1st Semester

HUM-101: ISLAMIC STUDIES / ETHICS

Credit Hours:	3	**Contact Hours:**	48
Pre-requisite:	Nil	**Stream:**	N/A
Domain:	Non-Engineering	**Knowledge Area:**	Humanities

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Describe** basics of prophethood, Islamic Law (Sharia'a) and practices of Islam	Cognitive	2	6
2	**Apply** Islam as the practical code of life for all times	Cognitive	3	8

Course Objective and Contents:

This course introduces first year students to the Seerat (The life of the Holy Prophet PBUH) as a role model for whole mankind, the life after death, the concept of accountability and its impact on daily life, 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 development of the modern age.

Recommended Books:

Teachers are recommended to use the latest edition of the following books

1. Tafseer Ibn-i-Kasir by Ibn-i-Kasir
2. Emergence of Islam By Hameed Ullah Muhammad

IEM-111: APPLIED CALCULUS

Credit Hours:	3	**Contact Hours:**	48
Pre-requisite:	Nil	**Stream:**	MO
Domain:	Engineering	**Knowledge Area:**	Engineering Foundation

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Interpret** a function from an algebraic, numerical, graphical and verbal perspective	Cognitive	2	1
2	**Infer** information relevant to the phenomenon modeled by the function	Cognitive	3	2
3	**Solve** complex problems by combining the acquired mathematical concepts and principles	Cognitive	4	3

Course Objective and Contents:

This course introduces first year students to fundamental concepts of single and multi-variable calculus and their applications in engineering fields. Students will be taught to apply mathematical skills to model and solve engineering problems. Contents include: introduction to complex numbers, de'moivre's theorem, basic functions, differentiation and its application, Leibritze's theorem, equations of tangents and normals, curvature, radius and centre of curvature, maxima and minima of function, convexity and concavity, Taylor's and Mclaurin's series and expansion of functions, errors and approximations and limiting values of functions, partial differential, Euler's theorem, integral calculus: standard integrals, integration by substitution, by partial fractions and by parts, integration of trigonometric functions, definite integrals, two and three dimensional integration. The use of spreadsheet to compliment by-hand solution to solve problems is recommended.

Recommended Books:

Teachers are recommended to use the latest edition of the following books

1. Applied Calculus by Hughes-Hallet and Shutterstock
2. Applied Calculus by Stefan Waner and Steven Costenoble
3. Applied Calculus by Geoffrey C. Berresford and Andrew M. Rockett
4. Calculus for Engineering: I by Chester Miracle
5. Calculus for Engineering: II by Chester Miracle

IEM-121: INDUSTRIAL ENGINEERING PRINCIPLES

Credit Hours:	3	**Contact Hours:**	48
Pre-requisite:	Nil	**Stream:**	SD
Domain:	Engineering	**Knowledge Area:**	Engineering Foundation

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Identify** the role of an industrial engineer in a modern manufacturing and service organization	Cognitive	2	6
2	**Discuss** the role of industrial engineering during class participation	Affective	2	10
3	**Analyze** case studies of industrial systems from IE perspective	Cognitive	4	2

Course Objective and Contents:

This course introduces first year students to what engineers do and to the engineer's thought process. Real Industrial Engineering systems will be used to show how engineers use this discipline of engineering to design, make and test systems. Through grasping engineering fundamentals, students learn how engineering systems work and fail. Through examples of real systems, students learn how multi-disciplinary concepts are tied together. The students will also learn basic design, experimentation and evaluation of engineering systems. The course also covers basic introduction to different types of industries like textile and garments manufacturing, process industries, and automotive industries with the help of videos and documentaries. Current and potential employers employing Industrial Engineers in Pakistan and their major roles and job descriptions in these sectors will also be discussed.

Recommended Books:

Teachers are recommended to use the latest edition of the following books

1. Industrial Engineering Foundations: Bridging the Gap between Engineering and Management by Farrokh Sassani
2. Maynard's Industrial Engineering Handbook by Kjell B. Zandin and Harold B. Maynard
3. Handbook of Industrial and Systems Engineering by Adedeji B. Badiru
4. Handbook of Industrial Engineering by Gavriel Salvendy

IEM-131 T: WORKSHOP PRACTICE

Credit Hours:	1	**Contact Hours:**	16
Pre-requisite:	Nil	**Stream:**	DM
Domain:	Engineering	**Knowledge Area:**	Engineering Foundation

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Identify** the hand, power and machine tools used in the workshop	Cognitive	2	1
2	**Choose** suitable tools and operations to produce a part	Cognitive	3	5

Course Objective and Contents:

This course introduces first year students to basics processes and tools in a fitting shop, wood work shop, and machine shop. The course also introduces the basics of fusion and solid-state welding.

Recommended Books:

Teachers are recommended to use the latest edition of the following books

1. Workshop Technology Part-I, II by W.A. Chapman
2. Workshop Processes, Practices, and Materials by Bruce J. Black
3. Manufacturing Technology by P. N. Rao
4. Technology of Machine Tools by S. F. Krar, J. W. Oswald, J. E. St. Amand

IEM-131 L: WORKSHOP PRACTICE

Credit Hours:	1	**Contact Hours:**	48
Co-requisite:	Nil	**Stream:**	DM
Domain:	Engineering	**Knowledge Area:**	Engineering Foundation

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Produce** the required part with the help of hand tools	Psychomotor	3	3
2	**Produce** the required part with the help of power tools	Psychomotor	3	3
3	**Follow** safety and general instructions while performing experiments	Affective	2	8

Course Objective and Contents:

This course introduces first year students to basics processes and tools in a fitting shop, wood work shop, and machine shop. This course also introduces the basics of fusion and solid-state welding.

Suggested Labs:

The purpose of this lab is to enable the students to have the practical skills for basic workshop practices e.g. hand tools, power tools, and machine tools. Basic information and skills about fitting shop, wood workshop, machine shop, and foundry shop. The students will also have practical exposure to various welding and joining processes.

A complex engineering problem within the domain of the course will be assigned to the students (preferably working in groups) by the lab instructor.

IND-151 T: ENGINEERING MECHANICS

Credit Hours:	3	**Contact Hours:**	48
Pre-requisite:	Nil	**Stream:**	N/A
Domain:	Engineering	**Knowledge Area:**	Inter-Disciplinary Engineering Breadth

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Explain** the fundamental laws and principles of engineering mechanics	Cognitive	2	1
2	**Apply** the principles of statics and dynamics to solve engineering problems	Cognitive	3	2
3	**Apply** the concepts of stress & strain and axial loading.	Cognitive	3	1

Course Objective and Contents:

In this course students will get an introduction to force, force system, rectangular components of force, 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, plane trusses, method of joints, method of sections, frames and machine analysis, distributed forces, flexible cables, friction, types of friction, dry friction, applications of friction and principles and applications of dynamics.

Recommended Books:

Teachers are recommended to use the latest edition of the following books

1. Vector Mechanics for Engineers: Statics and Dynamics by Ferdinand P. Beer, E. Russell Johnston Jr.
2. Engineering Mechanics: Statics & Dynamics by Russell C. Hibbeler
3. Engineering Mechanics: Dynamics by James L. Meriam, L. G. Kraige, J. N. Bolton

IND-151 L: ENGINEERING MECHANICS

Credit Hours:	1	**Contact Hours:**	48
Pre-requisite:	Nil	**Stream:**	N/A
Domain:	Engineering	**Knowledge Area:**	Inter-Disciplinary Engineering Breadth

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Measure** key variables of interest using principles of engineering mechanics	Psychomotor	2	4
2	**Interpret** the data collected from experiments to reinforce the relevant theoretical concepts	Cognitive	3	2
3	**Follow** safety and general instructions while performing experiments	Affective	2	8

Course Objective and Contents:

In this course students will get an introduction to 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, plane trusses, method of joints, method of sections, frames and machine analysis, distributed forces, flexible cables, friction, types of friction, dry friction, applications of friction.

Suggested Labs:

The focus of this lab is to provide complete insight about different law of triangle of forces for a concurrent force system (static equilibrium), resultant forces using law of parallelogram, reactions on a simply supported beam subjected to multiple loads, coefficient of friction of a flat and V-belt in contact with cast iron pulley and kinematics mechanism of machines in daily life and industries. Lab also emphasize on calculations of different kinematical and numerical analysis of different mechanisms. It also provides hand on experience on and design of different mechanisms.

A complex engineering problem within the domain of the course will be assigned to the students (preferably working in groups) by the lab instructor.

IND-152 L: FUNDAMENTALS OF COMPUTING

Credit Hours:	2	**Contact Hours:**	96
Pre-requisite:	Nil	**Stream:**	N/A
Domain:	Engineering	**Knowledge Area:**	Computing

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Use** basic and advance features of MS Word	Cognitive	3	5
2	**Use** MS PowerPoint to make effective presentations	Cognitive	3	5
3	**Use** MS Excel to solve basic engineering problems	Cognitive	3	5
4	**Develop** computer programs for simple applications	Cognitive	3	5

Course Objective and Contents:

The course will provide a fundamental understanding of computer applications with the core focus on the Microsoft Office applications (Microsoft Word, Microsoft PowerPoint, and Microsoft Excel), applications of advanced features of MS Excel to solve problems, and developing basic programming skills for simple applications using C++ or Python (to serve as foundation for ID-1264: Computer Programming). This is a complete lab-based course where students will learn these applications by working on computers.

Suggested Labs:

Basic and advanced features of Word, PowerPoint, and Excel, focusing on application and usage in engineering profession. Introduction to computational thinking and developing some simple programs using a commonly used programming language.

