate of return, External rate of return
   - Choosing the best alternative
   - Incremental Analysis
4. **Benefits and Cost ratio and Payback period**
   - Benefit and cost ratio (B/C Ratio), discounted benefit and cost ratio
   - Simple payback period, discounted payback period
   - Sensitivity & breakeven analysis

- Principle of comparative advantage

5. **Depreciation**
   - Depreciation using Unit of Production
   - Depreciation using straight line method
   - Depreciation using Depletion

6. **Taxes**
   - Income Taxes, after tax RoR

7. **Replacement analysis**
   - Design life, salvage value
   - Up gradation VS replacement

8. **Risk and Uncertainty**
   - Estimation of future events
   - Monte Carlo Simulation
   - Bayes theorem

9. **Concepts of Imports and Exports**
   - Basic concepts of import and export
   - Dumping and anti-dumping and related laws

Recommended Books:

i. Engineering Economy by William G. Sullivan, Elin M. Wicks and C. Patrick Koelling, 14th edition, 2011, ISBN 978-81-317-3442-1.
ii. Fundamentals of Financial Management by James C. Van Horne and John M. Wachowicz, Jr, 13th edition, 2015, ISBN 978-0273713630
iii. Industrial Engineering and Management by Raju, N. V. S., 2013, ISBN: 9788131519486

EIGHTH SEMESTER

Following courses are offered in eighth semester:

ME 432 - Power Plants

Contact Hours:		Credit Hours:	
Theory	**48**	Theory	**3**
Practical	**48**	Practical	**1**
Total	**96**	Total	**4**

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:

No	CLO Statement	Domain	Taxonomy Level	PLO
1	Relate different types of power plants and environmental impacts	Cognitive	5	7
2	Analyze working of power plants and effect of modifications with thermodynamics calculations.	Cognitive	4	2
3	Interpret the processes of major components of power plants.	Cognitive	5	3

Course Outline:

1. **Review of mass and energy balances for steady flow devices, energy sources and classification; Fossil fuels; composition, ranking and analysis; combustion calculations; environmental pollution**
2. **Gas Turbine Power plants Gas turbine (Brayton) cycle, regeneration, intercooling**
3. **Jet Propulsion Jet propulsion cycle, Turbo Jet Engines, Ramjet Engines, Turbo prop Engines**
4. **Diesel Engine Power plant General layout, Site selection criterion, performance characteristics & environmental impact consideration**
5. **Steam Generators and Turbines Combustion equipment and firing methods, boiler types and their applications; boiler components, boiler operation and safety, water treatment. Impulse and reaction turbines; Pressure and Velocity Compounding, Turbine governing and controls**
6. **Steam Power plants Rankine Cycle, Superheat, Reheat; Regenerative Cycle, Open Type Feed Water Heaters (FWH), Closed Type FWHs with Drains Cascaded Backwards and Pumped Forward**
7. **Combined Cycle Power plants Topping and bottoming cycles, combined cycle efficiency**

8. Cogeneration of power and process heat, Back Pressure and Extraction Turbines
9. Nuclear Power Plant Nuclear fuels, nuclear reaction types, Components, reactor types, Site selection criterion, safety and environmental considerations
10. Renewable Energy Power plants Introduction to Solar, Wind, Hydro and Geothermal Power plants
11. Power plant Economics and Management Effect of variable load, load curve, economics of thermal power plants, energy conservation and management

Recommended Books:

  i. A Textbook of Power Plant Engineering in S.I. Units by Rajput, R. K., 2008, ISBN: 9788131802557
  ii. Power Plant Engineering by Sharma, P. C., 2010, ISBN: 8189757202
  iii. Power Plant Technology by M. M. El Wakil, McGraw-Hill, 1984, ISBN: 9780070702448
  iv. Power Plant Engineering by Gupta, Manoj Kumar, 2012, ISBN: 9788120346123
  v. Applied Thermodynamics for Engineering Technologist, By T. D. Eastop& A. McConkey, 5th edition, 1993, ISBN: 9788177582383

