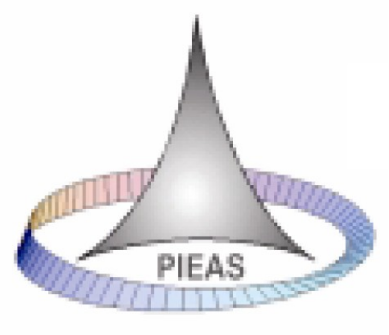
Department of Mechanical Engineering

Pakistan Institute of Engineering and Applied Sciences



Curriculum

for

Bachelor of Science

in

Mechanical Engineering

2017

(Outcome Based Education)

Table of Contents

BSME Program Vision Statement

To be recognized as producers of knowledgeable mechanical engineers capable of acting responsibly towards the socioeconomic needs of the society.

BSME Program Mission Statement

Through its Bachelor of Science in Mechanical Engineering (BS ME) program, Department of Mechanical Engineering at PIEAS aims at producing mechanical engineers having sufficient technical and managerial competence in the main disciplines of mechanical engineering with reasonable exposure to related branches of engineering and applied sciences so that they are able to pursue successful industrial / educational careers and also have a repute of a responsible member of the society with high level of moral and ethical integrity.

Program Educational Objectives (PEOs)

The Department of Mechanical Engineering aims at producing graduates who:

PEO-1: are confident in delivering a wide variety of technical assignments in the key areas of mechanical engineering and allied disciplines as well;

PEO-2: are able to demonstrate effective management skills in the capacity of a team member as well as a team leader;

PEO-3: are keen to pursue lifelong learning and are motivated towards pursuing higher education / applied research to cope with current / growing needs of society and industry;

PEO-4: display and appreciate high levels of moral and ethical values.

Mapping of PEOs to PLOs

		PEO_1	PEO_2	PEO_3	PEO_4
		Technical Knowledge and Skills	Management, Teamwork & Leadership	Motivation for Higher Education and Applied Research	Moral and Ethical Values
PEC Graduate Attributes (PLOs)					
1.	Engineering Knowledge	H	·	L	·
2.	Problem Analysis	H	·	H	·
3.	Design/Development of Solutions	H	·	L	L
4.	Investigation	H	·	H	·
5.	Modern Tool Usage	H	·	L	·
6.	Engineer & Society	·	L	L	H
7.	Environment & Sustainability	·	·	L	H
8.	Ethics	·	L	·	H
9.	Individual & Teamwork	·	H	·	H
10.	Communication	·	H	·	L
11.	Project Management	·	H	·	L
12.	Lifelong Learning	L	·	H	·

Legend:

H	Denotes HIGH emphasis
L	Denotes LOW emphasis
·	Denotes NO emphasis

Program Learning Outcomes (PLOs)

Pakistan Engineering Council (PEC) has already defined following Program Learning Outcomes on the basis of the Knowledge Attributes defined in the Washington Accord. The same have been adopted by DME PIEAS. These are listed below:

PLO-1: **Engineering Knowledge**: An ability to apply knowledge of mathematics, science and engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

PLO-2: **Problem Analysis**: An ability to identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

PLO-3: **Design/Development of Solutions**: An ability to design solutions for complex engineering problems and design systems, components, or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

PLO-4: **Investigation**: An ability to investigate complex engineering problems in a methodical way including literature survey, design and conduct of experiments, analysis and interpretation of experimental data, and synthesis of information to derive valid conclusions.

PLO-5: **Modern Tool Usage**: An ability to create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering activities, with an understanding of the limitations.

PLO-6: **The Engineer and Society**: An ability to apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solution to complex engineering problems.

PLO-7: **Environment and Sustainability**: An ability to understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.

PLO-8: **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.

PLO-9: **Individual and Team Work**: An ability to work effectively, as an individual or in a team, on multifaceted and/or multidisciplinary settings.

PLO-10: **Communication**: An ability to communicate effectively, orally as well as in writing on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentations, make effective presentations, and give and receive clear instructions.

PLO-11: **Project Management**: An ability to demonstrate management skills and apply engineering principles to one's own work, as a member and/or leader in a team to manage projects in a multidisciplinary environment.

PLO-12: **Lifelong Learning**: An ability to recognize importance of, and pursue lifelong learning in the broader context of innovation and technological developments.

PEC requires that the program must demonstrate that by the time of graduation the students have attained a certain set of knowledge, skills and behavioral traits, at least to some acceptable minimum level. This is ensured by having CLOs of at least four (4) courses relate to any one PLO.

The table on next page relates these PLOs to Course Learning Outcomes of each course.

HUMANITIES

CMS-101 Islamic Studies

Contact Hours:

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

Credit Hours:

Theory = **2.0**
Practical = **0.0**
Total = **2.0**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**DESCRIBE** the basic beliefs of Islam.	Cognitive	1	8
2.	**DESCRIBE** the belonging to Islam and responsibility through the texts of Holy Quran and Hadith.	Cognitive	2	8
3.	**EXPLAIN** Islam as the practical code of life for all times.	Cognitive	2	6
4.	**STATE** the relevance of Islamic teachings to social and economic developments of modern age.	Cognitive	2	6

Course Contents:

Tauheed: Arguments for the existence and oneness of Allah; Purpose of creation; Impact of *tauheed* on human life. *Risalat*: Need for prophets; Finality of prophethood; Seerat (The life of the Holy Prophet); *Khutba Hijjat-ul-Wida*; The importance of *Sunnah*. *Aakhirat*: The life after death; The day of judgment; The concept of accountability and its impact on daily life. The Holy Quran: Its revelation and compilation; Introduction to *Aijaaz-ul-Quran* and the principles of *Tafseer-ul-Quran*; *Sura al-Fatiha*; 1st *Raku* of *Sura al-Baqarah*; *Sura Al-Hujraat* and lessons from *Sura Yaseen*. *Hadith*: Its authenticity and importance; An introduction to *Sihah-i-Sitta*; Types of *Ahadith*; *Chehal hadith* (Forty Ahadith). *Ibadah*: The concept of *Ibadah*; Major *Ibadaat* (*Salaat, Saum, Zakat, Hajj* and *Jihad*). Moral, Social and Political Philosophy of Islam: The concept of good and evil; *Akhlaq-i-Hasanah, Kasb-i-Hilal*; Responsibilities of the head of state; Rights and duties of the citizens. Applications of Islamic teachings to social and economic developments of the modern age such as interest free economy, etc.

Recommended Texts:

1. Ibn-i-Kasir, *Tafseer Ibn-i-Kasir*, Dar Ibn Hazam, Beirut, Lebanon, 2005
2. A B Baqilani, *Al-Intisaar Lil-Quran*, Dar Ibn Hazam, Beirut, Lebanon, 2005
3. *Majalisul Abrar (for forty Ahadith)*, Mir Muhammad Kutabkhana, Markaz-i-Ilm-o-Adab Karachi, 2005
4. Imam Nauwwi, *Arbaeen Hadith*, (for forty *Ahadith*)
5. M Naumani, *Deen-o-Shariat*, Mir Muhammad Kutabkhana, Markaz-i-Ilm-o-Adab Karachi, 2005

CMS-103 Pakistan Studies

Contact Hours:

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

Credit Hours:

Theory = **2.0**
Practical = **0.0**
Total = **2.0**

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 history of Pakistan before independence.	Cognitive	1	6
2.	**DESCRIBE** the political structure of Pakistan.	Cognitive	2	6
3.	**EXPLAIN** the key features of 1973 Constitution.	Cognitive	2	6
4.	**DESCRIBE** current issues, resources and problems faced by Pakistan.	Cognitive	2	6

Course Contents:

Important geological and geographical features of Pakistan; Pakistan's geographical location in a regional and global perspective. Earliest human settlements in Pakistan; The Indus Valley civilization; Aryan settlement and the Gandhara civilization; The advent of Islam in Pakistan; The work of Al-Beruni and early Sufi-savants in Pakistani lands. The British domination and its causes; Brief chronology of the freedom movement; The founding documents of Pakistan including Allama Iqbal's 1930 Allahabad address, the Lahore Resolution of 23rd March 1940, and Quaid-i-Azam's presidential address to the Constituent Assembly of Pakistan. Political and constitutional phases in Pakistan since 1947; Important features of the 1973 constitution and its current status. Current issues in Pakistan including: Administrative infrastructure; Population growth; Water, energy and mineral resources; Agricultural resources and industrial infra-structure; Educational problems; economic growth pattern and budgetary issues; Environmental problems; Foreign policy issues.

Recommended Texts:

1. K A Saeed, *The Economy of Pakistan, Oxford University Press, Karachi*, 2007
2. J Briscoe, U Qamar, *Pakistan's Water Economy: Running Dry*, Oxford University Press, 2006.
3. J M Kenoyer, *Ancient Cities of the Indus Valley Civilization*, Oxford University Press, Karachi, 1998
4. L A Sherwani (Editor), Speeches, *Writings and Statements of Iqbal*, Iqbal Academy, Lahore, 1995
5. *The New Oxford Atlas for Pakistan*, Oxford University Press, Karachi, 1998
6. *Jinnah: Speeches and Statements 1947-48*, Oxford University Press, Karachi, 2000

CMS-104 Composition and Grammar

Contact Hours:

Theory = **32**

Practical = **0**

Total = **32**

Credit Hours:

Theory = **2.0**

Practical = **0.0**

Total = **2.0**

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** clear and grammatically correct sentences using a variety of sentence structures and appropriate vocabulary.	Cognitive	3	10
3.	**ORGANIZE** ideas in paragraphs and essays with clarity.	Cognitive	3	10

Course Contents:

Pre-writing techniques (cubing, looping, mind-maps, brainstorming, free-writing, narrowing and Focusing); Audience; Voice; Critical Reading and Analysis; Return to the Modes of Persuasion; Thesis Statements; Outlining and Organizing the Essay; Introductory Paragraphs; Developing the Essay; Paragraphing; Summary and Paraphrase; Synthesis Essays; Basic Sentence Analysis/Usage; Correct sentences; Paragraph types including exemplification, narration, comparison/contrast, cause/effect, and persuasion; Fallacies in argumentation; Claim, Support, and Warrant; Counterarguments/ Rebuttals; Revision Techniques and Editing; Peer Reviews Grammar: Figure of speech; sentence elements; sentence types; coordination & subordination; verb tenses; sentence types; fragments; run-ons; subject-verb agreement; count/non-count and modals. Mechanics: commas, capitalization and punctuation.

Recommended Texts:

1. P Hartmann, L Blass, *Quest 1 – Reading and Writing,* 2nd ed, McGraw-Hill ESL/ELT, 2007
2. P Hartmann, L Blass, *Quest 2– Listening and Speaking*, 2nd ed McGraw-Hill ESL/ELT, 2007
3. Kolln, Funk, *Understanding English*, 7th ed, 2005
4. E Balleisen, S K Bland, *Intermediate Grammar: From Form to Meaning*, Oxford University Press, USA; Teacher's edition, 1996.