A complex engineering problem within the domain of the course will be assigned to the students (preferably working in groups) by the lab instructor.

Recommended Books:

Teachers are recommended to use the latest edition of the following books

1. Microsoft Office 2019 Step by Step by Joan Lambert and Curtis Frye
2. MS – Office 2016 by Elaine Marmel
3. Microsoft Excel Data Analysis and Business Modeling by Wayne Winston

2nd Semester

HUM-102: PAKISTAN STUDIES

Credit Hours:	2	**Contact Hours:**	32
Pre-requisite:	Nil	**Stream:**	N/A
Domain:	Non-Engineering	**Knowledge Area:**	Humanities

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Discuss** the history of Pakistan before independence	Cognitive	2	6
2	**Explain** the constitutional history of Pakistan	Cognitive	2	6
3	**Analyze** different regimes in Pakistan after independence	Cognitive	4	6
4	**Analyze** current issues and problems faced by Pakistan	Cognitive	4	6

Course Objective and Contents:

The course is aimed to provide the historical and ideological background of Pakistan and also the process of governance and national development. It enables students to critically analyze different regimes and their governance after independence. The course also focuses on analyzing the contemporary issues posing challenges to Pakistan.

Recommended Books:

Teachers are recommended to use the latest edition of the following books

1. Muslim Struggle for Independence: From Sir Syed Ahmad Khan to Quaid-e-Azam Mohammad Ali Jinnah, 1857-1947 by Syed Qalb-e-Abid.
2. The Struggle for Pakistan by Ishtiaq Hussain Qureshi
3. Pakistan – The Formative Phase 1857-1948 by Khalid bin Sayyed
4. Landmarks of the Pakistan Movement by S. M. Burke
5. Pakistan Foreign Policy 1947-2016 (A Concise History) by Abdul Sattar
6. Constitutional History of Pakistan by Hamid Khan

IEM-112: APPLIED LINEAR ALGEBRA

Credit Hours:	3	**Contact Hours:**	48
Pre-requisite:	Nil	**Stream:**	MO
Domain:	Engineering	**Knowledge Area:**	Engineering Foundation

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Interpret** the basic concepts and methods of linear algebra	Cognitive	2	1
2	**Solve** engineering problems using the techniques of linear algebra	Cognitive	3	2
3	**Apply** the learned concepts on real world problems	Cognitive	3	3

Course Objective and Contents:

The course teaches students to apply algebraic reasoning to solve engineering problems effectively. The topics include 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, and graph theory. The students will be introduced to the use of MATLAB to solve problems related to these concepts.

Recommended Books:

1. Introduction to Applied Linear Algebra: Vectors, Matrices, and Least Squares by Stephen Boyd and Lieven Vandenberghe
2. Linear Algebra and Its Applications by D. C. Lay
3. Introduction to Linear Algebra by Gilbert Strang
4. Linear Algebra Done Right by Sheldon Axler

IEM-132 T: ENGINEERING DRAWING

Credit Hours:	2	**Contact Hours:**	32
Pre-requisite:	Nil	**Stream:**	DM
Domain:	Engineering	**Knowledge Area:**	Engineering Foundation

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Explain** the basics of engineering drawing and graphics and their importance in engineering profession	Cognitive	2	1
2	**Interpret** the symbols, abbreviations, and dimensional values found on engineering drawings	Cognitive	2	10
3	**Analyze** an engineering drawing according to standard drafting practices	Cognitive	3	2

Course Objective and Contents:

This course introduces students to the use of technical drawing in an effective way for communicating and integrating with engineering concepts. Students should be able to apply the skill and knowledge of engineering drawing to interpret design, using graphics methods such as geometric drawing, orthographic projection, isometric, detailed drawing, and basic CAD software. Principles of part assembly are also introduced.

Recommended Books:

Teachers are recommended to use the latest edition of the following books

1. Engineering Drawing and Design by David A. Madsen and David P. Madsen
2. Engineering Drawing and Design by Cecil Jensen, Jay Helsel, et al.
3. Fundamentals of Modern Drafting by Paul Ross Wallach
4. Technical Drawing with Engineering Graphics by Frederick E. Giesecke, et al.
5. Fundamentals of Graphics Communication by Gary Bertoline
6. Manual of Engineering Drawing by Colin H. Simmons and Dennis E Maguire

IEM-132 L: ENGINEERING DRAWING

Credit Hours:	1	**Contact Hours:**	48
Pre-requisite:	Nil	**Stream:**	DM
Domain:	Engineering	**Knowledge Area:**	Engineering Foundation

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Illustrate** the concepts of basic drawing techniques	Psychomotor	3	1
2	**Draw** projections of various mechanical components and assemblies by using drawing equipment	Psychomotor	3	10
3	**Illustrate** engineering drawing knowledge for precise and accurate communication of drawing by using AutoCAD	Cognitive	3	5

Course Objective and Contents:

This course introduces students to the use of technical drawing in an effective way for communicating and integrating with engineering concepts. Student should be able to apply the skill and knowledge of engineering drawing to interpret design, using graphics method such as geometric drawing, orthographic projection, isometric, detailed drawing, and basic CAD software. Principles of part assembly are also introduced.

Suggested Labs:

This lab introduces students to the use of technical drawing in an effective way for communicating and integrating with engineering concepts. The students are taught basic of engineering drawing to enable them to communicate information about the shape, size, surface quality, material, manufacturing process, etc., of the object. Students will be given hands on experience of using a CAD software like AutoCAD.

A complex engineering problem within the domain of the course will be assigned to the students (preferably working in groups) by the lab instructor.

IEM-133 T: MATERIALS ENGINEERING

Credit Hours:	3	**Contact Hours:**	48
Pre-requisite:	Nil	**Stream:**	DM
Domain:	Engineering	**Knowledge Area:**	Engineering Foundation

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Classify** engineering materials and their properties	Cognitive	3	1
2	**Identify** the processing routes of different materials and their potential applications	Cognitive	2	2
3	**Select** best material for engineering applications under given conditions	Cognitive	4	7

Course Objective and Contents:

This course exposes students to the properties and applications of a variety of engineering materials. Students will be able to make informed decisions regarding selection of materials for a variety of applications. Topics to be covered in the course include some basics like types of materials, sources of materials, material science and engineering, crystalline and amorphous materials, application of materials, indigenous materials available in Pakistan and scope of their uses in industry.

The course further explores metallic materials and alloys, their major properties and heat treatment. It also covers properties and applications of ceramics, glasses, rubbers, refractory materials, polymers, and composites. Environmental degradation of materials, corrosion, and its types are also discussed.

Recommended Books:

Teachers are recommended to use the latest edition of the following books

1. Materials Science and Engineering: An Introduction by William D. Callister Jr. and David G. Rethwisch
2. Introduction to Physical Metallurgy by Sidney H. Avner
3. Structure and Properties of Engineering Alloys by William F. Smith

IEM-133 L: MATERIALS ENGINEERING

Credit Hours:	1	**Contact Hours:**	48
Pre-requisite:	Nil	**Stream:**	DM
Domain:	Engineering	**Knowledge Area:**	Engineering Foundation

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Measure** key variables of interest using principles of materials engineering	Psychomotor	2	4
2	**Interpret** the data collected from experiments to reinforce the relevant theoretical concepts	Cognitive	3	2
3	**Follow** safety and general instructions while performing experiments	Affective	2	8

Course Objective and Contents:

This course exposes students to the properties and applications of a variety of engineering materials. Students will be able to make informed decisions regarding selection of materials for a variety of applications. Topics to be covered in the course include some basics like types of materials, sources of materials, material science and engineering, crystalline and amorphous materials, application of materials, indigenous materials available in Pakistan and scope of their uses in industry.

The course further explores metallic materials and alloys, their major properties and heat treatment. It also covers properties and applications of ceramics, glasses, rubbers, refractory materials, polymers, and composites. Environmental degradation of materials, corrosion, and its types are also discussed.

Suggested Labs:

This lab focuses on the fundamental knowledge of various material properties. The lab teaches the essential steps in manufacturing and fabrication of different materials. The lab also provides hands-on opportunities and trainings for the students to learn various mechanical tests to evaluate physical and mechanical properties of engineering materials. By receiving a thorough fundamental theoretical and practical knowledge, students will be more equipped and more confident for the selection of an appropriate material for any targeted application. A complex engineering problem within the domain of the course will be assigned to the students (preferably working in groups) by the lab instructor.

IEM-134 T: MANUFACTURING PROCESSES-I

Credit Hours:	3	**Contact Hours:**	48
Pre-requisite:	Nil	**Stream:**	DM
Domain:	Engineering	**Knowledge Area:**	Major Based Core (Depth)

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Explain** how shape is imparted to raw material using basic manufacturing processes	Cognitive	2	1
2	**Select** the most suitable material and process to make a product to get the desired properties	Cognitive	4	7
3	**Analyze** a process based on different material and process parameters	Cognitive	4	2
4	**Contribute** to the class discussion on basic manufacturing processes	Affective	2	10

Course Objective and Contents:

This course introduces the students to commonly used discrete manufacturing processes for metals. It covers important physical and mechanical properties of materials in the context of manufacturing; properties of some common metals used in manufacturing; metal casting processes, casting defects and their remedies, types of furnaces; bulk deformation processes and their applications; important plastics, their properties and shaping processes; ceramics and their shaping; joining processes like welding, brazing, soldering and mechanical assembly. The course also covers the need for sustainable manufacturing in modern world.