MS 403 - Production Management

Contact Hours:		Credit Hours:	
Theory	**48**	Theory	**3**
Practical	**0**	Practical	**0**
Total	**48**	Total	**3**

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:

No	CLO Statement	Domain	Taxonomy Level	PLO
1	Classify the factors affecting industrial development.	Cognitive	2	2
2	Assess concepts of productivity, role of labor and productivity measurement techniques.	Cognitive	3	1
3	Choose appropriate plant layouts and locations.	Cognitive	3	3
4	Develop production planning and control techniques such as PERT & CPM, critical path, activity scheduling, inventory control, etc.	Cognitive	4	5

Course Outline:

1. **The production and service systems, inputs and output, factors affecting industrial development, industrial development in Pakistan**
2. **Productivity:**
   - Basic concepts
   - Role of labor
   - Classification
   - Productivity measurement improvement
3. **Work study:**
   - Principles of motion economy
   - Methods improvement, rating
   - Standard time
4. **Plant location:**
   - Types of layout
5. **Material handling:**
   - Plant utilities
   - Types of production
   - gro technology
   - Variety control

- Demand forecasting
- Production routing
- Man material and machine requirement
- Planning simplifying scheduling problem
- Multilevel scheduling
- Production control

6. **Project planning and control:**
- PERT & CPM Networks
- Critical path
- Activity scheduling
- Activity crashing
- Inventory control
- Economic lot size
- A-B-C analysis of inventories
- Safety stock level and record point
- Linear programming and its application

Recommended Books:

i. Production & Operations Management by Evert E.Adam Jr and Ronald, 1993, ISBN: 8120308387
ii. Production and Operations Management by Kieth&Loekyer., 6th edition, 2008, ISBN: 8131708896
iii. Operations Management by Heizer and Render, Prentice Hall, 9th edition, 2009, ISBN: 9780136072775
iv. Factory Physics by Hopp& Spearman, 3rd edition, 2008, ISBN: 9780071232463

ME 422 - Finite Element Analysis

Contact Hours:		Credit Hours:	
Theory	**48**	Theory	**3**
Practical	**48**	Practical	**1**
Total	**96**	Total	**4**

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:

No	CLO Statement	Domain	Taxonomy Level	PLO
1	Develop an understanding of the fundamental theory of the FEA method	Cognitive	3	1
2	Analyze the stiffness matrix of the different systems	Cognitive	4	2
3	Estimate the response of the system by using the FEA method	Cognitive	6	3

Course Outline:

1. **Introduction to Finite Element Modeling and preliminary decisions:**
    - Elements types and their properties
    - Basic concepts of equilibrium & compatibility
    - General factors affecting element performance – Sources of errors
    - Convergence.
2. **Direct Stiffness Method, Energy Methods:**
    - Shape Function: Linear and Quadratic Element
    - Beam Elements, Truss Elements, Linear and Planar elements
    - Stiffness matrix, Local to Global Co-ordinate Transformation Assembly
3. **Static Structural Analysis:**
    - Modeling and analysis of 1D, 2D and 3D structures under static loading
4. **Heat Transfer and Thermal Stress Analysis:**
    - Introduction to Heat transfer, Thermal and Thermal Stress analysis concepts
    - Selection of Boundary Conditions based on the identification of problem
    - Thermal Analysis (Steady State)
    - Thermal stress Analysis
5. **Dynamic Analysis**
    - Introduction to different types of dynamic analysis
    - Modal Analysis, Frequency Response Analysis, Transient Response Analysis, Master Degrees of Freedom

Recommended Books:

i. A First Course in FEM by D. L. Logan, 4th edition, 2011, ISBN: 9780495667919
ii. An Introduction to Finite Element Method byReddy, J. N., 3rd edition, 2006, ISBN: 9780070607415
iii. Finite Element Procedures by Bathe, 1996, ISBN: 9788120310759
iv. Finite Element Analysis bySaeed Moaveni, 3rd edition, 2011, ISBN: 9788131760642