CMS-105 Communication Skills

Contact Hours:

Theory = **48**

Practical = **0**

Total = **48**

Credit Hours:

Theory = **3.0**

Practical = **0.0**

Total = **3.0**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
	APPLY the five-step writing process	Cognitive	3	10
	PRESENT information through written and oral communication.	Cognitive	3	10
	PRESENT orally in an appropriate manner.	Psychomotor	4	8
	PRACTICE in interpersonal communication in a well-suited manner.	Affective	3	8

Course Contents:

Overview and Importance of Effective Communications; Business Communication and the Ethical Context; Business Communication and the Technology Context; Successful Listening; Communicating in Teams and Mastering Listening and Nonverbal Communication Skills; Strategies for Successful Speaking and Successful Listening; Leading Feel; Logical Fallacies and the Art of Debate; General principles of Communication; The Seven C's of Effective Communication; Format and Layout of Business Documents; Preparing Effective Business Messages; Good News; Bad News and Neutral Messages; Persuasive Written Messages; Writing Resumes and Application Letters; Interviewing for Employment and Following Up; Reports; Proposals and Presentations; Research Process; Communicating Information Through Visuals; Short Reports; Formal Reports; Proposals. Oral Communication; Impromptu & Extempore Talks; Onion Ring Activity; Individual Talks; Meetings and Group Dynamics; Member Roles and Leadership in Groups; Communicating in Teams; Mastering Listening; Nonverbal Communication Skills; Strategies for Business and Group Meetings; Preparation for Presentations; Planning, writing, and Completing Oral Presentations; Strategies for Successful Speaking and Successful Listening.

Recommended Texts:

1. J V Thill, C L Bovee, *Business Communication Today*, Prentice-Hall, 8th Intl. ed, 2004,
2. T Fulwiler, A R Hayakawa, C Kupper, *The college writer's reference*, Prentice Hall, 1999
3. H A Murphy, H W Hildebrandt, J P Thomas, *Effective Business Communications*, 8th ed, McGraw-Hill/Irwin, 1997
4. Corporate Classrooms, *Get a grip on grammar: language skills for today's business world*, Prentice Hall, 1992

CMS-106 Technical Writing

Contact Hours:

Theory = **48**

Practical = **0**

Total = **48**

Credit Hours:

Theory = **3.0**

Practical = **0.0**

Total = **3.0**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**DESCRIBE** formal technical communication conventions found in workplace.	Cognitive	2	10
2.	**DEMONSTRATE** skills in effective presentation of quantitative data in a graphic format	Cognitive	3	10
3.	**CREATE** technical documents including but not limited to reports, proposals, research articles, etc.	Cognitive	5	10
4.	**DEMONSTRATE** knowledge of conventions / ethics in preparing communication for an audience of diverse cultures.	Cognitive	3	6, 8

Course Contents:

Overview of the field; manuals and handbooks; technical reports; technical articles; technical sales literature; technical training material; technical presentations; educational textbooks; software documentation; outline and design, requirement; specification; outline design; sources of information; library classifications; contacts; meetings; information gathering; verbal information; visual information; synopsis; work schedule; costing; development phase: first draft; style of writing; technical vetting; editing; final draft; commercial books; production phase: camera copy; proofreading; printing; illustrations: technical illustrations; diagrams/line illustrations; perspective drawings; half-tones; validating illustrations; miscellaneous topics: materials and equipment; translations; abstracting and abridging; indexing; development of a documentation system; diagnostic/ maintenance documentation; network planning; copyright; contracts.

Recommended Texts:

1. Tech Biz Writing, *TechBiz Writing Course: A Free Course in Technical and Business Writing which builds gradually into a valuable resource*, [Online]: http://www.techbizwriting.com [Accessed: Mar 11 2008]
2. K R Woolever, *Writing for the Technical Professions*, 4th ed, Longman, 2007

CMS-109 Entrepreneurship

Contact Hours:

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

Credit Hours:

Theory = **2.0**
Practical = **0.0**
Total = **2.0**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**COMPREHEND** key concepts related to entrepreneurship, startup, and economic growth.	Cognitive	2	6
2.	**APPLY** the key concepts of entrepreneurship such as effective written and oral communication skills to business situations for a self-analysis to start an entrepreneurial career and to find an attractive market that can be reached economically.	Cognitive	3	10
3.	**ANALYZE** the opportunity to create a business model and articulate an effective elevator pitches to gain support for the venture.	Cognitive	4	11
4.	**DEVELOP** a well-presented business plan that is feasible for student led enterprises.	Cognitive	6	12

Course Contents:

Introduction to Entrepreneurship; Entrepreneurial Process; Business opportunity identification; Market assessment; Financing the emerging firm; new product innovation; technology commercialization; Business plan development; Strategy and entrepreneurship; Managing the growing firm.

Recommended Texts:

1. P F Drucker, *Innovation and Entrepreneurship*, 2nd ed, Butterworth-Heinemann, 2007
2. P Burns, J D Hurst, *Small Business and Entrepreneurship*, Palgrave Macmillan, 2001
3. P N Singh, *Entrepreneurship for Economic Growth*, Vikas Publishing
4. J B Miner, *Entrepreneurial Success*, Berrett-Koehler Publishers, 1996

CMS-202 Engineering Economics

Contact Hours:

Theory = **32**

Practical = **0**

Total = **32**

Credit Hours:

Theory = **2.0**

Practical = **0.0**

Total = **2.0**

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 basic knowledge of engineering economics and conventions.	Cognitive	2	1
2.	**DEVELOP** the cash flow diagrams based on the time value of money.	Cognitive	3	3
3.	**SOLVE** economics problems involving comparison and selection of alternatives by using a variety of analytical & computational techniques.	Cognitive	3	5
4.	**DESCRIBE** the concepts of depreciation and depletion and their role in income tax, capital gain tax, etc.	Cognitive	2	12

Course Contents:

Principles of Engineering Economy; Cost Concepts and Design Economics; Time Value of Money; Applications of Time-Money Relationships (MARR, PW, FW, AW, IRR, ERR and Payback period methods); Comparison Methods; Depreciation; Cost Estimation Techniques; Replacement Analysis; Taxes; Inflation.

Recommended Texts:

1. WG Sullivan, J A Bontadelli, E M Wicks, *Engineering Economy*, 14th ed, Prentice Hall, 2000
2. J Knutson, I Bitz, *Project Management: How to Plan and Manage Successful Projects*, American Management Association, 1991
3. C S Park, Gunter, Sharp-Bette, *Advanced Engineering Economics*, 10th ed., John Wiley & Sons Inc., 1990

CMS-301 Principles of Management

Contact Hours:

Theory = **32**

Practical = **0**

Total = **32**

Credit Hours:

Theory = **2.0**

Practical = **0.0**

Total = **2.0**

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 basic knowledge of management principles.	Cognitive	2	11
2.	**APPLY** the management principles for process analysis and product design.	Cognitive	3	11
3.	**ANALYZE** a total system approach to planning and controlling the supply chain.	Cognitive	3	6
4.	**DESCRIBE** different decision making styles and **EXPLAIN** the qualities of leadership.	Cognitive	2	8

Course Contents:

Introduction to Management and Organizations; Organizational Vision, Mission and Strategies; Organizational Culture; Socially Responsible Organizations; Foundations of Planning; Planning Tools and Techniques; Organizational Structure and Design; Human Resource Management; Foundations of Behavior; Leadership and Motivation; Operations and Value Chain Management; Performance Management; Project Portfolio Management System; Project Networks; Scheduling; Resource Allocation and Resource Leveling; Project Execution and Controlling; Introduction to PMBOK.

Recommended Texts:

1. C F Gray, E W Larson, *Project Management: The Managerial Process*, Boston: McGraw-Hill/Irwin, 2005
2. S P Robbins, M Coulter, *Management*, 10th ed, Prentice Hall, 2008
3. *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*, 4th ed, Project Management Institute

NATURAL SCIENCES

PAM-131T Engineering Physics

Contact Hours:
Theory = **48**
Practical = **0**
Total = **48**

Credit Hours:
Theory = **3.0**
Practical = **0.0**
Total = **3.0**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**DESCRIBE** key concepts of units and measurements (standards, conversions, significant figures, etc)	Cognitive	2	1
2.	**DESCRIBE** the basics of waves and light propagation along with associated physical quantities and phenomena.	Cognitive	2	1
3.	**SOLVE** problems of dynamics of particles and rigid bodies moving at constant acceleration.	Cognitive	3	2

Course Contents:

Measurement, Motion in a plane, forces and equilibrium, Newton's laws, Applications of Newton's law, Rotation, Torque, Rigid bodies and rotational dynamics, Work and potential energy, Collisions and conservation laws, Universal gravitation, Sound waves, Waves & Oscillations, Simple harmonic motion, Wave speed, Energy and power of Traveling waves, Doppler's effect, Nature and propagation of light.

Recommended Texts:

1. R Resnik, D Halliday, K S Krane, *Physics, Vol-1 & 2*, John Wiley & Sons Inc., 2007
2. R A Serway, *Physics, Vol1, Physics for Scientists & Engineers with Modern Physics*, Saunders College, Publishing, Philadelphia, 2007
3. H D Young, R A Freedman, TR Sandin, AL Ford, *University Physics*, Addison-Wesley, 2006

PAM-131L Engineering Physics (Lab)

Contact Hours:
Theory = **0**
Practical = **48**
Total = **48**

Credit Hours:
Theory = **0.0**
Practical = **1.0**
Total = **1.0**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**PERFORM** experiments in mechanics, waves and oscillations, etc., as per instructions.	Psycho-motor	3	2

Course Contents:

Experiments related to concepts learned in theory classes will be conducted.

Recommended Texts:

- Lab Manuals

PAM-101 Calculus – I

Contact Hours:

Theory = **48**

Practical = **0**

Total = **48**

Credit Hours:

Theory = **3.0**

Practical = **0.0**

Total = **3.0**

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 mathematics used in this course.	Cognitive	1	1
2.	**APPLY** concepts of Calculus of one variable like limits, continuity, rates of change and integration.	Cognitive	3	1
3.	**CALCULATE** derivatives and integrals of basic and some complex functions.	Cognitive	4	2
4.	**APPLY** the mathematical concepts on real world problems.	Cognitive	3	2

Course Contents:

Functions, Limits and Continuity; Derivatives and its Applications; Rules of Differentiation; Implicit Differentiation; Extreme Values of Functions; Mean Value Theorem; Linearization and Differentials; Newton's Method; Integration and its Applications; Indefinite integrals; Rules of Integration; Riemann Sum; Definite Integrals; Improper Integrals; Integration by Parts; Partial Fractions; Trigonometric Substitution; L Hospital Rule; First Order Differential Equations; Linear Equation with Variable Coefficients; Separable Equations; Exact Equation and Integrating Factor; The Existence and Uniqueness Theorem; Infinite Series; Limits of Sequence of Numbers; Series of Non-negative Terms; Power Series; Taylor and Maclaurin Series; Application of Power Series; Fourier Series; Fourier Cosine and Sine Series.

Recommended Texts:

1. G B Thomas, R L Finney, *Calculus and Analytic Geometry*, AWL, 10th ed, 2002
2. E Kreyszig, *Advance Engineering Mathematics*, John Wiley and Sons, 9th ed, 2005.
3. W Kaplan, *Advanced Calculus*, 5th ed, Addison-Wesley, 2002.
4. R Ellis, D Gulick, *Calculus: One and Several Variables*, Saunders College Pub, 1991.