Recommended Books:

Teachers are recommended to use the latest edition of the following books

1. Fundamentals of Modern Manufacturing: Materials, Processes, and Systems by Mikell P. Groover
2. Degarmo's Materials and Processes in Manufacturing by J.T. Black, R. A. Kohser
3. Manufacturing Processes for Engineering Materials by S. Kalpakjian, S. R. Schmid
4. Manufacturing Engineering and Technology by S. Kalpakjian, S. R. Schmid

IEM-134 L: MANUFACTURING PROCESSES-I

Credit Hours:	1	**Contact Hours:**	48
Pre-requisite:	Nil	**Stream:**	DM
Domain:	Engineering	**Knowledge Area:**	Major Based Core (Depth)

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Perform** different tests to check properties of molding sand	Psychomotor	3	4
2	**Prepare** sand casting mold using different types of pattern, riser, and core	Psychomotor	3	1
3	**Prepare** different ceramic and plastic parts	Psychomotor	3	1
4	**Follow** safety and general instructions while performing experiments in the lab	Affective	2	8
5	**Satisfy** the timelines while performing the experiments	Affective	2	11

Course Objective and Contents:

This course introduces the students to commonly used discrete manufacturing processes for metals. It covers important physical and mechanical properties of materials in the context of manufacturing; properties of some common metals used in manufacturing; metal casting processes, casting defects and their remedies, types of furnaces; bulk deformation processes and their applications; important plastics, their properties and shaping processes; ceramics and their shaping; joining processes like welding, brazing, soldering and mechanical assembly. The course also covers the need for sustainable manufacturing in modern world.

Suggested Labs:

The lab introduces students to foundry materials, consumables and tools. The experiments include: testing different properties of molding sand, preparing molasses sand mold using different types of pattern like loose piece pattern, split piece pattern, match plate pattern with and without open riser, loose piece pattern with blind riser, and loose piece pattern with an internal chill, preparing a sand core using molasses sand, preparing green sand mold using match plate pattern by incorporating molasses sand core in it.

A complex engineering problem within the domain of the course will be assigned to the students (preferably working in groups) by the lab instructor.

IND-153: GENERAL ENGINEERING

Credit Hours:	2	**Contact Hours:**	32
Pre-requisite:	Nil	**Stream:**	N/A
Domain:	Engineering	**Knowledge Area:**	Inter-Disciplinary Engineering Breadth

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	*Description*	*Domain*	*Taxonomy Level*	*PLOs*
1	**Apply** the knowledge of electrical technology for engineering applications	Cognitive	3	*2*
2	**Apply** the knowledge of mechanical technology for engineering applications	Cognitive	3	2
3	**Justify** their findings in different assigned activities	Affective	3	9

Course Objective and Contents:

The course focuses on introduction to electrical technology, basic circuit analysis, transformers, DC machines, AC machines, and semiconductor devices. Topics covered include Ohm's Law, DC circuits (series and parallel), Kirchhoff's Laws, DC generators and motors, principles of alternating current, inductance, inductive reactance, and inductive circuits, capacitance, capacitive reactance, and capacitive circuits, single phase circuits, AC generators and motors, transformers, three-phase systems, and magnetism and electromagnetism.

After mid-term the course focuses on introduction to kinematics, links, joints and mechanisms. Types, geometry and working of gears and gear trains; types, working, and applications of cams and followers; belts and pulleys; and flywheel will be covered. Use of simulation of different mechanisms is recommended for clarifying concepts. The introductory concepts and definitions, using energy and the laws of thermodynamics, first law and second law of thermodynamics, air cycles, carnot's cycle, the otto cycle, diesel cycle, and refrigeration systems. Working of elements of mechanical power transmission, modes of heat transfer and their equations, basic concepts of cooling load calculation, fluids and their properties, fluid statics, pressure measurement: bourdon pressure gauge, manometers. kinematics of fluid flow: laminar and turbulent flow, continuity and Bernoulli's Equation, Flow through pipes: Moody Charts. Introduction to hydraulic machinery.

Recommended Books:

Teachers are recommended to use the latest edition of the following books

1. Basic Electrical Engineering by PS Doghal
2. Electrical Technology by BL Tharaja
3. Theory of Machines and Mechanisms by John Uicker, Gordon Pennock, Joseph Shigley
4. Machines and Mechanisms: Applied Kinematic Analysis by David H. Myszka
5. Motion Simulation and Mechanism Design with SoildWorks Motion

6. Thermodynamics – An Engineering Approach by Yunus A. Cengel and Michael A. Boles
7. Fundamentals of Fluid Mechanics by Bruce R. Munson, Donald F. Young and Theodore H. Okiishi

3rd Semester

HUM-203 L: COMMUNICATION SKILLS-I

Credit Hours:	1	**Contact Hours:**	48
Pre-requisite:	Nil	**Stream:**	N/A
Domain:	Non-Engineering	**Knowledge Area:**	Humanities

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Craft** a clear and impactful speech / presentation	Cognitive	3	12
2	**Develop** and **deliver** complex arguments persuasively	Affective	4	10
3	**Critique** other communicators using the principles of effective communication	Affective	3	10

Course Objective and Contents:

In this course students will be exposed to methods that help to reduce anxiety, build confidence, and customize a process which will result in successful speaking experiences. This course is designed to equip students with knowledge of the principles necessary for formal speaking with an emphasis on organization, evidence, language use, strategy, delivery, ethics, and effective use of media aids. Students will be taught to design and deliver basic arguments, informative and powerful presentations, and complex arguments clearly.

Suggested Labs:

Students will be exposed to practical scenarios and role play settings to prepare a speech / presentation to address a targeted audience. Topics could include both social and technical.

IEM-213: STATISTICS FOR ENGINEERS

Credit Hours:	3	**Contact Hours:**	48
Pre-requisite:	Nil	**Stream:**	MO
Domain:	Engineering	**Knowledge Area:**	Engineering Foundation

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Interpret** the basic concepts of statistics and their need in engineering	Cognitive	2	1
2	**Apply** statistical methods to collect and analyze data for engineering problems	Cognitive	3	4
3	**Use** software package to deduce information from data	Cognitive	3	5

Course Objective and Contents:

This course deals mainly with the applications of statistics in the engineering context with IE-based case studies. Students will be able to appreciate the importance of statistics in data analysis and industrial decision making. Topics include types of variables with examples, descriptive statistics for both categorical and numeric variables, sampling distributions, point and interval estimates, statistical inference for single and two samples, one-way and two-way analysis of variance (ANOVA), simple linear regression and correlation, multiple linear regression, and non-parametric tests.

Software like R and MATLAB will be used to solve problems.

Recommended Books:

Teachers are recommended to use the latest edition of the following books

1. Engineering Statistics by Douglas C. Montgomery, George C. Runger
2. Applied Statistics and Probability for Engineers by Douglas C. Montgomery
3. Statistics for Engineers and Scientists by William Navidi Prof.

IEM-235 T: MANUFACTURING PROCESSES-II

Credit Hours:	3	**Contact Hours:**	48
Pre-requisite:	IEM-133, IEM-134	**Stream:**	DM
Domain:	Engineering	**Knowledge Area:**	Major Based Core (Depth)

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Explain** how shape is imparted to raw material using basic manufacturing processes	Cognitive	2	1
2	**Select** the most suitable material and process to make a product to get the desired properties	Cognitive	4	7
3	**Analyze** a process based on different material and process parameters	Cognitive	4	2
4	**Contribute** to the class discussion on basic manufacturing processes	Affective	2	10

Course Objective and Contents:

This course builds on IEM-134 and introduces the students to some discrete manufacturing processes other than introduced in IEM-134. Topics include: particulate processing of metals, main types, properties, and applications of composite materials, shaping processes for composites, some common sheet metal working operations and their use to make parts, types of material removal processes, main parts and kinematics of conventional machine tools, traditional machining processes, non-traditional machining processes with applications, and introduction to NC and CNC machines. The course also covers the need for sustainable manufacturing in modern world.

Recommended Books:

Teachers are recommended to use the latest edition of the following books

1. Fundamentals of Modern Manufacturing: Materials, Processes, and Systems by Mikell P. Groover
2. Degarmo's Materials and Processes in Manufacturing by J.T. Black, R. A. Kohser
3. Manufacturing Processes for Engineering Materials by S. Kalpakjian, S. R. Schmid
4. Manufacturing Engineering and Technology by S. Kalpakjian, S. R. Schmid
5. Technology of Machine Tools by Steve Krar

IEM-235 L: MANUFACTURING PROCESSES-II

Credit Hours:	1	**Contact Hours:**	48
Pre-requisite:	IEM-133, IEM-134	**Stream:**	DM
Domain:	Engineering	**Knowledge Area:**	Major Based Core (Depth)

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Prepare** different samples using metal powders and composites	Psychomotor	2	4
2	**Perform** different machining tasks on conventional machines	Psychomotor	2	4
3	**Perform** different operations on sheet metal presses	Psychomotor	2	4
4	**Follow** safety and general instructions while performing experiments in the lab	Affective	2	8
5	**Contribute** as an effective team member	Affective	2	9

Course Objective and Contents:

This course builds on IEM-134 and introduces the students to some discrete manufacturing processes other than introduced in IEM-134. Topics include: particulate processing of metals, main types, properties, and applications of composite materials, shaping processes for composites, some common sheet metal working operations and their use to make parts, types of material removal processes, main parts and kinematics of conventional machine tools, traditional machining processes, non-traditional machining processes with applications, and introduction to NC and CNC machines. The course also covers the need for sustainable manufacturing in modern world.