MS 402 - Entrepreneurship

Contact Hours:		Credit Hours:	
Theory	**48**	Theory	**3**
Practical	**0**	Practical	**0**
Total	**48**	Total	**3**

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:

No	CLO Statement	Domain	Taxonomy Level	PLO
1	Examine employ entrepreneurial skills.	Cognitive	2	1
2	Construct sustainable business plans, and team building for successful businesses.	Cognitive	4	4
3	Inspect projects successfully.	Cognitive	3	12
4	Create knowledge and skills throughout the project.	Cognitive	4	6

Course Outline:

1. **Introduction:**
   - The concept of entrepreneurship, the economist view of entrepreneurship, the sociologist view, behavioral approach, entrepreneurship and management.
2. **The Practice of Entrepreneurship:**
   - The process of entrepreneurship, entrepreneurial management, the entrepreneurial business, entrepreneurship in service institutions, the new venture
   - Entrepreneurship and Innovation: The innovation concepts, Importance of innovation for entrepreneurship, Sources of innovative opportunities, the innovation process, Risks involved in innovation.
3. **Developing Entrepreneur:**
   - Entrepreneurial profile, Trait approach for understanding entrepreneurship, factors influencing entrepreneurship, the environment, socio cultural factors, support systems.
4. **Entrepreneurship Organization:**
   - Team work, networking organization, motivation and compensation, value system.
5. **Entrepreneurship and SMES:**
   - Defining SMEs, scope of SMEs, entrepreneurial, managers of SME, financial and marketing problems of SMEs
6. **Entrepreneurial Marketing:**

- Framework for developing entrepreneurial marketing, devising entrepreneurial marketing plan, Entrepreneurial marketing strategies, product quality and design

7. **Entrepreneurship and Economic Development:**
   - Role of entrepreneur in the economic development generation of services, employment creation and training, ideas, knowledge and skill development, the Japanese experience.

8. **Case Studies of Successful Entrepreneurs**

Recommended Books:

i. Entrepreneurship by Robert Hisrich, Michael Peters and Dean Shepherd, 9th edition, 2013,ISBN: 9780071326315
ii. Entrepreneurship: New Venture Creation by David H. Holt, 2013, ISBN-13: 978-8120312814
iii. Entrepreneurship by Barringer, Bruce R., 4th edition, 2015, ISBN: 9789332555587
Innovation and Entrepreneurship Peter F. Drucker,

ME 434 - Computational Fluid Dynamics (CFD)

Contact Hours:		Credit Hours:	
Theory	**32**	Theory	**2**
Practical	**0**	Practical	**0**
Total	**32**	Total	**2**

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:

No	CLO Statement	Domain	Taxonomy Level	PLO
1	Analyze the major theories, approaches and methodologies used in CFD.	Cognitive	4	1
2	Formulate CFD methods (e.g. boundary conditions, turbulence modelling etc.) in commercial CFD codes and describe the limitations on accuracy.	Cognitive	6	2
3	Use commercial CFD software to model relevant engineering flow problems.	Cognitive	3	3
4	Apply CFD analysis to real engineering designs.	Cognitive	3	5

Course Outline:

1. **Introduction to CFD:**
   - CFD in A Nutshell
   - CFD Application
   - Advantages of Computational Fluid Dynamics
   - As a Research Tool, As an Educational Tool in Basic Thermal-Fluid Science, As a Design Tool, Aerospace, Automotive Engineering, Biomedical Science and Engineering, Chemical and Mineral Processing, etc.
2. **CFD Solution Procedure: A Beginning:**
   - Introduction, Strategy in CFD solution
   - Commercial CFD Software
   - Problem Setup -- Pre-Processing
   - Creation of Geometry
   - Mesh Generation
   - Selection of Physics and Fluid Properties
   - Specification of Boundary Conditions
   - Numerical Solution—CFD Solver
   - Initialization and Solution Control
   - Monitoring Convergence

- Result Report And Visualization—Post-Process, X-Y Plots, Vector Plots, Contour Plots, Other Plots, Data Report and Output, Animation
- Summary