PAM-202 Calculus – II

Contact Hours:
Theory = **48**
Practical = **0**
Total = **48**

Credit Hours:
Theory = **3.0**
Practical = **0.0**
Total = **3.0**

Prerequisite Course: **PAM-201 Calculus – I**

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 mathematics used in this course.	Cognitive	1	1
2.	**APPLY** concepts of Calculus like limits, continuity, rates of change and integration for multi-variable functions.	Cognitive	3	1
3.	**CALCULATE** derivatives and integrals of basic and some complex functions.	Cognitive	4	2
4.	**APPLY** the mathematical concepts on real world problems.	Cognitive	3	2

Course Contents:

Infinite Series; Limits of Sequence of Numbers; Series of Non-negative Terms; Power Series; Taylor and Maclaurin Series; Application of Power Series; Fourier Series; Fourier Cosine and Sine Series; Vectors in the Plane and Polar Functions; Dot Products; Vector Valued Functions; Modelling Projectile Motion; Polar Coordinates and Graphs; Calculus of Polar Curves; Vectors and Motion in Space; Cartesian Coordinates and Vectors in Space; Dot and Cross Product; Lines and Plane in Space; Cylinders and Quadric Surfaces; Vector Valued Functions and Space Curves; Arc Length and Unit Tangent Vector; Multivariable Functions and Their Derivatives; Limits and Continuity in Higher Dimensions; Partial Derivatives; The Chain Rule; Linearization and Differentials; Extreme Values and Saddle Points; Lagrange Multiplier; Partial Derivatives with Constrained Variables; Taylor's Formula for Two variables; Multiple Integrals; Double integrals; Areas, Moments and Center of Mass; Double Integral in Polar and Rectangular Coordinates; Masses and Moments in Three Dimensions; Triple Integrals in Rectangular and Spherical Coordinates; Integration in Vector Field; Work, Circulation and Flux; Path Independence; Potential Functions and Conservative Fields; Green's Theorem in Planes; Surface Area and Surface Integrals; Parameterized Surface; Stokes Theorem; Divergence Theorem and Unified Theory.

Recommended Texts:

1. G B Thomas, R L Finney, *Calculus and Analytic Geometry*, AWL, 10th ed, 2002.
2. E Kreyszig, *Advance Engineering Mathematics*, John Wiley and Sons, 9th ed, 2005.
3. W Kaplan, *Advanced Calculus*, Addison-Wesley, 5th ed, 2002.
4. R Ellis, D Gulick, *Calculus: One and Several Variables*, Saunders College Pub, 1991.

PAM-247 Elementary Linear Algebra and Differential Equations

Contact Hours:

Theory = **64**

Practical = **0**

Total = **64**

Credit Hours:

Theory = **4.0**

Practical = **0.0**

Total = **4.0**

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.	**EXPLAIN** concepts of matrices, determinant, linear transformations, linear systems, vector spaces and solution to ODEs.	Cognitive	2	1
3.	**APPLY** the learned concepts on real world problems.	Cognitive	3	2

Course Contents:

An introduction to the basic concepts of linear algebra, matrices, determinants, elementary row operations, system of linear equations, vector spaces and linear transformations, eigenvalues and eigen vectors. Ordinary differential equations, homogeneous and non-homogenous second and higher order differential equations, methods of variation of parameters, systems of first order differential equation; Laplace transforms and its applications to solve initial value problems, series solution of differential equations, applications to physical, engineering and life sciences.

Recommended Texts:

1. M R Boelkins, L G Jack, M C Potter. *Differential Equations with Linear Algebra,* Oxford University Press, Oxford, 2009
2. C H Edwards, D E Penney, *Elementary Differential Equations*, 6th ed., Pearson Prentice Hall, New Jersey, 2007
3. D C Lay, *Linear Algebra and its Applications,* 4th ed., Pearson, Cambridge, 2011

PAM-267 Probability and Statistics

Contact Hours:

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

Credit Hours:

Theory = **2.0**
Practical = **0.0**
Total = **2.0**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**DESCRIBE** basic concepts of statistics, difference between descriptive and inferential statistics and sampling techniques.	Cognitive	2	1
2.	**ANALYZE** data to determine measures of central tendency and measures of dispersion.	Cognitive	4	2
3.	**DESCRIBE** concepts of probability, Bayes theorem and types of probability distributions.	Cognitive	2	1
4.	**EXPLAIN** hypothesis testing and **USE** different tests for statistical significance.	Cognitive	3	2

Course Contents:

Basic concepts of statistics; difference between descriptive and inferential statistics; sampling techniques; collection, organization and presentation (bar charts, pie charts, histograms, etc.) of data; rounding of data and significant figures; Measures of central tendency (mean, median, mode, percentile, decile, quartiles, etc.); Measures of dispersion (range, mean deviation, standard deviation, variance, etc.); Skewness and Kurtosis; Probability and Conditional Probability; Dependent and Independent Events; Mutually Exclusive Events; Probability Distributions; Binomial, Normal and Poisson Distribution; Statistical significance and hypothesis testing, confidence interval, tests for statistical significance (chi-square, student T-test, Z-test, etc.); Error analysis and error propagation, least square fit.

Recommended Texts:

1. W DeCoursey, *Statistics & Probability for Engineering Applications,* Newnes, 2003
2. T T Soong, *Fundamentals of Probability & Statistics for Engineers,* John Wiley & Sons, 2004

PAM-360 Numerical Methods

Contact Hours:

Theory = **48**

Practical = **0**

Total = **48**

Credit Hours:

Theory = **3.0**

Practical = **0.0**

Total = **3.0**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**DESCRIBE** theoretical & practical concepts behind different numerical methods	Cognitive	2	1
2.	**APPLY** learned numerical methods to solve different problems	Cognitive	4	2
3.	**DEVELOP** skills for design and implementation of various numerical algorithms.	Cognitive	3	5

Course Contents:

Floating point number system; Sources of errors; Error definitions and analysis; Taylor's theorem; Solutions of equations of one variable; Interpolation and polynomial approximation; Numerical differentiation and integration; Iterative methods for system of linear equations; Approximating eigenvalues; Numerical solution of ordinary and partial differential equations.

Recommended Texts:

1. E Kreyszig, *Advanced Engineering Mathematics*, 9th ed, John Wiley & Sons, 2005.
2. R L Burden, J D Faires, *Numerical Methods*, 3rd ed, PWS, 2002
3. R L Burden, J D Faires, *Numerical Analysis*, 7th ed, Brooks Cole, 2001.

CHE-200T Applied Chemistry

Contact Hours:
Theory = **32**
Practical = **0**
Total = **32**

Credit Hours:
Theory = **2.0**
Practical = **0.0**
Total = **2.0**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**COMPREHEND** key concepts of bonding, crystals, thermodynamics, chemical equilibrium & kinetics, phase equilibrium and phase rule.	Cognitive	2	1
2.	**APPLY** these concepts for metallurgy of copper, aluminum, iron & steel manufacturing, fabrication of polymers, resins, plastics & elastomers, composites, ceramics and refractories.	Cognitive	3	1
3.	**APPLY** learned concepts in battery industry, corrosion, coating & lubricants, fuel & combustion and pollution control.	Cognitive	3	2
4.	**APPLY** knowledge of physical chemistry for analyzing chemical substances using instrumental technique	Cognitive	3	2

Course Contents:

Atomic and molecular structure; Thermodynamics; Chemical equilibrium and dynamics; Phase equilibrium and phase rule; Polymers, Resins, Plastics and elastomers; Composite materials; Metallurgy of copper, iron and aluminum etc; Steel manufacturing; Crystal structures; Structures of solids; Ceramics; Refractories; Electrochemistry; Battery and battery technologies; Corrosion; Lubricants; Protective coating; Fuel and combustion; Environmental chemistry and pollution control; Instrumental techniques in chemistry.

Recommended Texts:

1. S S Dara, S Chand, *A textbook of Engineering Chemistry*, S Chand & Co., 2005
2. Salahuddin, *Chemistry for Engineers*, National book Foundation, 1985
3. Maron, Landau, *Fundamentals of Physical Chemistry,* Macmillan, 1974

CHE-200L Applied Chemistry (Lab)

Contact Hours:
Theory = **0**
Practical = **48**
Total = **48**

Credit Hours:
Theory = **0.0**
Practical = **1.0**
Total = **1.0**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**PERFORM** experiments in analytical chemistry, polymers & polymer matrix composites as per instructions.	Psycho-motor	3	2

Course Contents:

The experiments in this course are based on various topics taught in theory lectures.

Recommended Texts:

- Lab Manuals

COMPUTING

CIS-104T Computer Fundamentals

Contact Hours:

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

Credit Hours:

Theory = **2.0**
Practical = **0.0**
Total = **2.0**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**COMPREHEND** basics of computers and computer programming.	Cognitive	2	1
2.	**COMPREHEND** fundamental programming concepts such as variables, functions, arrays, if-else, file handling, loops.	Cognitive	2	1

Course Contents:

Fundamentals of computer hardware and software; introduction to programming in C; data types; input and output operators; arithmetic operators; operator precedence; relational operators; conditional statements (if, if-else, and switch statements); loop statements (for, while, do-while statements); pointers; file handling and structures.

Recommended Texts:

1. R Lafore, *Waite Group's Turbo C Programming for the PC*, Revised ed, Sams Pub., 1990
2. B S Gottfried, *Schaum's Outline of Programming with C*, McGraw Hill, 2nd Edition, 1996.

CIS-104L Computer Fundamentals (Lab)

Contact Hours:

Theory = **0**
Practical = **48**
Total = **48**

Credit Hours:

Theory = **0.0**
Practical = **1.0**
Total = **1.0**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
3.	**APPLY** programming skills to write basic level programs.	Cognitive	3	2
4.	**TRANSLATE** problems into programs and solve them.	Cognitive	5	5

Course Contents:

In the lab part, students will be writing computer programs that cover all the topics covered in lectures and solve relevant problems in science and engineering.

Recommended Texts:

1. R Lafore, *Waite Group's Turbo C Programming for the PC*, Revised ed, Sams Pub., 1990
2. B S Gottfried, *Schaum's Outline of Programming with C*, McGraw Hill, 2nd Edition, 1996.

MECHANICAL ENGINEERING COURSES

ME-101T Engineering Drawing and Graphics

Contact Hours:
Theory = **32**
Practical = **0**
Total = **32**

Credit Hours:
Theory = **2.0**
Practical = **0.0**
Total = **2.0**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**ACQUIRE** the basic knowledge of drawing & graphics.	Cognitive	1	1
2.	**UNDERSTAND** the concepts of basic drawing techniques.	Cognitive	2	1

Course Contents:

Introduction, Types of lines, lettering, dimensioning, use of pencil and drawing instruments, planning of drawing sheet; Types of projections, orthographic projections, plane of projections, quadrants, projection of points and straight lines, examples with different quadrants, traces of a line, true length of a line, inclination to the planes, projection of oblique and auxiliary planes; Loci of points and generated curves. Loci of points and straight lines. cycloid, epicycloid, involute, Archemedian spiral; development of solids. types of solids: polyhedra, solids of revolution, prism, pyramid, cylinder, cone, sphere; intersection of surfaces. Intersection of various solids; projection of solids. projection of various solids in simple position and inclined positions; section of solids, true shape of section on auxiliary plane of various solids.

Recommended Texts:

1. F Giesecke, *Technical Drawing*, 12th ed, Prentice-Hall, 2003
2. Bertoline, Wiebe, Miller, Mohler, Irwin, *Technical Graphics Communication*, 2008

ME-101L Engineering Drawing and Graphics (Lab)

Contact Hours:
Theory = **0**
Practical = **96**
Total = **96**

Credit Hours:
Theory = **0.0**
Practical = **2.0**
Total = **2.0**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**APPLY** the concepts of basic drawing techniques.	Psychomotor	3	1
2.	**CLEARLY DRAW** projections of various mechanical components / assemblies.	Psychomotor	3	1

Course Contents:

Lettering; Geometric constructions of engineering curves; Orthographic projections of various solids; Orthographic projections of machine elements such as nuts, bolts, threads, flanges, bearings, etc. Drawing of assemblies.