Suggested Labs:

The emphasis throughout the laboratory course will be to provide an insight to the basic features of the machine tools and presses and operations that can be performed on them. The lab work will train students into machining and stamping operations to enrich their practical skills. The lab will also expose students to part manufacturing using metal powders and composites. It will also inculcate team qualities and educate students about ethical, environmental and safety standards.

A complex engineering problem within the domain of the course will be assigned to the students (preferably working in groups) by the lab instructor.

IEM-241: OPERATIONS MANAGEMENT

Credit Hours:	3	**Contact Hours:**	48
Pre-requisite:	Nil	**Stream:**	EM
Domain:	Management	**Knowledge Area:**	Major Based Core (Depth)

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Explain** the relationship of operations functions with other functions in an organization	Cognitive	2	1
2	**Apply** the concepts of operations management to better manage different types of processes	Cognitive	3	3
3	**Apply** best practices in the design of products, services, and layouts	Cognitive	3	3

Course Objective and Contents:

This course exposes students to how operations in an organization are configured and factors that can potentially drive the complexity of managing such operations. The course will base on types of operations systems i.e. projects, jobbing, batch, and assembly lines. It will further cover estimating capacity, identifying bottlenecks, and de-bottlenecking. The course also covers the tools and techniques to better design products and services and layouts for both manufacturing and service organizations. The course will equip students with the right tools, techniques and skills to estimate, compute, analyze and configure key elements of operations management. Case studies will be discussed to strengthen the concepts.

Recommended Books:

Teachers are recommended to use the latest edition of the following books

1. Operations Management: Creating Value Along the Supply Chain by R. S. Russell and B. W. Taylor
2. Operations Management by William J Stevenson
3. Operations Management: An Integrated Approach by R. Dan Reid and Nada R. Sanders
4. Operations Management: Sustainability and Supply Chain Management by Jay Heizer and Barry Render
5. Matching Supply with Demand by Gerard Cachon and Christian Terwiesch

IND-254: ENVIRONMENTAL ENGINEERING

Credit Hours:	2	**Contact Hours:**	32
Pre-requisite:	Nil	**Stream:**	N/A
Domain:	Engineering	**Knowledge Area:**	Inter-Disciplinary Engineering Breadth

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Describe** the basic principles, concepts, and applications of environmental engineering	Cognitive	2	7
2	**Identify** the modern age issues and challenges facing our environment and possible remedial measures	Cognitive	3	6
3	**Express** the concepts of sustainable development	Cognitive	2	7

Course Objective and Contents:

The course focuses on Introduction to environmental engineering, Identification of the factors affecting the environment. The causes and effects of environmental pollution (water, air and land). An overview of national environmental problems, global environmental issues (acid rain, global warming, ozone depletion and greenhouse gases). Point source and non-point source pollution, basic understanding of natural resources characteristics, ecology and ecosystems, urban planning and sustainable development, definition and inter-relationship between its components. Overview of safety and environmental risk assessment.

Recommended Books:

Teachers are recommended to use the latest edition of the following books

1. Introduction to Environmental Engineering and Science by Gilbert M. Masters
2. Principles of Environmental Engineering and Science by Mackenzie L. Davis, and Susan J. Masten
3. Introduction to Environmental Engineering by Mackenzie Davis, and David Cornwell

IND-255 T: COMPUTER PROGRAMMING

Credit Hours:	3	**Contact Hours:**	48
Pre-requisite:	Nil	**Stream:**	N/A
Domain:	Engineering	**Knowledge Area:**	Computing

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Demonstrate** the basic programming skills for a commonly used programming language	Cognitive	2	1
2	**Write** codes to solve real world engineering problems	Cognitive	4	5
3	**Apply** essential algorithmic techniques to solve optimization problems	Cognitive	3	4

Course Objective and Contents:

The course focuses on developing the ability to write programs to solve practical problems using programming language like C++ / Python. Topics include: Algorithms, elements of programming languages, basic data types, sequential and conditional execution, iterative solutions, arrays, matrices and their applications, functions, sorting and searching, elements of string processing, introduction to pointers, structures, and file processing. This course also concentrates on the design of algorithms and the rigorous analysis of their efficiency. Topics include the basic definitions of algorithmic complexity (worst case, average case); basic tools such as dynamic programming, sorting, searching, and selection; advanced data structures and their applications (such as union-find); graph algorithms and searching techniques such as minimum spanning trees, depth-first search, shortest paths, maximum flows, scheduling, knapsack problem and competitive analysis.

Recommended Books:

Teachers are recommended to use the latest edition of the following books

1. How to Think Like a Computer Scientist – Learning with Python by Allen Downey
2. Python Programming: A Step by Step Guide from Beginner to Expert (Beginner, Intermediate & Advanced) by Anthony Brun
3. The C++ Programming Language by Bjarne Stroustrup
4. Introduction to Algorithms by T. H. Cormen, C. E. Leiserson, R. L. Rivest
5. Model Building in Mathematical Programming by H. Paul Williams

IND-255 L: COMPUTER PROGRAMMING

Credit Hours:	1	**Contact Hours:**	48
Pre-requisite:	Nil	**Stream:**	N/A
Domain:	Engineering	**Knowledge Area:**	Computing

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Compile** programs to solve real world engineering problems	Cognitive	4	5
2	**Formulate** real life computational problem as rigorous algorithmic problem	Cognitive	4	3
3	**Debug** the code for some common algorithms	Cognitive	3	2

Course Objective and Contents:

The course focuses on developing the ability to write programs to solve practical problems using programming language like C++ / Python. Topics include: Algorithms, elements of programming languages, basic data types, sequential and conditional execution, iterative solutions, arrays, matrices and their applications, functions, sorting and searching, elements of string processing, introduction to pointers, structures, and file processing. This course also concentrates on the design of algorithms and the rigorous analysis of their efficiency. Topics include the basic definitions of algorithmic complexity (worst case, average case); basic tools such as dynamic programming, sorting, searching, and selection; advanced data structures and their applications (such as union-find); graph algorithms and searching techniques such as minimum spanning trees, depth-first search, shortest paths, maximum flows, scheduling, knapsack problem and competitive analysis.

Suggested Labs:

The lab part supplements the theory part and should focus on solving practical problems using programming language like C++ / Python. This lab also focuses on teaching coding of algorithms that operate on common data structures, for instance, sorting and searching, advanced design and analysis techniques such as dynamic programming and greedy algorithms, advanced graph algorithms such as minimum spanning trees and shortest paths, NP-completeness theory, and approximation algorithms.

A complex engineering problem within the domain of the course will be assigned to the students (preferably working in groups) by the lab instructor.

4th Semester

HUM-204: COMMUNICATION SKILLS-II

Credit Hours:	3	**Contact Hours:**	48
Pre-requisite:	Nil	**Stream:**	N/A
Domain:	Non-Engineering	**Knowledge Area:**	Humanities

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Explain** why business communication is important for engineers	Cognitive	2	10
2	**Effectively** use modern tools of communication for interaction with diverse audiences	Cognitive	3	10
3	**Create** a variety of effective and clearly written business documents to better communicate in different situations	Cognitive	4	6

Course Objective and Contents:

In this course students will learn techniques to effectively and succinctly articulate business ideas to a diverse range of audiences to ensure they understand even the most complex concepts. Students will learn to assess needs of clients and colleagues and employ best practices for face-to-face and remote communication. Course will cover introduction and importance of business writing, important document types and their considerations: agendas, letters and memos, reports, proposals, and business cases. Course will also teach students how to effectively use emails and social media to communicate with a variety of stakeholders.

Recommended Books:

Teachers are recommended to use the latest edition of the following books

1. Essentials of Business Communication by Mary Ellen Guffey, Dana Loewy
2. Business Communication: Building Critical Skills by Kitty O. Locker, Stephen Kyo Kaczmarek
3. Excellence in Business Communication by John V. Thill, Courtland L. Bovee
4. Business Communication: In Person, In Print, Online by Amy Newman, Scot Ober

IEM-214: PROBABILITY MODELS

Credit Hours:	3	**Contact Hours:**	48
Pre-requisite:	Nil	**Stream:**	MO
Domain:	Engineering	**Knowledge Area:**	Engineering Foundation

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Distinguish** between basic probability concepts and rules	Cognitive	2	1
2	**Apply** probability models with discrete and continuous random variables for decision making in a dynamic setting	Cognitive	3	4
3	**Model** real-world problems with the help of probability concepts	Cognitive	4	12

Course Objective and Contents:

The course covers the applications of stochastic modeling. Topics include: review of basic probability, discrete and continuous random variables, discrete and continuous distributions, conditional probability and conditional expectation, Bernoulli process, Poisson process, discrete time Markov chains, basic queueing models and continuous time Markov chains, Markov decision process (MDP), Monte Carlo Markov Chain (MCMC) and Renewal theory. Students will eventually be conversant with the properties of these models and appreciate their roles in engineering applications.