3. **Governing Equations for CFD—Fundamentals:**
   - Introduction
   - Finite control volume
   - Conservative & Non-conservative form
   - The substantial, Local & Convective Derivatives
   - The Continuity Equation-Mass Conservation, the Continuity Equation-Integral Form, the Continuity Equation-Differential Form, Physical Interpretation of Continuity Equation, Integral versus Differential Form of the Equations:
   - An Important Comment
   - The Momentum Equation, The Momentum Equation-Conservative, The Momentum Equation-2D Case, What is Advection and Diffusion? The Momentum Equation-Physical Interpretation
   - The Energy Equation-Energy Conservation, Physical Interpretation

4. **Turbulence Modelling:**
   - What is Turbulence? Turbulence—How?
   - Energy Cascade, In a nutshell, Boussinesq eddy-viscosity approximation
   - Turbulence Models, k-epsilon two-Equation Turbulence Model
   - Comments-Weakness of two equations models

Recommended Books:

i. J.D. Anderson, Jr., Computational Fluid Dynamics: The Basic with Applications, McGraw Hill, Inc., 1995

ii. J.Y. Tu, G.H. Yeoh, and C. Liu, *Computational Fluid Dynamics: A Practical Approach*, 2nd Edition, 2012.

iii. David C. Wilcox, Turbulence Modelling for CFD 2nd Edition (1994) DCW Industries Inc.

iv. H. Versteeg and W. Malalasekra, An Introduction to Computational Fluid Dynamics: The Finite Volume Method, 2007

v. J.C. Tannehil, D.A. Anderson, and R.H. Pletcher, *Computational Fluid Mechanics and Heat Transfer*, 2nd Edition, Taylor & Francis, 1997, ISBN 1-56032-046-X

vi. Suhas V. Patankar, *Numerical Heat Transfer and Fluid Flow*, Taylor & Francis, 1980.

vii. Niyogi, P. Chakrabarty, S.K. and Laha, M.K., *Introduction to computational fluid dynamics*, Pearson education (2006).

viii. J H Ferziger and M Peric, *Computational Methods for Fluid Dynamics*, Springer (2002).

MS 443 - Health Safety & Environment

Contact Hours:		Credit Hours:	
Theory	**32**	Theory	**2**
Practical	**0**	Practical	**0**
Total	**32**	Total	**2**

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:

No	CLO Statement	Domain	Taxonomy Level	PLO
1	Demonstrate knowledge of Health, Safety and Environment.	Cognitive	2	1
2	Classify the types of pollution and their impact on Health and Environment.	Cognitive	4	7
3	Analyze various types of hazards at work and living places.	Cognitive	4	2

Course outline:

1. **Introduction to Health, Safety and Environment.**
2. **Objectives and Importance of Industrial Safety, Industrial accidents and Effects of the Accidents.**
3. **Accident prevention and Hazard analysis.**
4. **Fire prevention and control.**
5. **Safety inspection procedures & Safety training, First aid and Emergency procedure.**
6. **Legal, humanitarian & economic reasons for action.**
7. **Pollution: Atmospheric Pollution.**
8. **Pollution: Industrial Waste.**
9. **Pollution: Noise Pollution.**
10. **Health and Safety Act.**
11. **Environmental Protection Act.**
12. **ISO 9001:2008 Standard requirement.**
13. **OHSAS 18001:2004.**
14. **OHSAS 14001:2007.**

Recommended Books:

i. John Ridley and John Channing. Safety at Work, 6th edition, Butterworth Heinemann, 2003.ISBN: 0-7506-5493-7

ii. Phil Hughes, Ed Ferrett. Introduction to Health and Safety at Work, 4th Edition, Butterworth Heinemann, 2009.ISBN: 978-1-85617-668-2

iii. Charles D. Reese, Occupational Health and Safety Management – A Practical Approach, 2nd edition, CRC Press Taylor & Frances Group ISBN: 978-1-4200-5181-0