Recommended Texts:

- A C Parkinson, *A First Year Engineering Drawing*, Pitman

ME-102 Engineering Mechanics – I (Statics)

Contact Hours:

Theory = **48**

Practical = **0**

Total = **48**

Credit Hours:

Theory = **3.0**

Practical = **0.0**

Total = **3.0**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**COMPREHEND** concepts of scalars & vectors, forces, moments and couples.	Cognitive	2	1
2.	**APPLY** the learned concepts of forces, moments and couples to solve problems of equilibrium in 2-D and 3-D with or without friction.	Cognitive	3	2
3.	**ANALYZE** structures such as plain trusses, frames and machines for reaction forces.	Cognitive	4	2

Course Contents:

Force System. Force, rectangular components, moment, couples, resultant of forces, moments and couples (two and three dimensional systems). Equilibrium. Mechanical systems, isolation and equilibrium equations for two and three dimensional systems. Free body diagram, two force and three force members. Structures. Plane trusses, method of joints, method of sections, frames and machine analysis. Forces in beams and cables. Friction. Types of friction, dry friction, application of friction.

Recommended Texts:

1. R C Hibbler, *Engineering Mechanics: Statics,* 14th ed, Prentice Hall, 2016
2. J L Meriam, L G Kraige*, Engineering Mechanics: Statics,* 7th ed, Wiley, 2012
3. F P Beer, E R Johnston *Vector Mechanics: Statics,* 7th ed, McGraw Hill, 2003

ME-202T Engineering Mechanics – II (Dynamics)

Contact Hours:
Theory = **48**
Practical = **0**
Total = **48**

Credit Hours:
Theory = **3.0**
Practical = **0.0**
Total = **3.0**

Prerequisite Course: **ME-102T Engineering Mechanics – I**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**IDENTIFY** objects in engineering problems to be formulated as particles or rigid bodies.	Cognitive	1	1
2.	**COMPREHEND** concepts of velocity, acceleration, force, etc, of particles and the corresponding angular terms for rigid bodies.	Cognitive	2	1
3.	**SOLVE** a complex mechanism / machine for various planar motion parameters.	Cognitive	3	2

Course Contents:

Kinematics of Particles. Rectilinear motion, curvilinear motion, normal and tangential coordinates, polar coordinates; Kinetics of Particles. Force, mass, and acceleration, equations of motion, kinetic diagrams, rectilinear motion, curvilinear motion. Work and energy, potential energy. Impulse and momentum, conservation of momentum; Plane Kinematics of Rigid Bodies. Angular motion relations, absolute motion, relative velocity, instantaneous center of zero velocity, relative acceleration; Plane Kinetics of Rigid Bodies: Force, mass, and acceleration, equation of motion, translation, fixed axis rotation, general plane motion, work and energy relationship, impulse and momentum equation.

Recommended Texts:

1. R C Hibbler, *Engineering Mechanics: Dynamics*, 14th Prentice Hall, 2016
2. J L Meriam, L G Kraige*, Engineering Mechanics: Dynamics*, 7th ed, Wiley, 2012
3. F P Beer, E R Johnston *Vector Mechanics: Dynamics,* McGraw Hill, 2003

ME-202L Engineering Mechanics – II (Lab)

Contact Hours:
Theory = **0**
Practical = **48**
Total = **48**

Credit Hours:
Theory = **0.0**
Practical = **1.0**
Total = **1.0**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**UNDERSTAND** force and moment equilibrium.	Cognitive	2	1
2.	**UNDERSTAND** effects of friction between various surfaces.	Cognitive	2	1

Course Contents:

Demonstration of force & moment equilibrium, friction between surfaces, etc.

ME-103 Workshop Practice

Contact Hours:

Theory = **0**
Practical = **96**
Total = **96**

Credit Hours:

Theory = **0.0**
Practical = **2.0**
Total = **2.0**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**UNDERSTAND** and **RECOGNIZE** the basic workshop tools and practices.	Cognitive	2	1
2.	**DEVELOP ELEMENTARY SKILLS** for making various simple parts using basic manufacturing tools.	Psycho-motor	3	1
3.	**BEHAVE RESPONSIBLY** regarding the safety of oneself and others.	Affective	3	9

Course Contents:

Fitter Shop: Assembly / disassembly of basic mechanical components, e.g. bearings, keys, belts, etc. Basic Processes in Wood Work Shop: Timber, its defects and preservation methods, different types of wood joints. Basics of Electric Shop: Types and uses of cables. Study of household electrical appliances. Functions of Forge & Foundry Shop: Brief introduction, tools and accessories, furnace types, heat treatment furnaces. Carbon dioxide casting. Machine Shop: Introduction to machine tools, basic lathe operations including turning, facing, screw cutting. Welding: Introduction to soldering, brazing and welding, brief details of gas, and electric arc welding. Students will be assigned practical jobs in various workshops.

Recommended Texts:

1. W A J Chapman, *Workshop Technology Part-I*, 5th ed, Butterworth-Heinemann, 1972
2. H P Schwan, *Electrical Wiring*, McGraw Hill, 1982
3. *Wiring Manual,* Pak Cables Limited.

ME-205 Mechanics of Materials – I

Contact Hours:
Theory = **48**
Practical = **0**
Total = **48**

Credit Hours:
Theory = **3.0**
Practical = **0.0**
Total = **3.0**

Prerequisite Course: **ME-102T Engineering Mechanics – I**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**UNDERSTAND** mechanical properties of materials and their stress-strain behavior.	Cognitive	2	1
2.	**CALCULATE** stresses and strain in mechanical structures.	Cognitive	3	2
3.	**SOLVE** problems related to bending, torsion and deflection in mechanical structures.	Cognitive	4	2

Course Contents:

Introduction to the concept of stress & strain, along with their types & components at a point. Allowable stress and its application to the design of simple connections. Tension and Compression Tests, Stress-Strain Diagrams of Ductile and Brittle materials, Mechanical properties of materials; Shear Stress-Strain Diagram, Saint-Venant's Principle and Principle of Superposition. Elastic Deformation of an Axially Loaded Member, Statically Indeterminate Axially Loaded Member, Thermal Stress, Stress Concentrations, Inelastic Axial deformation and Residual Stress; Torsional Deformation of a Circular Shaft, The Torsion Formula, Power Transmission, Angle of Twist, Statically Indeterminate Torque-Loaded Members, Inelastic Torsion and Residual Stress; Shear and Moment Diagrams, Bending Deformation of a Straight Member, The Flexure Formula, Unsymmetric Bending, Composite Beams, Reinforced Concrete Beams, Curved Beams, Inelastic Bending and Residual Stress; The Shear Formula, Shear Flow in Built Members, Shear Flow in Thin-walled Members; The Elastic Curve, Slope and Displacement by Integration, Discontinuity Functions, Method of Superposition, Statically Indeterminate Beams; Critical Load, Ideal Column with Pin Supports, Columns having various types of supports

Recommended Texts:

1. R C Hibbeler, *Mechanics of Materials*, 8th ed, McGraw Hill, 2011
2. F P Beer, E R Johnston, *Mechanics of Materials,* 5th ed, McGraw Hill, 2009
3. P P Benham, RJ Crawford, *Mechanics of Engineering Materials,* 2nd ed, Prentice Hall, 1996

ME-305T Mechanics of Materials – II

Contact Hours:
Theory = **48**
Practical = **0**
Total = **48**

Credit Hours:
Theory = **3.0**
Practical = **0.0**
Total = **3.0**

Prerequisite Course: **ME-205 Mechanics of Materials – I**

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 strain energy, virtual work and Castigliano's theorem.	Cognitive	2	1
2.	**ANALYZE** problems of combined loading and two-dimensional stress-strains.	Cognitive	4	2
3.	**UNDERSTAND** the applications of experimental techniques (photo-elasticity, strain gauges).	Cognitive	2	2
4.	**DESCRIBE** theories of failure.	Cognitive	2	1

Course Contents:

Stresses in Thin-Walled Pressure Vessels (cylindrical & spherical), Combined loading; Plane-Stress Transformation using analytical and graphical approach (Mohr's Stress Circle), Principal Stresses, Maximum Shear Stress (In-Plane & Absolute); Plane-Stain Transformation using analytical and graphical approach (Mohr's Strain Circle), Principal Strains, Maximum Shear Strain (In-Plane & Absolute), Strain Rosettes; Theories of Failure of Ductile and Brittle Materials; Basis for Beam Design, Prismatic Beam Design, Fully Stressed Beams, Shaft Design; External Work and Strain Energy, Elastic Strain Energy for Various Types of Loading, Conservation of Energy, Impact Loading, Principle of Virtual Work and Castigliano's Theorem along with their Application to Trusses and Beams; Misc. Topics of Thick Cylinders, Hardness, Toughness, Fatigue, Creep, Introduction to Fracture Mechanics; Theory of electrical resistance strain gauges & photoelastic stress analysis.

Recommended Texts:

1. R C Hibbeler, *Mechanics of Materials*, 8th ed, McGraw Hill, 2011
2. F P Beer, E R Johnston, *Mechanics of Materials,* 5th ed, McGraw Hill, 2009
3. P P Benham, RJ Crawford, *Mechanics of Engineering Materials,* 2nd ed, Prentice Hall, 1996

ME-305L Mechanics of Materials – II (Lab)

Contact Hours:
Theory = **0**
Practical = **48**
Total = **48**

Credit Hours:
Theory = **0.0**
Practical = **1.0**
Total = **1.0**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Level	PLO
1.	**PERFORM** experiments demonstrating various concepts learned in theory lectures.	Psychomotor	3	1
2.	**DEMONSTRATE** use of photo-elasticity & strain gauges	Psychomotor	3	2

ME-302T Mechanics of Machines

Contact Hours:
Theory = **48**
Practical = **0**
Total = **48**

Credit Hours:
Theory = **3.0**
Practical = **0.0**
Total = **3.0**

Prerequisite Course: **ME-202T Engineering Mechanics – II**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**SYNTHESIZE** linkages that follow a simple desired motion.	Cognitive	5	3
2.	**ANALYZE** the motion of cam-followers and gear-trains.	Cognitive	4	2
3.	**ANALYZE** the forces acting on a system which relate to the dynamic behavior of a system and use these for prediction of vibrations, shocks and stress distribution.	Cognitive	4	2

Course Contents:

Review of kinematics. Links, joints and mechanisms, kinematics of four-bar and slider-crank mechanisms, two-point & three-point graphical synthesis of four-bar mechanisms. Geometry of gears, conditions for transmission of constant velocity ratio, velocity of sliding, path of contact, arc of contact, interference, compound and reverted gear trains, epicyclic trains, compound epicyclic trains,. Types of cams and followers, motion for a given cam profile. Dynamics of engine mechanism / slider-crank mechanism. Velocity and acceleration of piston, angular velocity, acceleration. Forces and couples transmitted in a direct acting engine, velocity and acceleration diagrams, turning moment diagram, fluctuation of energy and speed. Flywheels, Balancing of rotating and reciprocating masses, balancing of engines.

Recommended Texts:

1. R L Norton, *Design of Machinery,* 5th ed, McGraw Hill, 2011
2. Erdman, Sandor*, Mechanism Design,* 4th ed, Prentice Hall, 2001
3. J Uicker, J Shigley, *Theory of Machines & Mechanisms,* 5th ed, Oxford Univ. Press, 2010

ME-302L Mechanics of Machines (Lab)

Contact Hours:
Theory = **0**
Practical = **48**
Total = **48**

Credit Hours:
Theory = **0.0**
Practical = **1.0**
Total = **1.0**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**EXPLAIN** motion characteristics of various mechanisms	Psychomotor	3	1
2.	**COLLECT** linear & angular displacement data and graphically **DETERMINE** velocity & acceleration for various mechanisms.	Psychomotor	3	2
3.	**EXPLAIN** procedure for balancing a rotating imbalance.	Psychomotor	3	2

Course Contents:

Motion of linkages, gear trains & cam-followers, balancing rotating imbalance.