Recommended Books:

Teachers are recommended to use the latest edition of the following books

1. Introduction to Probability Models by Sheldon Ross
2. Introduction to Probability by Dimitri P. Bertsekas and John N. Tsitsiklis
3. Applied Probability: Models and Intuition by Arnold I. Barnett

IEM-215 T: OPERATIONS RESEARCH

Credit Hours:	3	**Contact Hours:**	48
Pre-requisite:	IEM-112	**Stream:**	MO
Domain:	Engineering	**Knowledge Area:**	Major Based Core (Breadth)

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Identify** areas of mathematical models implementation for better decision making	Cognitive	2	1
2	**Formulate** models considering constraints to optimize the decision making	Cognitive	3	3
3	**Select** and apply appropriate model / tool for decision-making	Cognitive	4	4

Course Objective and Contents:

This course introduces students to some of the basic concepts and models of operations research. It aims to be a foundation course. The topics include operations research (OR) and its problem-solving approach, deterministic and stochastic operations research models, linear programming, integer programming, network models, and dynamic programming. Besides these modeling concepts, the students will also learn how to use commercial software such as CPLEX, Lingo or Gurobi Optimizer to solve complex real-world problems. Case studies from different engineering and managerial perspectives will be discussed to strengthen the concepts.

Recommended Books:

Teachers are recommended to use the latest edition of the following books

1. Introduction to Operations Research by Frederick S. Hillier
2. Operations Research: An Introduction by Hamdy A. Taha
3. An Introduction to Management Science: Quantitative Approaches to Decision Making by David R. Anderson, Dennis J. Sweeney, Thomas A. Williams, Jeffrey D. Camm, & Kipp Martin
4. Spreadsheet Modeling & Decision Analysis, A Practical Introduction to Management Science by Cliff T. Ragsdale
5. Introduction to Management Science by Bernard W. Taylor III
6. Operations Research: Applications and Algorithms by Wayne L Winston

IEM-215 L: OPERATIONS RESEARCH

Credit Hours:	1	**Contact Hours:**	48
Pre-requisite:	IEM-112	**Stream:**	MO
Domain:	Engineering	**Knowledge Area:**	Major Based Core (Breadth)

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Construct** mathematical models for engineering and decision-making problems	Cognitive	3	2
2	**Solve** mathematical models using optimization software	Cognitive	3	5
3	**Evaluate** mathematical models for engineering and decision-making problems	Cognitive	4	4

Course Objective and Contents:

This course introduces students to some of the basic concepts and models of operations research. It aims to be a foundation course. The topics include operations research (OR) and its problem-solving approach, deterministic and stochastic operations research models, linear programming, integer programming, network models, and dynamic programming. Besides these modeling concepts, the students will also learn how to use commercial software such as CPLEX, Lingo or Gurobi Optimizer to solve complex real-world problems. Case studies from different engineering and managerial perspectives will be discussed to strengthen the concepts.

Suggested Labs:

The main focus of lab is to use mathematical software e.g. Gurobi, Excel Solver or CPLEX to solve the proposed models and develop a report that describes the model and the solving technique, analyze the results and propose recommendations in language understandable to the decision-making processes.
A complex engineering problem within the domain of the course will be assigned to the students (preferably working in groups) by the lab instructor.

IEM-222 T: WORK AND PROCESS DESIGN

Credit Hours:	2	**Contact Hours:**	32
Pre-requisite:	Nil	**Stream:**	SD
Domain:	Engineering	**Knowledge Area:**	Major Based Core (Depth)

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Identify** the characteristics of industrial work systems	Cognitive	2	1
2	**Improve** an industrial work system by using principles of work and process design	Cognitive	4	3

Course Objective and Contents:

This course focuses on designing and improving industrial processes, especially those performed in manufacturing organizations. Students will learn how to follow systematic approach of work and process design i.e. selection of process, data collection, critical examination of data, developing and defining new process, installing the process, follow-up and change management. Different methods of work measurement like stop-watch time study, pre-determined motion time systems, work sampling, and standard data method will be discussed. The course will also teach on calculating and maximizing efficiency and utilization of resources. The concepts of wage and incentives calculations, product costing, and labor productivity are also the part of the course. A number of case studies of developing and improving industrial processes will be discussed.

Recommended Books:

Teachers are recommended to use the latest edition of the following books

1. Niebel's Methods, Standards and Work Design by Andris Freivalds
2. Work Systems: The Methods, Measurement and Management of Work by Mikell P. Groover
3. Motion and Time Study – Design and Measurement of Work by Ralph M. Barnes
4. Matching supply with Demand – An Introduction to Operations Management by G. Cachon and C. Terwiesch

IEM-222 L: WORK AND PROCESS DESIGN

Credit Hours:	1	**Contact Hours:**	48
Pre-requisite:	Nil	**Stream:**	SD
Domain:	Engineering	**Knowledge Area:**	Major Based Core (Depth)

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Measure** and analyze the processes of an industrial work system	Psychomotor	2	4
2	**Analyze** the results obtained from the experiment / task performed	Cognitive	4	4
3	**Follow** safety and general instructions while performing experiments	Affective	2	9

Course Objective and Contents:

This course focuses on designing and improving industrial processes, especially those performed in manufacturing organizations. Students will learn how to follow systematic approach of work and process design i.e. selection of process, data collection, critical examination of data, developing and defining new process, installing the process, follow-up and change management. Different methods of work measurement like stop-watch time study, pre-determined motion time systems, work sampling, and standard data method will be discussed. The course will also focus on calculating and maximizing efficiency and utilization of resources. The concepts of wage and incentives calculations, product costing, and labor productivity are also the part of the course. A number of case studies of developing and improving industrial processes will be discussed.

Suggested Labs:

Students will be taught to draw different diagrams and layouts using state-of-the-art software like MS–Visio, Excel, and Smart Draw. Students will also be exposed to case studies and video-based tasks to define and standardize a process and develop its work instructions. Finally, students will learn how to visualize and analyze the system as a whole using basic plant simulation.

A complex engineering problem within the domain of the course will be assigned to the students (preferably working in groups) by the lab instructor.

IEM-236 L: COMPUTER-AIDED DESIGN

Credit Hours:	2	**Contact Hours:**	96
Pre-requisite:	IEM-132	**Stream:**	DM
Domain:	Engineering	**Knowledge Area:**	Major Based Core (Depth)

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Build** a 3D model using state-of-the-art design software for engineering applications	Cognitive	4	5
2	**Analyze** a 3D model using simulation based on different parameters	Cognitive	4	5
3	Effectively **present** CAD models and assemblies for stakeholders	Cognitive	3	10

Course Objective and Contents:

This course focuses on the principles and applications of computer-aided design in product and system design. This is a lab-based course that teaches the essential steps that one takes to develop a product from concept starting with design and progressing to motion study simulation. It will provide hands-on opportunities and training for the students to learn popular CAD software like SolidWorks or Pro-Engineer.

Suggested Labs:

This lab enables students to master the use of a state-of-the-art software like SolidWorks or Pro-engineer to create models with the help of part modeling and assembly design. Course also teaches specialized modeling tools like sheet metalworking, surface modeling, mold design, and weldments. The lab culminates by covering design simulation, motion study, rendering tools, part costing, and material analysis.

A complex engineering problem within the domain of the course will be assigned to the students (preferably working in groups) by the lab instructor.

IEM-242: QUALITY MANAGEMENT

Credit Hours:	3	**Contact Hours:**	48
Pre-requisite:	IE-213	**Stream:**	EM
Domain:	Management	**Knowledge Area:**	Major Based Core (Depth)

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Describe** the basics of quality engineering and management	Cognitive	2	1
2	**Use** tools of quality engineering and management for process and system improvement	Cognitive	4	5
3	**Use** a software to apply different tools of quality engineering and management	Cognitive	3	5

Course Objective and Contents:

This course introduces students to the fundamental concepts and tools of quality engineering and quality management. The concepts covered include history and evolution of quality, quality philosophies, benchmarking, seven QC tools, seven new management tools, failure mode and effects analysis (FMEA), quality function deployment (QFD), measurement system analysis (MSA), and gauge R and R.

Students are exposed in detail to DMAIC cycle for six sigma and different tools used in each phase with the help of examples. Topics related to statistical process control (SPC) like control charts for variable and attribute data, process capability, advanced SPC methods like moving averages, cumulative sum, exponentially weighted moving average (EWMA) charts, and principal component analysis (PCA).

The course discusses a number of case studies of application of quality management tools in different contexts. Software like Minitab or R is used to master the use of different quality management tools.

Recommended Books:

Teachers are recommended to use the latest edition of the following books

1. A First Course in Quality Engineering: Integrating Statistical and Management Methods of Quality by K.S. Krishnamoorthi and V. Ram Krishnamoorthi
2. Total Quality Management by Dale H. Besterfield et. al.
3. The Six Sigma Handbook by Thomas Pyzdek and Paul A. Keller
4. Six Sigma for Business Excellence by Hemant Urdhwareshe
5. The Lean Six Sigma Black Belt Handbook by Frank Voehl, H. James Harrington

5th Semester

IEM-316 T: ENGINEERING OPTIMIZATION TECHNIQUES

Credit Hours:	3	**Contact Hours:**	48
Pre-requisite:	IEM-215	**Stream:**	MO
Domain:	Engineering	**Knowledge Area:**	Major Based Core (Depth)

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Identify** areas of mathematical models implementation for better decision making	Cognitive	2	1
2	**Formulate** models considering constraints to optimize the decision making	Cognitive	3	3
3	**Select** and apply appropriate model / tool for decision-making	Cognitive	4	4

Course Objective and Contents:

This module builds upon IEM-215 to introduce students to some advanced concepts of operations research. The topics include advanced linear and integer programming methods e.g. revised simplex method, column generation method, interior point method, branch and price method etc., goal programming, non-linear programming, game theory, heuristic and meta-heuristics e.g. simulated annealing, genetic algorithm, etc. The students will also learn the applications of these topics to complex engineering and management problems. The use of software like CPLEX or Gurobi Optimizer is recommended.

Recommended Books:

Teachers are recommended to use the latest edition of the following books

1. Introduction to Operations Research by Frederick S. Hillier
2. Operations Research: An Introduction by Hamdy A. Taha
3. An Introduction to Management Science: Quantitative Approaches to Decision Making by David R. Anderson, Dennis J. Sweeney, Thomas A. Williams, Jeffrey D. Camm, & Kipp Martin
4. Spreadsheet Modeling & Decision Analysis, A Practical Introduction to Management Science by Cliff T. Ragsdale
5. Operations Research: Applications and Algorithms by Wayne L Winston

IEM-316 L: ENGINEERING OPTIMIZATION TECHNIQUES

Credit Hours:	1	**Contact Hours:**	48
Pre-requisite:	IEM-215	**Stream:**	MO
Domain:	Engineering	**Knowledge Area:**	Major Based Core (Depth)

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Construct** mathematical models for engineering and decision-making problems	Cognitive	3	2
2	**Solve** mathematical models using optimization software	Cognitive	3	5
3	**Evaluate** mathematical models for engineering and decision-making problems	Cognitive	4	4

Course Objective and Contents:

This module builds upon IEM-215 to introduce students to some advanced concepts of operations research. The topics include advanced linear and integer programming methods e.g. revised simplex method, column generation method, interior point method, branch and price method etc., goal programming, non-linear programming, game theory, heuristic and meta-heuristics e.g. simulated annealing, genetic algorithm, etc. The students will also learn the applications of these topics to complex engineering and management problems. The use of software like CPLEX or Gurobi Optimizer is recommended.

Suggested Labs:

The main focus of lab is to use mathematical software e.g. Gurobi, Excel Solver or CPLEX to solve the proposed models and develop a report that describes the model and the solving technique, analyze the results and propose recommendations in language understandable to the decision-making processes.
A complex engineering problem within the domain of the course will be assigned to the students (preferably working in groups) by the lab instructor.

IEM-323 T: HUMAN FACTORS ENGINEERING

Credit Hours:	2	**Contact Hours:**	32
Pre-requisite:	Nil	**Stream:**	SD
Domain:	Engineering	**Knowledge Area:**	Major Based Core (Breadth)

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Design** work systems based on physical and physiological capabilities of humans	Cognitive	3	3
2	**Incorporate** environmental factors in work system design and assess their impact on humans	Cognitive	3	7
3	**Design** information for easy understanding and retrieval	Cognitive	3	3

Course Objective and Contents:

This course introduces concepts in human factors engineering and ergonomics. The topics that will be covered include: human factors and systems, human factors research methodologies, information input and processing, visual and auditory displays, human output and control, motor skills and hand tools, anthropometry and workplace design, environmental conditions of illumination, and climate and noise. The objectives are to provide students with a broad overview of the application areas and an appreciation of the need for human factors engineers.

Recommended Books:

Teachers are recommended to use the latest edition of the following books

1. Introduction to Ergonomics by Robert S. Bridger
2. A Guide to Human Factors and Ergonomics by Martin Helander
3. An Introduction to Human Factors Engineering by Wickens, Lee, Liu, and Becker
4. Human Factors in Engineering and Design by Sanders and McCormick
5. Niebel's Methods, Standards, and Work Design by Andris Freivalds
6. Handbook of Human Factors and Ergonomics Methods by Stanton, Hedge, Brookhuis, Salas, and Hendrick
7. Bodyspace – Anthropometry, Ergonomics, and the Design of Work by S. Pheasant

IEM-323 L: HUMAN FACTORS ENGINEERING

Credit Hours:	1	**Contact Hours:**	48
Pre-requisite:	Nil	**Stream:**	SD
Domain:	Engineering	**Knowledge Area:**	Major Based Core (Breadth)

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Measure** relationship between humans and their working environment	Psychomotor	2	7
2	**Respond** to safety instructions and time constraint while working individually and in teams	Affective	2	9
3	**Analyze** and compare results obtained from experiment with standard values	Cognitive	4	4

Course Objective and Contents:

This course introduces concepts in human factors engineering and ergonomics. The topics that will be covered include: human factors and systems, human factors research methodologies, information input and processing, visual and auditory displays, human output and control, motor skills and hand tools, anthropometry and workplace design, environmental conditions of illumination, and climate and noise. The objectives are to provide students with a broad overview of the application areas and an appreciation of the need for human factors engineers.

Suggested Labs:

Lab should introduce students to the use of ergonomics assessment tools to real world situations. These tools might include tools for assessment of posture like rapid upper limb assessment (RULA), rapid entire body assessment (REBA), Ovako Working posture analysis system (OWAS), assessment of manual material handling tasks using revised NIOSH Lifting Equation, tools for assessment of tasks requiring high physical effort. The use of software like Human CAD for design and simulation of workplace is recommended. The measurements of different environmental factors like light, noise, and humidity will be made using relevant measurement devices. Similarly, the measurement of different physiological variables like pulse, heart-beat, calories burnt will be made using certain activities on a treadmill.

A complex engineering problem within the domain of the course will be assigned to the students (preferably working in groups) by the lab instructor.

IEM-337 T: COMPUTER-AIDED MANUFACTURING

Credit Hours:	2	**Contact Hours:**	32
Pre-requisite:	IEM-235, IEM-236	**Stream:**	DM
Domain:	Engineering	**Knowledge Area:**	Major Based Core (Depth)

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Classify** the production systems based on the manufacturing facility characteristics	Cognitive	3	2
2	**Appraise** the role of modern manufacturing techniques to meet global challenges	Cognitive	4	4
3	**Interpret** the use of modern techniques to fulfill the niche market requirements	Affective	2	7

Course Objective and Contents:

This is an advanced course building on IEM-235 and IEM-236 and exposes students to the use of computer technology in a manufacturing enterprise. It covers computer numerical control (CNC) machines hardware, part programming for CNC machines, computer aided process planning (CAPP), computer aided quality control, rapid prototyping and additive manufacturing technologies, group technology, use of robots in manufacturing, flexible manufacturing system and automatic material handling. The use of latest CAM software like Mastercam, SolidCAM or PowerMill is recommended.

Recommended Books:

Teachers are recommended to use the latest edition of the following books

1. Computer-Aided Manufacturing by Tien-Chien Chang, Richard A. Wysk, et al.
2. Principles of Computer Aided Design and Manufacturing by Farid M. Amirouche
3. Fundamentals of Computer Aided Manufacturing by G S Sawhney
4. Computer Aided Design and Manufacturing by M.M. Sarcar
5. CNC Machining Handbook: Building, Programming, and Implementation by Alan Overby

IEM-337 L: COMPUTER-AIDED MANUFACTURING

Credit Hours:	1	**Contact Hours:**	48
Pre-requisite:	IEM-235, IEM-236	**Stream:**	DM
Domain:	Engineering	**Knowledge Area:**	Major Based Core (Depth)

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Employ** G & M codes to develop and execute a part program	Psychomotor	2	5
2	**Operate** a virtual machining environment for generation of machining codes automatically	Cognitive	3	5
3	**Build** models using additive manufacturing techniques	Psychomotor	2	3
4	**Manipulate** the SCORBOT ER-4u to pick and place blocks from different points	Psychomotor	2	5

Course Objective and Contents:

This is an advanced course building on IEM-235 and IEM-236 and exposes students to the use of computer technology in a manufacturing enterprise. It covers computer numerical control (CNC) machines hardware, part programming for CNC machines, computer aided process planning (CAPP), computer aided quality control, rapid prototyping and additive manufacturing technologies, group technology, use of robots in manufacturing, flexible manufacturing system and automatic material handling. The use of latest CAM software like Mastercam, SolidCAM or PowerMill is recommended.

Suggested Labs:

The lab gives hands on experience of developing part programs for CNC machining and turning centers using Mastercam, Solidcam or Powermill, programming of robots for different material handling tasks and part and prototype manufacturing using 3-D printing.

A complex engineering problem within the domain of the course will be assigned to the students (preferably working in groups) by the lab instructor.

IEM-343: HUMAN RESOURCE MANAGEMENT

Credit Hours:	2	**Contact Hours:**	32
Pre-requisite:	Nil	**Stream:**	EM
Domain:	Management	**Knowledge Area:**	Major Based Core (Breadth)

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Identify** different approaches to managing human resources and motivating employees	Cognitive	2	6
2	**Apply** best practices for hiring and rewarding employees and for managing employee performance	Cognitive	3	6
3	**Analyze** existing HR practices of the organization and propose changes in them	Cognitive	4	12

Course Objective and Contents:

This course introduces the students to the role and best practices of human resource management function in an organization. Topics covered in the course include introduction to the human resource management and its increasing importance in Pakistani context, recruitment, placement, and talent management, training and development, compensation, rewards, and performance management of employees, increasing and maintaining employee motivation, building positive and healthy relations among employees, labor laws as application in Pakistan for both local organizations and the ones involved in export, and human resource information system (HRIS).