ME-201 Thermodynamics – I

Contact Hours:

Theory = **48**

Practical = **0**

Total = **48**

Credit Hours:

Theory = **3.0**

Practical = **0.0**

Total = **3.0**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**UNDERSTAND** The difference between working substances (gas and vapors) and techniques to evaluate and plot state characteristics for different thermodynamic processes.	Cognitive	2	1
2.	**UNDERSTAND** the 1st and 2nd laws of thermodynamics as applied to open and close systems.	Cognitive	2	1
3.	**ANALYZE** the performance of power cycles.	Cognitive	3	2

Course Contents:

Basic concepts, system and control volume, working substance, heat and work, state and properties, Thermodynamic process and cycle, First law of thermodynamics, 1st law for a cycle, 1st law for state change, Internal energy, enthalpy, specific heats. Ideal gas laws, equations of state. Properties of pure substances. Phase diagram, use of steam tables. Thermodynamic processes relationship. Constant volume, constant pressure, constant temperature, constant enthalpy and general law processes. Steady state and steady flow process, uniform state and uniform flow processes. Steady flow energy equation and steady flow devices. Second law of thermodynamics, definitions, its applications. Reversible and irreversible processes. Carnot cycle and thermodynamic temperature scale, Concept of entropy and its application to flow and non-flow processes. Enthalpy-entropy diagrams of working fluids. Thermodynamic cycles, efficiencies, and their applications. Idealized P-V and T-S diagrams of cycles. Rankine cycle and its application. Difference between direct and reversed cycles. Concept of open and closed cycles.

Recommended Texts:

1. Y A Cengel, M A Boles, *Thermodynamics, An Engineering Approach,* McGraw Hill, 2007
2. Moran Michael, *Fundamentals of Thermodynamics*, 5th ed, Wiley, 2003
3. Van Wylen, Sonntag, *Fundamentals of Classical Thermodynamics,* 3rd ed, John Wiley & Sons, 1985

ME-207T Thermodynamics – II

Contact Hours:
Theory = **48**
Practical = **0**
Total = **48**

Credit Hours:
Theory = **3.0**
Practical = **0.0**
Total = **3.0**

Prerequisite Course: **ME-201 Thermodynamics – I**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**APPLY** the laws of thermodynamics to the chemical and phase equilibrium, and combustion process.	Cognitive	3	2
2.	**UNDERSTAND** working principles of boilers, nozzles, compressor and steam turbines	Cognitive	2	1
3.	**UNDERSTAND** the classification and thermodynamics of psychometric process	Cognitive	2	1

Course Contents:

Non reacting gas mixtures. Dalton's law and Gibbs-Dalton law, volumetric analysis of gas mixtures, gas mixture constants and specific heats. Adiabatic mixture of perfect gases. Mixture with chemical reaction, simple reaction equation, Stoichiometric chemical reaction, rich & lean air-fuel ratio mixture, enthalpy of formation and reaction. Adiabatic flame temperature. Compressors, classification and working principles, single stage and multistage compressors, inter-cooling, efficiencies and *p-v* diagrams of reciprocating compressors. Velocity diagrams of centrifugal compressors. Performance characteristics & working regimes. Boilers, generation of steam through boilers. Classification and configurations of boilers and their applications. Boiler efficiencies & heat balance sheet. Steam nozzles, flow through steam nozzle & its efficiencies. Steam engine & turbine, their classification working principles, efficiency and heat balance sheet. Introduction to air / gas nozzles.

Recommended Texts:

1. Y A Cengel, M A Boles, *Thermodynamics, An Engineering Approach,* McGraw Hill, 2007
2. Moran Michael, *Fundamentals of Thermodynamics*, 5th ed, Wiley, 2003
3. V Wylen, Sonntag, *Fundamentals of Classical Thermodynamics,* 3rd ed, John Wiley, 1985
4. R Joel, *Basic Engineering Thermodynamic*, 5th ed, Prentice Hall, 1996

ME-207L Thermodynamics – II (Lab)

Contact Hours:
Theory = **0**
Practical = **48**
Total = **48**

Credit Hours:
Theory = **0.0**
Practical = **1.0**
Total = **1.0**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy	PLO
1.	**UNDERSTAND** basic working of different types of engines and their thermodynamic cycles.	Cognitive	2	1
2.	**DETERMINE** performance characteristics of power cycles	Psychomotor	4	2

Course Contents:

Demonstration of working of various engine models. Engines' performance characteristics.

ME-206 Fluid Mechanics – I

Contact Hours:

Theory = **48**

Practical = **0**

Total = **48**

Credit Hours:

Theory = **3.0**

Practical = **0.0**

Total = **3.0**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**CALCULATE** the hydrostatic forces on planar and curved submerged and floating surfaces.	Cognitive	3	2
2.	**APPLY** the principles of conservation of mass, momentum and energy to control volumes.	Cognitive	3	2
3.	**PRESENT** data or governing equations in non-dimensional form, design experiments and perform model studies.	Cognitive	3	3
4.	**SOLVE** for internal flow in pipes and channels using simple solutions of Navier-Stokes equations, the Moody Chart or the head loss equation.	Cognitive	3	3

Course Contents:

Fluid statics. Absolute, gauge and vacuum pressures, difference between static and dynamic pressure. Pressure gradient, manometery and Bourdon gauge, hydrostatic pressure, forces on plane and curved surfaces, buoyancy and stability. Integral relations for a control volume and incompressible flow. Reynold's transport theorem. Bernoulli's theorem, integral conservation equations of mass, linear momentum, angular momentum and energy and their applications. Total and static pressure. Impact of jets on curved surfaces. Differential relations for a fluid particle. Differential equations of mass, linear momentum, angular momentum and energy conservation. Introduction to Navier-Stokes equations, potential flow theory, stream function, stream lines and stream tube. Dimensional analysis, similitude and its applications viscous flow in ducts. Steady, quasi-steady and unsteady flow, underdeveloped and fully developed, laminar and turbulent flow, flow between parallel plates, flow in tubes, losses in pipes, Moody's chart and pumping power.

Recommended Texts:

1. Munson, Young, Okiishi, Huebsch, *Fundamentals of Fluid Mechanics*, 6th ed, John Wiley & Sons, 2009
2. F M White, *Fluid Mechanics,* 6th ed McGraw Hill, 2006
3. I Shames, *Fluid Mechanics*, 4th ed, McGraw Hill, 2002
4. C T Crowe, D F Elger, *Engineering Fluid Mechanics*, 9th ed, Wiley, 2008

ME-301T Fluid Mechanics – II

Contact Hours:
Theory = **32**
Practical = **0**
Total = **32**

Credit Hours:
Theory = **2.0**
Practical = **0.0**
Total = **2.0**

Prerequisite Course: **ME-206 Fluid Mechanics – I**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**APPLY** the boundary layer theory to calculate the drag and lift forces under different flow/geometry conditions.	Cognitive	3	2
2.	**APPLY** the basic compressible flow principles to design 1D converging diverging nozzles.	Cognitive	3	3
3.	**ANALYZE** the performance of various Turbo-machines.	Cognitive	4	2

Course Contents:

Incompressible flow machines, hydraulic turbines, Introduction to hydraulic system, hydraulic fluids, hydraulic circuits, actuators. Hydraulic pumps and motors, their performance characteristics, efficiency and similarity laws. Hydraulic presses, lifts and jacks. Hydraulic cranes, accumulators, and intensifiers. Hydraulic couplings, rams and hydraulic systems of earth-moving machinery. Compressible Flow, mass, momentum and energy conservation equations of compressible flow. Adiabatic, isentropic flow, converging and diverging nozzles and diffusers. Boundary layer flow. Boundary layer equations, flat plate boundary layer, effect of pressure gradient, separation and wake, lift and drag of immersed bodies. Airfoil theory; numerical analysis. introduction to CFD.

Recommended Texts:

1. Munson, Young, Okiishi, Huebsch, *Fundamentals of Fluid Mechanics*, 6th ed, Wiley, 2009
2. F M White, *Fluid Mechanics,* 6th ed McGraw Hill, 2006
3. I Shames, *Fluid Mechanics*, 4th ed, McGraw Hill, 2002
4. C T Crowe, D F Elger, *Engineering Fluid Mechanics*, 9th ed, Wiley, 2008

ME-301L Fluid Mechanics – II (Lab)

Contact Hours:
Theory = **0**
Practical = **48**
Total = **48**

Credit Hours:
Theory = **0.0**
Practical = **1.0**
Total = **1.0**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**CALCULATE** the hydrostatic forces and their point of application to determine the stability of various surfaces and geometries.	Cognitive	2	2
2.	**STUDY** of Bernoulli's theorem and frictional losses in pipes and flow-meters.	Cognitive	2	2
3.	**CALCULATE** Drag, Lift and impact of jet on various surfaces and objects.	Cognitive	2	4
4.	**ANALYZE** the performance of various turbo-machines.	Psychomotor	3	4

ME-303 Manufacturing Processes – I

Contact Hours:

Theory = **48**

Practical = **0**

Total = **48**

Credit Hours:

Theory = **3.0**

Practical = **0.0**

Total = **3.0**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**UNDERSTAND** various manufacturing processes.	Cognitive	2	1
2.	**IDENTIFY** the right type of process & its parameters for performing certain manufacturing.	Cognitive	4	2
3.	**APPLY** effectively various manufacturing techniques / operations in broad spectrum of engineering.	Cognitive	3	3

Course Contents:

Forming & Shaping Processes and Equipment. Rolling. Flat rolling, rolling mills, shapes rolling, production of seam less tubing and piping. Extrusion and Drawing. Hot and cold extrusion, Extrusion and drawing equipment, Hydrostatic extrusion. Sheet Metal Forming. Sheet metal characteristics, formability of sheet metals, bending sheet and plate, tube bending & forming, deep drawing, supper plastic forming, explosive forming, equipment for sheet metal forming. Forming & Shaping Plastics & Composite Materials. Extrusion, injection molding, blow molding, thermo-forming, processing elastomers, processing reinforcer plastics, manufacturing honeycomb material, processing metal matrix and ceramic matrix composites. Joining Process & Equipment. Fusion welding process: Oxy-fuel gas welding, arc welding, electrodes, thermite welding, electron beam welding. Solid State welding process: Cold welding, ultrasonic welding, friction welding, resistance welding. Weld quality weldability, weld design and process selection, brazing, soldering, adhesive bonding, joining plastics. Metal Casting Process & Equipment. Molding and molding sands, classification of foundry process, casting and its types, pattern and pattern making, core and core making, furnaces, crucibles, molding tools and foundry equipment. Powder Metallurgy. Production of metal powders, compaction, sintering, design considerations. Surface Treatment, Coating and Cleaning. Mechanical surface treatment and coating, painting and its testing, thermal spraying, vapor deposition, electroplating and electro-forming, anodizing, hot dipping, surface texturing and cleaning.