Recommended Books:

Teachers are recommended to use the latest edition of the following books

1. Human Resource Management by Robert L. Mathis, John H. Jackson, Sean R. Valentine, Patricia Meglich
2. Human Resource Management by Gary Dessler
3. Human Resource Management by R. Wayne Dean Mondy, Joseph J. Martocchio
4. Human Resource Management by Raymond Andrew Noe, John R. Hollenbeck, Barry Gerhart, Patrick M. Wright
5. Human Resource Management by Leslie W. Rue, Lloyd L. Byars Director, Nabil A Ibrahim

IEM-344: INTERNATIONAL SYSTEMS AND STANDARDS

Credit Hours:	3	**Contact Hours:**	48
Pre-requisite:	Nil	**Stream:**	EM
Domain:	Management	**Knowledge Area:**	Major Based Core (Breadth)

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Discuss** the purpose, requirements and clauses of different standards	Cognitive	2	2
2	**Appraise** interrelationship among different standards	Cognitive	4	12
3	**Apply** latest version of ISO standard(s) in a case organization	Cognitive	4	11

Course Objective and Contents:

This course introduces students to fundamentals, vocabulary, and requirements of some of the well-known series of standards like ISO 9001, 14001, 45001, and 17025 with the help of case studies and practical examples. Contents include the genesis of some well-known standards, how to implement these standards in true spirit, how to develop different documents, conduct internal audit, and effectively prepare for third-party audit. The ultimate goal of the course is to teach students to develop sustainable systems for an organization.

Recommended Books:

Teachers are recommended to use the latest edition of the following books

1. ISO 9001: 2015 – A Complete Guide to Quality Management Systems by Itay Abuhav
2. ISO 9000: 2015 – Quality management systems - Fundamentals and Vocabulary by International Organization for Standardization
3. ISO 9001: 2015 – Quality management systems - Requirements by International Organization for Standardization
4. The ISO 14001: 2015 – Implementation Handbook: Using the Process Approach to Build an Environmental Management System by Milton P. Dentch
5. The ISO 45001:2018 – Implementation Handbook: Guidance on Building an Occupational Health and Safety Management System by Milton P. Dentch

6th Semester

IEM-318: PRODUCTION PLANNING AND SCHEDULING

Credit Hours:	3	**Contact Hours:**	48
Pre-requisite:	IEM-215	**Stream:**	MO
Domain:	Engineering	**Knowledge Area:**	Major Based Core (Depth)

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Apply** concepts and techniques for production planning and control in a manufacturing organization	Cognitive	3	3
2	**Develop** production schedules under different conditions	Cognitive	3	3
3	**Integrate** different functions of an organization using an ERP software	Cognitive	4	5

Course Objective and Contents:

This course focuses on production planning and scheduling hierarchy in a manufacturing organization. Starting with demand management and forecasting, the course discusses the components of production planning like sales and operations planning, master production scheduling, and material requirement planning.

The concepts related to production scheduling like single machine scheduling, scheduling in flow shops, batch production, job shops, and network base production systems will be discussed. Case studies in the subject area will be discussed to strengthen the concepts.

The use of software (ERP) for integration of production planning functions with other functions of the organizations is recommended. The students will be taught to develop aggregate production plans using MS Excel solver or R. They will be taught to develop master production schedule and material requirements plans, and distributions requirements plans as well. Hands-on exposure to some ERP software like SAP business one is recommended.

A complex engineering problem within the domain of the course will be assigned to the students (preferably working in groups) by the instructor.

Recommended Books:

Teachers are recommended to use the latest edition of the following books

1. Production Planning and Industrial Scheduling: Examples, Case Studies and Applications by Dileep R. Sule
2. Manufacturing Planning and Control for Supply Chain Management: The CPIM Reference by F. Robert Jacobs, William Lee Berry, et al.
3. Fundamentals of Inventory Management by Paul H. Zipkin
4. Scheduling Theory, Algorithms, and Systems by Michel Gendreau · Jean-Yves Potvin

IEM-324: LEAN PRODUCTION SYSTEM

Credit Hours:	2	**Contact Hours:**	32
Pre-requisite:	Nil	**Stream:**	SD
Domain:	Engineering	**Knowledge Area:**	Major Based Core (Depth)

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Distinguish** between various components and principles of lean production system	Cognitive	2	1
2	**Apply** tools and principles of lean production system to practical case studies	Cognitive	3	7

Course Objective and Contents:

This course introduces students to principles and components of lean production system. The concepts like origins and philosophy of lean production system, types of waste (muda), mura, muri, 5S, visual management, standardized work, Kanban, just-in-time, jidoka, kaizen circle activity, hoshin planning, group technology, and cellular manufacturing are discussed. Value stream mapping and total productive maintenance (TPM) with real world case studies in different sectors like textile and garments manufacturing, automotive and services sector are also covered.

Recommended Books:

Teachers are recommended to use the latest edition of the following books

1. The Lean Toolbox by John R. Bicheno and Matthias Holweg
2. Lean Production Simplified: A Plain-Language Guide to the World’s Most Powerful Production System, by Pascal Dennis
3. The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer by Jeffrey K. Liker

IEM-325 T: DESIGN OF EXPERIMENTS

Credit Hours:	2	**Contact Hours:**	32
Pre-requisite:	IEM-213	**Stream:**	DM
Domain:	Engineering	**Knowledge Area:**	Major Based Core (Depth)

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Develop** appropriate experimental design for engineering experiments under given conditions	Cognitive	4	4
2	**Use** suitable statistical tools to analyze the experimental data	Cognitive	3	4
3	**Design** the product, process or system based on the results of the experiment	Cognitive	4	3

Course Objective and Contents:

This course has IEM-213 as pre-requisite and discusses topics related to off-line and on-line quality control in detail. It teaches the importance, principles, and guidelines to conduct engineering experiments, concepts of replication, blocking, randomization, and control, one-factor experiments, full factorial designs, fractional factorial designs, response surface methods and designs, and Taguchi's orthogonal arrays. The course will be made clear using relevant case studies. Use of state-of-the art software like Minitab or R is recommended.

Recommended Books:

Teachers are recommended to use the latest edition of the following books

1. Statistical Quality Control by Douglas C. Montgomery
2. Statistical Process Control by John S Oakland
3. Statistical Process Control for Real-World Applications by William A. Levinson
4. Design and Analysis of Experiments by Douglas C. Montgomery
5. Design and Analysis of Experiments by Angela Dean, Daniel Voss, Danel Draguljić
6. Quality by Experimental Design by Thomas B. Barker, Andrew Milivojevich
7. Design of Experiments by Max Morris

IEM-325 L: DESIGN OF EXPERIMENTS

Credit Hours:	1	**Contact Hours:**	48
Pre-requisite:	IEM-213	**Stream:**	DM
Domain:	Engineering	**Knowledge Area:**	Major Based Core (Depth)

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Use** software to design and randomize experiments	Cognitive	3	5
2	**Perform** engineering experiments using principles of DOE	Psychomotor	3	9
3	Statistically **analyze** and explain the results of experiments using software	Cognitive	4	4

Course Objective and Contents:

This course has IEM-213 as pre-requisite and discusses topics related to off-line and on-line quality control in detail. It teaches the importance, principles, and guidelines to conduct engineering experiments, concepts of replication, blocking, randomization, and control, one-factor experiments, full factorial designs, fractional factorial designs, response surface methods and designs, and Taguchi's orthogonal arrays. The course will be made clear using relevant case studies. Use of state-of-the art software like Minitab or R is recommended.

Suggested Labs:

The lab part should focus on using state-of-the art software like Minitab or R to create experimental design, plot and analyze the results of an experiment, and deduce results from them.
A complex engineering problem within the domain of the course will be assigned to the students (preferably working in groups) by the lab instructor.

IEM-339 T: TOOL AND DIE DESIGN

Credit Hours:	2	**Contact Hours:**	32
Pre-requisite:	IEM-235	**Stream:**	DM
Domain:	Engineering	**Knowledge Area:**	Major Based Core (Depth)

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Interpret** the tools / die characteristics based on manufacturing process requirements	Cognitive	2	1
2	**Design** production tooling using design principles under given conditions	Cognitive	4	3
3	**Design** inspection tooling using design principles under given conditions	Cognitive	4	3

Course Objective and Contents:

This course introduces students to the design of tools that are used to impart shape to raw material to make the final product e.g. dies for sheet metal working and other forming operations; molds for plastic parts making like injection molds; or help in imparting shape to raw material to make the final product e.g. jigs and fixtures. Design of tools that check whether the shape has been properly imparted to the product e.g. gauges, and inspection fixtures is also discussed.

Recommended Books:

Teachers are recommended to use the latest edition of the following books

1. Fundamentals of Tool Design by Society of Manufacturing Engineers (SME)
2. Tool Design by Donaldson, LeCain, Goold
3. Machinery's Handbook by Industrial Press Inc.
4. Jig and Fixture Design by Edward G. Hoffman
5. Tool Design by H. W. Pollack
6. Manufacturing Engineering and Technology by Kalpakjian, Schmid

IEM-339 L: TOOL AND DIE DESIGN

Credit Hours:	1	**Contact Hours:**	48
Pre-requisite:	IEM-235	**Stream:**	DM
Domain:	Engineering	**Knowledge Area:**	Major Based Core (Depth)

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Develop** inspection tooling using design principles under given conditions	Psychomotor	4	3
2	**Develop** production tooling using design principles under given conditions	Psychomotor	4	3
3	**Use** data obtained from experiment to improve the process	Cognitive	3	4

Course Objective and Contents:

This course introduces students to the design of tools that are used to impart shape to raw material to make the final product e.g. dies for sheet metal working and other forming operations; molds for plastic parts making like injection molds; or help in imparting shape to raw material to make the final product e.g. jigs and fixtures. Design of tools that check whether the shape has been properly imparted to the product e.g. gauges, and inspection fixtures is also discussed.