Recommended Texts:

1. Kalpakjian, *Manufacturing Engineering and Technology,* 6th ed, Prentice Hall, 2009
2. A J Lissaman, S J Martin, *Principle of Engineering Production,* 3rd ed, Butterworth-Heinemann 1996
3. R A Higgins, *Engineering Metallurgy* 6th ed, Butterworth-Heinemann, 1993
4. Groover, *Fundamentals of Modern Manufacturing,* 3rd ed, John Wiley & Sons, 2007
5. E P Degarmo, *Materials and Processes in Manufacturing,* 10th ed, Wiley, 2007

ME-307T Manufacturing Processes – II

Contact Hours:

Theory = **48**

Practical = **0**

Total = **48**

Credit Hours:

Theory = **3.0**

Practical = **0.0**

Total = **3.0**

Prerequisite Course: **ME-303 Manufacturing Processes – I**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**UNDERSTAND** various machining processes.	Cognitive	2	1
2.	**IDENTIFY** the right type of technique & its parameters for performing certain machining process.	Cognitive	4	2
3.	**APPLY** effectively various machining operations for engineering applications.	Cognitive	3	3

Course Contents:

Material Removal. Mechanics of chips formation, types of chips produced, forces and pressures involved, surface finishing and integrity, machinability. Calculation of material removal rate. Cutting Tools. Single point tool geometry, mill cutters, factors which affect tool life, tool life relationships, tool materials, types and properties of cutting fluids. Machine Processes for Producing Various Shapes. Milling operation, milling machines, planning and shaping, broaching and broaching machines, gear manufacturing machining. Abrasive Machining & Finishing Operations. Abrasive, bonded abrasives (grinding wheels), grinding process, grinding fluids, design considerations for grinding, ultrasonic machining. Non Conventional Machining Process. Machining, electrochemical, electrical–discharge machining, wire EDM Control of Machine Tools. Machine tools control, numerical control system, sequence control, PLC, servo copying, Computerized Numerical Control. (CNC), adaptive control, programming for numerical control Jigs & Fixtures. General design principle, elements of jig, locating devices and clamping devices. Computer Integrated Manufacturing System. Manufacturing system, Computer Integrated Manufacturing (CIM), Computer Aided Manufacturing (CAM), computer simulation of manufacturing process and system, group technology, Flexible Manufacturing System (FMS), Artificial Intelligence (AI), Cellular manufacturing. Introduction to Process Planning

Recommended Texts:

1. Kalpakjian, *Manufacturing Engineering and Technology,* 6th ed, Prentice Hall, 2009
2. A J Lissaman, S J Martin, *Principle of Engineering Production,* 3rd ed, Butterworth-Heinemann 1996
3. R A Higgins, *Engineering Metallurgy* 6th ed, Butterworth-Heinemann, 1993

ME-307L Manufacturing Processes – II (Lab)

Contact Hours:

Theory = **0**

Practical = **48**

Total = **48**

Credit Hours:

Theory = **0.0**

Practical = **1.0**

Total = **1.0**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**APPLY** computer tools to automate manufacturing.	Cognitive	3	5
2.	**UNDERSTAND** working of various machine tools and manufacturing processes.	Psycho-motor	3	1

Course Contents:

This lab mainly comprises using conventional and computer-aided machine tools in addition to some manufacturing processes.

Recommended Texts:

1. Lab manuals

ME-308T Measurements and Instrumentation

Contact Hours:

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

Credit Hours:

Theory = **2.0**
Practical = **0.0**
Total = **2.0**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**UNDERSTAND** the basic concepts related to measurements.	Cognitive	2	1
2.	**UNDERSTAND** the construction, working and applications of various sensors.	Cognitive	2	1
3.	**UNDERSTAND** the use of various measurement devices.	Cognitive	2	5

Course Contents:

Significance of measurement, planning of experiments, general measurement system, calibration, static and dynamic measurement sensitivity, range, accuracy precision, repeatability, and uncertainty of instruments, measurement errors. Instruments for measurement of length, force, torque, frequency, pressure, flow and temperature. Introduction to data acquisition through computers. A/D and D/A converters.

Recommended Texts:

1. E Doeblin*, Measurement Systems Applications and Design*, McGraw Hill, 1975 *
2. R Figliola, D Beasley*, Theory & Design for Mechanical Measurements*, 4th ed, John Wiley, 2005
3. D G Alciatore, M B Histand, *Introduction to Mechatronics & Measurement Systems.*

ME-308L Measurements and Instrumentation (Lab)

Contact Hours:

Theory = **0**
Practical = **48**
Total = **48**

Credit Hours:

Theory = **0.0**
Practical = **1.0**
Total = **1.0**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**CALIBRATE** different measurement devices.	Psychomotor	4	2
2.	**APPROPRIATELY MAKE** common mechanical measurements using available instruments.	Psychomotor	5	4

Course Contents:

Experiments complimenting the theory lectures will be performed.

Recommended Texts:

1. Lab manuals

ME-312T Refrigeration and Air-Conditioning

Contact Hours:

Theory = **32**

Practical = **0**

Total = **32**

Credit Hours:

Theory = **2.0**

Practical = **0.0**

Total = **2.0**

Prerequisite Course: **ME-207 Thermodynamics – II**

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 performance of different refrigeration cycles.	Cognitive	4	2
2.	**UNDERSTAND** different air-conditioning processes and components of air-conditioning systems	Cognitive	2	1
3.	**EVALUATE** the heating and cooling load requirements.	Cognitive	5	3
4.	**DESIGN** of duct networks and selection of HVAC components for a particular load calculation scenario.	Cognitive	6	3

Course Contents:

Introduction, definition and basic terminology. Refrigeration cycles: vapor compression cycle, COP, pressure- enthalpy chart, types of refrigerants, air cycle refrigeration, vapor absorption system. Air conditioning: Indoor and outdoor air conditions, comfort conditions and comfort zone, indoor air quality. psychrometry, 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. Cooling load and heating load calculation procedures, duct sizing and piping design, pumps and fans selection Air ventilation: calculation of fresh air supply of a multi-story building, air handling unit for untreated fresh air, dust and bacteria removal systems, forced convection based air ventilator design.

Recommended Texts:

1. R S Khurmi, J K Gupta, *Textbook of Refrigeration & Air conditioning*, S Chand & Co, 1987
2. G F Hundy, A R Trott, T C Welch, *Refrigeration & Air conditioning*, 4th ed, Butterworth-Heinemann, 2008
3. C P Arora, *Refrigeration & Air conditioning*, 3rd ed McGraw-Hill, 2010
4. P N Ananthanarayanan, *Basic Refrigeration & Air conditioning*, 3rd ed, McGraw-Hill, 2005
5. ASHRAE Handbook

ME-312L Refrigeration and Air-Conditioning (Lab)

Contact Hours:

Theory = **0**
Practical = **48**
Total = **48**

Credit Hours:

Theory = **0.0**
Practical = **1.0**
Total = **1.0**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**UNDERSTAND** basics and application of psychrometry.	Cognitive	2	1
2.	**ANALYZE** the performance of various refrigeration cycles.	Psychomotor	4	2

Course Contents:

This lab-course comprises some simple experiments demonstrating thermodynamics of refrigeration and psychrometry.

Recommended Texts:

1. Lab manuals

ME-315T Machine Design & CAD – I

Contact Hours:
Theory = **32**
Practical = **0**
Total = **32**

Credit Hours:
Theory = **2.0**
Practical = **0.0**
Total = **2.0**

Prerequisite Courses: **ME-101T Engineering Drawing & Graphics**
ME-205 Mechanics of Materials – I

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**UNDERSTAND** the Design Philosophy and Design "Creed"	Affective	1	6, 8
2.	**APPLY** methodology to solve Machine component Design problem.	Cognitive	3	1
3.	**ANALYZE** Designed Machine components.	Cognitive	4	2
4.	**DESIGN** Machine components.	Cognitive	6	3, 9, 10

Course Contents:

Introduction to the Design Philosophy, Factor of Safety, Review of concepts of different types of stresses; Structural Design and Analysis of Power screws; Structural Design and Analysis of Fasteners (temporary and permanent); Structural Metal fits and tolerance; Structural Design, Analysis and Selection of Clutch, Brake and Flywheel.

Recommended Texts:

1. J E Shigley, *Mechanical Engineering Design,* 7th ed, McGraw Hill, 2007
2. R L Norton, *Mechanical Design*, *An Integrated Approach*, 3rd ed, Prentice Hall, 2005
3. M F Spotts, *Design of Machine Elements,* 8th ed, Prentice Hall, 2003

ME-315L Machine Design & CAD – I (Lab)

Contact Hours:
Theory = **0**
Practical = **48**
Total = **48**

Credit Hours:
Theory = **0.0**
Practical = **1.0**
Total = **1.0**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**UNDERSTAND** the basic concepts of CAD tools.	Cognitive	2	1
2.	**APPLY** engineering drawing knowledge for precise and accurate communication of mechanical design.	Cognitive	3	1
3.	**BUILD** solid models using CAD part/assembly modules	Psychomotor	5	2, 5, 12

Course Contents:

Fundamentals of Computer-Aided Drawing, Introduction to Creo® Parametric. Part drawings and assembly drawings.

Recommended Texts:

1. Lab manual

ME-316T Machine Design & CAD – II

Contact Hours:
Theory = **48**
Practical = **0**
Total = **48**

Credit Hours:
Theory = **3.0**
Practical = **0.0**
Total = **3.0**

Prerequisite Courses: **ME-302T Mechanics of Machines**
ME-315T Machines Design & CAD – I

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**APPLYING** methodology to solve machine component design problem.	Cognitive	3	1
2.	**ANALYZING** machine components.	Cognitive	4	2
3.	**DESIGN** machine components.	Cognitive	6	3, 9, 10

Course Contents:

Codes and Standards; Structural Design and Analysis of Shafts and Miscellaneous shaft components; Structural Design and Analysis of Springs; Structural Design and Analysis of Gears; Design and Analysis of Belts, Chains and ropes; Design, Analysis and selection of Bearings.

Recommended Texts:

1. J E Shigley, *Mechanical Engineering Design,* 7th ed, McGraw Hill, 2007
2. R L Norton, *Mechanical Design*, *An Integrated Approach*, 3rd ed, Prentice Hall, 2005
3. M F Spotts, *Design of Machine Elements,* 8th ed, Prentice Hall, 2003

ME-316L Machine Design & CAD – II (Lab)

Contact Hours:
Theory = **0**
Practical = **48**
Total = **48**

Credit Hours:
Theory = **0.0**
Practical = **1.0**
Total = **1.0**

Prerequisite Course: **ME-315L Machine Design & CAD – I (lab)**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**ANALYZE** an assembly / mockup for interference and clearance.	Psycho-motor	4	2, 5
2.	**EVALUATE** a mechanism for dynamic properties of the mechanical assembly.	Psycho-motor	5	3, 5

Course Contents:

Assembly drawing, mockups, creating 2D drawings from 3D part / assembly, Mechanism module, Introduction to Computer-Aided Manufacturing (CAM), Introduction to finite element analysis (static analysis).

Recommended Texts:

1. Lab manual

ME-403T Heat Transfer

Contact Hours:

Theory = **48**

Practical = **0**

Total = **48**

Credit Hours:

Theory = **3.0**

Practical = **0.0**

Total = **3.0**

Prerequisite Courses: **ME-201 Thermodynamics – I**
ME-206 Fluid Mechanics – I

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	Mathematically **DESCRIBE** 1-D conduction heat transfer problems in Cartesian, cylindrical and spherical coordinates using governing equations along with boundary and initial conditions and **SOLVE** them.	Cognitive	3	2
2.	**DESCRIBE** and **SOLVE** simple forced and free convection based engineering heat transfer problems using governing equations as well as non-dimensional criteria, such as Reynolds number, Nusselt number, Rayleigh number, etc.	Cognitive	3	2
3.	Mathematically **DESCRIBE** radiative heat transfer including black-body radiation and Kirchhoff's law, and be able to **SOLVE** radiative problems involving view factors and radiative exchange between surfaces.	Cognitive	3	2
4.	**DETERMINE** engineering design quantities (power, requirements, insulation thickness, thermal conductivity, exchanger size, etc) required for design of thermal engineering devices & systems such as heat exchangers etc.	Cognitive	5	3, 5

Course Contents:

Conduction, Heat equation, Fourier's law, one dimensional steady state heat conduction through plane and composite walls, cylinders and spheres with and without heat generating sources. Conduction heat transfer through extended surfaces, transient conduction, heat transfer lumped capacitance method. Convection, Newton's law of cooling, boundary layer, Natural (free) and forced convection heat transfer. Coefficient of heat transfer for free and forced convection, Effect of laminar, transition and turbulent flow on coefficient of heat transfer, flow over flat plates. Heat transfer through pipes and ducts flows. Critical thickness of insulation, Non-dimensional parameters related to heat transfer and their applications. Shear stress, friction coefficient for fully developed flow. Reynolds analogy. Radiation, Stefan Boltzmann's law, black-body radiation, absorptivity, reflectivity, transmissivity. Wien's law, Kirchhoff's law, gray-body radiation. Radiation shape factor and its applications. Heat Exchangers. Classification, overall heat transfer co-efficient. LMTD and NTU methods.

Recommended Texts:

1. Incropera, Dewitt, *Fundamentals of Heat and Mass Transfer,* 6th ed, Wiley, 2006
2. Y A Cengel, *Heat Transfer – A Practical Approach,* 3rd ed, McGraw Hill, 2006
3. J P Holman, *Heat Transfer,* 10th ed, McGraw Hill, 2009

ME-403L Heat Transfer (Lab)

Contact Hours:

Theory = **0**

Practical = **48**

Total = **48**

Credit Hours:

Theory = **0.0**

Practical = **1.0**

Total = **1.0**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**IDENTIFY** conduction heat transfer characteristics using Fourier law of heat conduction.	Cognitive	2	2
2.	**EVALUATE** heat exchanger design using temperature and flow rate data.	Cognitive	5	3
3.	**ANALYZE** radiative heat transfer characteristics.	Cognitive	4	2

Course Contents:

Various experiments covering conduction, convection, radiation and heat exchangers will be carried out.

Recommended Texts:

1. Lab manuals

ME-407 Mass Transfer

Contact Hours:

Theory = **32**

Practical = **0**

Total = **32**

Credit Hours:

Theory = **2.0**

Practical = **0.0**

Total = **2.0**

Prerequisite Course: **ME-403T Heat Transfer**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**UNDERSTAND** the principles of diffusive and convective mass transfer and develop and **SOLVE** governing equations for simple 1-D steady state systems along with boundary conditions.	Cognitive	2	2
2.	**UNDERSTAND** the principles of inter-phase mass transfer and their use in design of mass transfer equipment.	Cognitive	2	3
3.	**UNDERSTAND** heat & mass transfer analogies including their limitations.	Cognitive	2	1

Course Contents:

Introduction to Mass transfer and Mass-Transfer Operations, Classification of the Mass-Transfer Operations and Choice of Separation Method, Diffusion and Mass Transfer, Molecular Diffusion in Fluids, Steady-State Molecular Diffusion in Fluids at Rest and in Laminar Flow, Convection Mass Transfer and Concept of Mass-Transfer Coefficients, Mass-Transfer Coefficients in Laminar and Turbulent Flow, Mass-, Heat-, and Momentum-Transfer Analogies, Mass-Transfer Data for Simple Situations, Simultaneous Mass and Heat Transfer Diffusion in Solids, Fick's-Law Diffusion, Types of Solid Diffusion

Recommended Texts:

1. F P Incropera, D P DeWitt, *Fundamentals of Heat and Mass Transfer* 3rd ed. John Wiley & Sons, 1990
2. R E Treybal, *Mass Transfer Operations*, McGraw Hill Book Company, 1983
3. Y A Cengel, *Heat and Mass Transfer – A Practical Approach*, 3rd ed, McGraw Hill Book Company, 2007

ME-405T Mechanical Vibrations

Contact Hours:

Theory = **32**

Practical = **0**

Total = **32**

Credit Hours:

Theory = **2.0**

Practical = **0.0**

Total = **2.0**

Prerequisite Course: **ME-202T Engineering Mechanics – II (Dynamics)**

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 vibrating systems for one/two Degree of Freedom.	Cognitive	3	1
2.	**ANALYZE** the physical parameters involved in natural frequency and system response to free and forced inputs.	Cognitive	4	2
3.	**EVALUATE** the dynamic response of a vibrating system by measuring and analyzing its vibration parameters.	Cognitive	5	5

Course Contents:

Oscillatory motion. Elements of vibrating system, Harmonic motion, periodic motion, vibration terminology. Single degree of freedom systems. Equation of motion: Newton's method, energy method, undamped free vibration, viscously damped free vibration, logarithmic decrement, harmonically excited vibration, vibration isolation, vibration measuring instruments. Two degree of freedom systems. Normal modes of vibration, coordinate coupling, forced harmonic vibration, vibration absorber, vibration damper. Orthogonality conditions. Vibration of Elastic Bodies. Free and forced vibration of cables and uniform bars, free and forced lateral vibrations of simply supported thin beams, torsional vibration of circular shafts with single rotor and two rotors, critical speed of rotating shafts. Finding natural frequencies: Rayliegh method and Holzer method.

Recommended Texts:

1. W T Thompson, *Mechanical Vibrations: Theory & Applications,* Prentice Hall. 5th ed, 1997
2. S S Rao, *Mechanical Vibrations,* 4th ed, Prentice Hall, 2003
3. L Meirovitch, *Elements Of Vibration Analysis*, 2nd ed, McGraw Hill, 1986
4. E Dimaogonas, *Vibration for Engineers*, 2nd ed, Prentice Hall, 1996

ME-405L Mechanical Vibrations (Lab)

Contact Hours:

Theory = **0**

Practical = **48**

Total = **48**

Credit Hours:

Theory = **0.0**

Practical = **1.0**

Total = **1.0**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**UNDERSTAND** practically the concept of Natural Frequency and stiffness in different lab experiments.	Cognitive	1	1
2.	**ANALYZE** the dynamic response under different damping conditions used in lab experiments.	Cognitive	4	2
3.	**RELATE** the dynamic response to the daily life observations.	Psycho-motor	1	6, 7,12

Course Contents:

The experiments in this lab complement the knowledge gained in theory lectures.

Recommended Texts:

1. Lab manuals

ME-411 Power Plants

Contact Hours:
Theory = **32**
Practical = **0**
Total = **32**

Credit Hours:
Theory = **2.0**
Practical = **0.0**
Total = **2.0**

Prerequisite Course: **ME-201 Thermodynamics – I**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**REVIEW** different energy resources, environmental impacts of power generation and flue gas cleaning techniques.	Cognitive	2	7
2.	**ANALYZE** strengths and weaknesses of different types of power plants by performing its thermodynamic calculations.	Cognitive	4	2
3.	**DESIGN** of the major components or systems of a conventional or alternative energy power plant.	Cognitive	5	3

Course Contents:

Thermodynamics of Conventional Power Plants, fossil fuel steam generator, Brayton cycle, Open and closed cycle power plants, combined cycle power plants, Combustion chamber configuration, Fuel injection system, combustion, flame stabilization. Gas turbine and jet engine power plants, Diesel engine power plant Combined heat and power plants (CHP), Hydro-electric power plants. Nuclear Power Plants.

Recommended Texts:

1. M M El Wakil, *Power Plant Technology,* McGraw Hill, 2002
2. F T Morse, *Power plant,* Von Nostrand Inc, 1950 *

ME-412 Internal Combustion Engines

Contact Hours:

Theory = **48**

Practical = **0**

Total = **48**

Credit Hours:

Theory = **3.0**

Practical = **0.0**

Total = **3.0**

Prerequisite Course: **ME-201 Thermodynamics – I**

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 knowledge, construction and working of various types of IC engines and its components.	Cognitive	2	1
2.	**SOLVE** numerical problems related to the design and operation of IC engines.	Cognitive	3	2
3.	**ANALYZE** the effect of engine operating parameters on engine performance and environmental effects of emissions.	Cognitive	4	4, 7

Course Contents:

Engine classification, Combustion, real engine cycle. Working principles of SI and CI engines, Ignition delay and combustion phases. Testing and performance characteristics of petrol and diesel engines under variable condition of load and speed. Knocking characteristics, Octane and Cetane numbers, engine valve timing and ignition advance and retard, Pressure-crank angle diagram. Working principle of turbo- charged engine, its performance characteristics and comparison with naturally aspirated engine of equal power. Engine emissions and their control through in-cylinder and out-cylinder techniques. Exhaust gas recirculation (EGR) system. Thermal reactor and catalytic converters. Trade off of NOx and HC emissions. Fuel injected petrol engine and its performance, advantages over conventional petrol engine. Engine performance under part cut-out conditions and fuel savings Introduction to duel fuel / multi fuel engines, CNG engines. Engine lubrication and lubricants, fuel additives.

Recommended Texts:

1. J B Heywood, *Internal Combustion Engine Fundamentals,* McGraw Hill, 1989.
2. R Stone, *Introduction to I. C. Engines,* 2nd ed, SAE Inc, 1993

ME-413 Renewable Energy Resources

Contact Hours:

Theory = **32**

Practical = **0**

Total = **32**

Credit Hours:

Theory = **2.0**

Practical = **0.0**

Total = **2.0**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**STATE** alternative energy resources for engineering applications available in Pakistan and around the world.	Cognitive	1	1
2.	**UNDERSTAND** usage of renewable energy sources for power generation.	Cognitive	2	3
3.	**SELECT** proper renewable energy source based on geographical location.	Cognitive	3	7

Course Contents:

Introduction to types of renewable energy, solar energy, wind energy, geothermal energy, ocean thermal energy, tidal wave and geothermal energy, biomass energy. Fuel cell and heat pump systems, energy efficiency issues and energy storage. Potential of using renewable energy resources as supplement of conventional energy resources. Renewable and non-renewable energies used as hybrid energy systems, Modern renewable energy plants. Wind energy, wind turbine design specifications, compatible electric generators and major operational issues of the wind mill for electric power generation. Wind mills design usage for pumping water. Biomass energy conversion methods, detailed description of biomass energy conversion plant, operational and maintenance problems and their remedies.

Recommended Texts:

1. G Boyle, *Renewable Energy*, 2nd ed, Oxford University Press, 2004
2. J Twidell, T Weir, *Renewable Energy Resources*, 2nd ed, Spon Press, 2005

ME-408 Total Quality Management

Contact Hours:

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

Credit Hours:

Theory = **2.0**
Practical = **0.0**
Total = **2.0**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**UNDERSTAND** the fundamental principles and historic foundations of total quality management practices.	Cognitive	2	1
2.	**APPLY** the six sigma principles.	Cognitive	3	11
3.	**EVALUATE** process improvements using TQM tools.	Cognitive	5	11

Course Contents:

Fundamental principles; Standards; Techniques for quality analysis and improvements; Statistical methods and statistical process control (SPC); Acceptance sampling; Quality function deployment (QFD); Value engineering; Cross-functional management and benchmarking; ISO9000: application; classes and implementation issues.

Recommended Texts:

1. W J Stevenson, *Production / Operations Management*, 11th ed., McGraw-Hill, 2011
2. A Mitra, *Fundamentals of Quality Control & Improvement*, 3rd ed., Wiley, 2008
3. D L Montgomery, *Introduction to Statistical Quality Control*, 6th ed., Wiley, 2008
4. D H Beserfield, *Total Quality Management*, 3rd ed., Pearson Education Inc, 2003
5. A V Feigenbaum, *Total Quality Control*, McGraw Hill, 1991

ME-499A Design Project

Contact Hours:

Theory = **0**

Practical = **144**

Total = **144**

Credit Hours:

Theory = **0.0**

Practical = **3.0**

Total = **3.0**

Course Learning Outcomes:

Upon successful completion, the student will be able to:

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**UNDERSTAND** & **FORMULATE** the mechanical engineering problem and provide an engineering solution.	Cognitive	2	2
2.	**ACQUIRE** engineering knowledge and **APPLY** it to design components, systems and / or processes to meet required parameters.	Cognitive	3	3
3.	**COMMUNICATE** effectively engineering design details through a technical report and oral presentations.	Affective	4	10
4.	**DISPLAY MOTIVATION** for acquiring extra technical knowledge in order to solve real life problems.	Affective	5	12
5.	**PLAN**, **MANAGE** & **IMPLEMENT** the project as part of a team and fulfill his individual responsibilities.	Psycho-motor	7	9

Course Contents:

Students are required to select a design project. The project can be to solve a problem being faced in industry or it may be oriented towards designing a product. The project can also be motivated from a research problem taken from literature. At the end of 7th semester, students will have to submit a preliminary report of the project and have to clear a viva voce examination.

Recommended Texts:

- As advised by the Project Supervisor

ME-499B Design Project

Contact Hours:

Theory = **0**
Practical = **144**
Total = **144**

Credit Hours:

Theory = **0.0**
Practical = **3.0**
Total = **3.0**

Course Learning Outcomes:

Upon successful completion, the student will be able to:

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**ACQUIRE** engineering knowledge and **APPLY** it to design components, systems and / or processes to meet required parameters.	Cognitive	3	3
2.	**COMMUNICATE** effectively engineering design details through a technical report and oral presentations.	Affective	4	10
3.	**DISPLAY MOTIVATION** for acquiring extra technical knowledge in order to solve real life problems.	Affective	5	12
4.	**ANALYZE** & **INVESTIGATE** the engineering design problem.	Cognitive	6	4
5.	**PLAN**, **MANAGE** & **IMPLEMENT** the project as part of a team and fulfill his individual responsibilities.	Psycho-motor	7	9

Course Contents:

Students will continue their work in the 8th semester. The final evaluation will be based on Project Report and viva voce.

Recommended Texts:

- As advised by the Project Supervisor

INTER-DISCIPLINARY COURSES

MME-203 Introduction to Engineering Materials

Contact Hours:

Theory = **48**
Practical = **0**
Total = **48**

Credit Hours:

Theory = **3.0**
Practical = **0.0**
Total = **3.0**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**EXPLAIN** and **GIVE EXAMPLES** of different types of engineering materials based on bonding, crystal structure and mechanical properties.	Cognitive	2	1
2.	**IDENTIFY** different types of microstructures obtained in phase diagrams and after heat treatment of engineering alloys.	Cognitive	1	2
3.	**COLLECT** and **APPLY** the knowledge obtained from phase diagrams, SAE & ASTM designations.	Cognitive	3	3
4.	**ANALYZE**, **DIFFERENTIATE** and **DISTINGUISH** between the properties of interest in metals, polymers, ceramics and composites and their implication in terms of environment and sustainability.	Cognitive	4	7

Course Contents:

Introduction of engineering materials, metals and alloys, polymers, ceramics and composites. Bonding in different classes of materials. Physical, mechanical and chemical properties of engineering materials. Crystal structure of metals and ceramic. Crystallographic planes and directions, slip and slip systems, dislocation, twinning, yield phenomenon and strain aging. Classification of metals and alloy systems, steels, cast irons, aluminum alloys, copper alloys, super alloys, the SAE and ASTM designations. The iron-iron carbide phase diagram, ferrite, austenite, cementite, pearlite, martensite, bainite, etc. Alloying elements and their effect on the properties of alloy steel. Heat treatment of steel, annealing, normalizing, tempering, quenching, austempering, hardening etc. Hot and cold forming, recovery and recrystallization. Types and properties of structural ceramics. Classification of polymeric materials and their engineering properties.

Recommended Texts:

1. W D Callister, *Fundamentals of Materials Science*, 7th ed, John Wiley, 2007
2. M F Ashby, H Shercliff, D Cebon, *Materials Engineering, Science, Processing and Design*, Butterworth-Heinemann, 2007
3. W F Smith, *Material Science,* 5th ed, McGraw Hill, 2009
4. M F Ashby, *Materials Selection in Mechanical design*, 4th ed, Butterworth-Heinemann, 2011

EE-151T Electrical Engineering

Contact Hours:

Theory = **32**

Practical = **0**

Total = **32**

Credit Hours:

Theory = **2.0**

Practical = **0.0**

Total = **2.0**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**UNDERSTAND** basic concepts, network laws and theorems used to analyze linear circuits.	Cognitive	2	1
2.	**ANALYZE** linear circuits using network laws and steady state response of resistive and reactive elements to AC excitation.	Cognitive	4	2
3.	**EXPLAIN** operating principles of fundamental components of electric machines such as motors, generators and transformers including synchronous, asynchronous, DC and special purpose AC, DC generators and transformers.	Cognitive	2	2

Course Contents:

Introduction to DC Circuits: Series and parallel circuits, DC circuit analysis. Theory of Alternating Current. Series and parallel circuits, resistance, inductance and capacitance of AC circuits, power factor, resonance in RLC circuits, single phase and polyphase circuits. Power and power factor measurement, current and voltage relationship in phase and line circuits. Types, characteristics and testing of AC motors, motor starters and switch gears, electric traction and braking, solenoids. Transformers. Voltage and current relationship of primary and secondary types of transformers, losses and efficiency. Generators and motors. Types, construction and characteristics. Motor starters. Testing and efficiency of machines.

Recommended Texts:

1. S Chapman, *Electric Machinery Fundamentals,* 4th ed, McGraw Hill, 2003
2. T Wildi, *Electric Power Technology,* John Wiley & Sons, 1981
3. M Nahvi, J Edminister, *Electric Circuits, Basic Electricity, Schaum's Series*, 4th ed, McGraw Hill, 2002

EE-151L Electrical Engineering (Lab)

Contact Hours:

Theory = **0**

Practical = **48**

Total = **48**

Credit Hours:

Theory = **0.0**

Practical = **1.0**

Total = **1.0**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**ILLUSTRATE** knowledge of primary electronic lab instruments including DMM, Function Generator, Oscilloscope and electronic trainer.	Psycho-motor	3	1
2.	**IMPLEMENT** electronic circuits and **SIMULATE** their results using MULTISIM.	Psycho-motor	3	5

Course Contents:

This lab consists of experiments on electric circuits comprising common important electronic components.

Recommended Texts:

1. Lab Manual

EE-152T Electronics

Contact Hours:

Theory = **32**

Practical = **0**

Total = **32**

Credit Hours:

Theory = **2.0**

Practical = **0.0**

Total = **2.0**

Prerequisite Course: **EE-151T Electrical Engineering**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**DESCRIBE** and explain the basic construction, operation and characteristics of semiconductor devices.	Cognitive	2	1
2.	**APPLY** acquired knowledge to solve the small scale circuits consisting of semiconductor devices.	Cognitive	4	2
3.	**UNDERSTAND** fundamental concepts of digital logic design including basic and universal gates, number systems, binary coded systems and basic components of combinational and sequential circuits.	Cognitive	2	2

Course Contents:

Semiconductors, rectifiers, transistors, relays, Operational Amplifiers; Number systems, Boolean Algebra, gates. Combinational logic (adders, comparators, decoders, multiplexers, etc.) Sequential logic (flip-flops, registers, counters, ROM, PROM, EPROM). Microprocessors (registers; ALU; CU; memory, address, data and control buses). ADC and DAC. Micro-controllers.

Recommended Texts:

1. Floyd, *Electronic Devices,* 8th ed, Prentice Hall, 2007
2. Malvino, A Paul, *Electronic Principles,* 7th ed, McGraw Hill, 2006
3. Malvino, *Digital Computer Electronics,* 3rd ed, Career Education, 1992

EE-152L Electronics (Lab)

Contact Hours:

Theory = **0**

Practical = **48**

Total = **48**

Credit Hours:

Theory = **0.0**

Practical = **1.0**

Total = **1.0**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**EXPLAIN** of primary electronic lab instruments including DMM, Function Generator, Oscilloscope and Electronic trainer to power up and evaluate Diode, BJTs and Op-Amp based electronic circuits.	Psycho-motor	2	2
2.	**INVESTIGATE** the use of transistor and different passive electronic components in development of certain electronic solutions with possible variations to fine tune the output.	Cognitive	3	4

Course Contents:

This lab consists of experiments on using common important electronic circuits.

Recommended Texts:

1. Lab Manual

EE-401 Control Engineering

Contact Hours:

Theory = **32**

Practical = **0**

Total = **32**

Credit Hours:

Theory = **2.0**

Practical = **0.0**

Total = **2.0**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**DEVELOP** mathematical models of different physical system.	Cognitive	5	3
2.	**ANALYZE** complex engineering problems using mathematical models to examine different properties of the system	Cognitive	4	2
3.	**DEVELOP** a controller to achieve the desired response from the system	Cognitive	5	3

Course Contents:

Basic Concepts. System, control system, input, output, open-loop and closed loop control systems, elements of a general control system, examples of control system. Mathematical Modeling of Physical System. Operational notation, grounded chair representation, series parallel laws, equations of motion for spring mass damper systems, levered system, rotational system, geared system, electrical components and RLC circuits, electrical analogies for mechanical systems, scale factors, thermal systems and fluid system. Transfer Functions and Systems Response. Review of Laplace transform, impulse, step and ramp functions, concept of transfer functions of common components, block diagram algebra, signal flow graphs, impulse, step, and ramp response of first and second order systems, characterization of response (time constant, gain, overshoot, rise time, setting time, steady state error, etc.) relation of system response to location of system poles and zeros. Stability of Control System. Concept of stability, Routh-Hurwitz criterion. Root locus Methods and its Use in Control System Design Introduction to Digital Control.

Recommended Texts:

1. F H Raven, *Automatic Control*, 5th ed, McGraw Hill, 1994
2. R C Dorf*, Modern Control System*, 11th ed, Prentice Hall, 2007
3. B B Kuo, *Automatic Control Systems*, 9th ed, Wiley, 2009

EE-402T Application of Micro-controllers in Mechanical Engg

Contact Hours:
Theory = **32**
Practical = **0**
Total = **32**

Credit Hours:
Theory = **2.0**
Practical = **0.0**
Total = **2.0**

Prerequisite Course: **EE-152T Electronics**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**UNDERSTAND** common daily life problems where automation can be applied.	Cognitive	2	1
2.	**USE** PIC18Fxxx series for interfacing and programming for solving automation problems.	Psycho-motor	4	3
3.	**UNDERSTAND** devices such as I/O ports, timers, serial port, interrupt programming, ADC, DAC, etc.	Cognitive	2	5
4.	**DESIGN** solution for relatively complex automation problems by using basic interfacing and programmable skills	Cognitive	5	3

Course Contents:

PIC Micro-controller history and features; Interfacing using Assembly and C languages; I/O ports, timers, Serial port, Interrupt programming, CCP and ECCP programming, SPL, etc; Interfacing LCD, keyboards, ADC, DAC, sensors, etc; Full step and half step stepper motor control, DC motor control, Applications in mechanical engineering.

Recommended Texts:

1. M A Mazidi, R D McKinlay, R D Causey, *PIC Micro-controller & Embedded Systems using Assembly and C for PIC18*, Prentice Hall, 2007
2. H W Huang, L Chartrand, *PIC Micro-controller: An introduction to software & hardware interfacing*, Cengage Learning, 2004
3. Datasheets of PIC18Fxxxx series.

EE-402L Application of Micro-controllers in Mech Engg (Lab)

Contact Hours:
Theory = **0**
Practical = **48**
Total = **48**

Credit Hours:
Theory = **0.0**
Practical = **1.0**
Total = **1.0**

Course Learning Outcomes:

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

No	CLO Statement	Domain	Taxonomy Level	PLO
1.	**BUILD** IC programming skills for I/O ports, timers, serial port, interrupt programming, ADC, DAC, etc.	Psycho-motor	5	5

Course Contents:

The experiments in this lab complement the knowledge gained in theory lectures.

Recommended Texts:

1. Lab Manual