Suggested Labs:

The lab should focus on the application of concepts learnt in the theory part to design different types of tools, dies, and gauges. The students should be given the drawing of products to design the tools, dies, and gauges. They may be exposed to design attribute gauges and inspection fixtures using suitable tolerances and show their design using standard drafting principles. Similarly, they can be assigned to design the best locating and clamping devices for a jig / fixture design and present their design to the class. The use of standard drafting / designing software like AutoCAD or SolidWorks is recommended to show the results of the design.
A complex engineering problem within the domain of the course will be assigned to the students (preferably working in groups) by the lab instructor.

IEM-345: INDUSTRIAL MARKETING

Credit Hours:	2	**Contact Hours:**	32
Pre-requisite:	Nil	**Stream:**	EM
Domain:	Management	**Knowledge Area:**	Major Based Core (Breadth)

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Explain** the fundamentals of industrial marketing and business buying process	Cognitive	2	1
2	**Apply** marketing activities for a product mix	Cognitive	3	2
3	**Relate** the contemporary issues in the world of business marketing	Cognitive	4	7

Course Objective and Contents:

This course is designed to give the student an overall view of the marketing of industrial goods. It deals with the marketing characteristics of industrial goods, product planning and development, industrial marketing research, marketing channels, strategy, policies and pricing of industrial goods, organization and management of the industrial sales force, industrial advertising and sales promotion, managerial control, selling to the government, and government regulation of industrial marketing. Case studies will be discussed to strengthen the concepts.

Recommended Books:

Teachers are recommended to use the latest edition of the following books

1. Business-to-Business Marketing: Analysis and Practice by Vitale, Giglierano and Pfoertsch
2. Business Marketing Management: B2B by Michael D. Hutt & Thomas W. Speh

IND-356 T: INSTRUMENTATION AND PROCESS CONTROL

Credit Hours:	3	**Contact Hours:**	48
Pre-requisite:	Nil	**Stream:**	N/A
Domain:	Engineering	**Knowledge Area:**	Inter-Disciplinary Engineering Breadth

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Explain** the basic principles and importance of process control in industrial process plants	Cognitive	2	1
2	**Distinguish** between the construction, working, and applications of various sensors	Cognitive	2	2
3	**Explain** the use of block diagrams and the mathematical basis for the design of control systems	Cognitive	3	2
4	**Use** ladder logic for programable logic controllers	Cognitive	3	5

Course Objective and Contents:

Instrumentation and Process Control introduces students to in-depth technical exposure to instrumentation used in process control. With an emphasis on common industrial applications, this course covers the four fundamental instrumentation measurements of temperature, pressure, level, and flow. In addition, position, humidity, moisture, and typical liquid and gas measuring instruments are covered briefly.

Recommended Books:

Teachers are recommended to use the latest edition of the following books

1. Instrumentation and Process Control by Franklyn W. Kirk
2. Process Control Instrumentation Technology by Curtis D. Johnson
3. Fundamentals of Industrial Instrumentation and Process Control by William C. Dunn
4. Instrumentation and Process Control by Terry L.M. Bartelt
5. Instrumentation and Process Control Workbook by Thomas A. Weedon

IND-356 L: INSTRUMENTATION AND PROCESS CONTROL

Credit Hours:	1	**Contact Hours:**	48
Pre-requisite:	Nil	**Stream:**	N/A
Domain:	Engineering	**Knowledge Area:**	Inter-Disciplinary Engineering Breadth

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Interpret** number systems and Boolean logic for discrete control system (Programmable Logic Controllers)	Cognitive	2	1
2	**Develop** programs for PLC in Ladder Logic by utilizing the knowledge of a controller	Psychomotor	3	4
3	**Use** appropriate software tools for the modelling of plant dynamics	Psychomotor	3	5
4	**Follow** safety and general instructions while performing experiments in the lab	Affective	3	8

Course Objective and Contents:

Instrumentation and Process Control introduces students to in-depth technical exposure to instrumentation used in process control. With an emphasis on common industrial applications, this course covers the four fundamental instrumentation measurements of temperature, pressure, level, and flow. In addition, position, humidity, moisture, and typical liquid and gas measuring instruments are covered briefly.

Suggested Labs:

This lab focuses on the use of different sensors and programmable logic controller to monitor and control industrial processes.

A complex engineering problem within the domain of the course will be assigned to the students (preferably working in groups) by the lab instructor.

7th SEMESTER

IEM-419: SUPPLY CHAIN AND LOGISTICS ENGINEERING

Credit Hours:	4	**Contact Hours:**	64
Pre-requisite:	IEM-215, IEM-316	**Stream:**	MO
Domain:	Engineering	**Knowledge Area:**	Major Based Core (Depth)

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Explain** the importance of supply chain and logistics engineering in the modern era	Cognitive	2	1
2	**Solve** mathematical models for supply chain & logistics using software	Cognitive	4	5
3	**Apply** modern tools and techniques to better manage supply chain and logistics functions	Cognitive	4	12

Course Objective and Contents:

This course introduces the students to quantitative techniques for supply chain design and planning. The course covers mathematical techniques including forecasting models like moving average, exponential smoothing and causal methods, aggregate planning models, deterministic inventory models like economic order quantity and its special cases, newsvendor model, probabilistic inventory models, and transportation models. Practical software tools including Gurobi Optimizer and Microsoft Excel are used to formulate and solve supply chain models.

The course introduces students to science of movement and storage of goods in a supply chain. It covers logistics strategy, models for facility location decision, facilities layout design, logistic network design, controlling material flow, warehousing and material handling, use of IT in logistics, reverse logistics, 3PL, 4PL, InCoTerms, different parties involved in import and export, and efficient use of transportation. This course aims to convey the intuitions behind many logistics concepts and to demonstrate the application of operations research techniques to this area.

Recommended Books:

Teachers are recommended to use the latest edition of the following books

1. Supply Chain Management for Engineers by Samuel H. Huang
2. Supply Chain Network Design: Understanding the Optimization behind Supply Chain Design Projects by Michael Watson, Sara Hoormann, Peter Cacioppi, Jay Jayaraman

3. Modeling the Supply Chain by Jeremy F. Shapiro
4. Supply Chain Management: Strategy, Planning, and Operation by Sunil Chopra
5. Introduction to Logistics Engineering by G. Don Taylor
6. Facilities Planning by James A. Tompkins, John A. White, Yavuz A. Bozer, J. M. A. Tanchoco
7. Manufacturing Facilities: Location, Planning, and Design by Dileep R. Sule

IEM-446: ENGINEERING ECONOMICS AND ACCOUNTING

Credit Hours:	3	**Contact Hours:**	48
Pre-requisite:	Nil	**Stream:**	EM
Domain:	Management	**Knowledge Area:**	Major Based Core (Breadth)

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Use** tools of engineering economics to plan and control business activities for decision making	Cognitive	3	3
2	**Use** tools of accounting to plan and control business activities for decision making	Cognitive	3	3

Course Objective and Contents:

This course introduces the students to employ the fundamentals concepts of engineering economics, break even analysis, balance sheet, cost and investment analysis, basis for comparison of alternatives, time value of money, decision making in present economy, evaluating replacement alternatives, cash flow, interest formulas and equivalence, depreciation, economic analysis of operations, economic analysis of projects.

The course also introduces the recording, classifying, analyzing, summarizing, and allocating costs associated with a process, and then developing various courses of action to control the costs. It focuses on how to improve a business with constraint analysis, target costing, capital budgeting, price setting, and cost of quality analysis.

The course also addresses the essential tasks of inventory valuation and job costing, and shows how to create a cost collection system for these activities. The objective is to equip students with essential tools needed to foster more profitable decision-making. The course will use Excel to solve problems.

Recommended Books:

Teachers are recommended to use the latest edition of the following books

1. Engineering Economy by Leland Blank, Anthony Tarquin
2. Fundamentals of Engineering Economics by Chan S. Park
3. Engineering Economy by William G. Sullivan, Elin M. Wicks and C. Patrick Koelling
4. Cost Accounting Fundamentals: Essential Concepts and Examples by Steven M. Bragg
5. Principles of Cost Accounting by Edward J. Vanderbeck, Maria R. Mitchell
6. Fundamentals of Cost Accounting by William N. Lanen Professor, Shannon Anderson, Michael W Maher
7. Principles of Managerial Finance by Lawrence J. Gitman and Chad J. Zutter
8. Finance and Accounting for Nonfinancial Managers by Steven A. Finkler

IEM-447 T: PROJECT MANAGEMENT

Credit Hours:	2	**Contact Hours:**	32
Pre-requisite:	Nil	**Stream:**	EM
Domain:	Management	**Knowledge Area:**	Major Based Core (Breadth)

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Explain** the basics of Project Management and its literature	Cognitive	2	1
2	**Develop** project selection criteria to choose a project among available options	Cognitive	3	11
3	**Prepare** the project plan using CPM & PERT and other management techniques	Cognitive	3	11
4	**Apply** solutions by using different management techniques and practices to ensure project's success	Cognitive	4	11

Course Objective and Contents:

The course enables the students to understand and implement modern project management techniques using software. The major areas of focus include: project management concepts, project proposals and feasibility, initiating, planning, execution, monitoring and control, closing and exit strategy. Knowledge areas are covered as per PMBOK/PRINCE-2. The course gives students hands-on exposure to a state-of-the-art project management software using case studies.

Recommended Books:

Teachers are recommended to use the latest edition of the following books

1. Project Management: A Systems Approach to Planning, Scheduling, and Controlling by Harold Kerzner
2. Case studies in project management by Harold Kerzner
3. Project Management for Engineering, Business and Technology by John M. Nicholas, Herman Steyn

IEM-447 L: PROJECT MANAGEMENT

Credit Hours:	1	**Contact Hours:**	48
Pre-requisite:	Nil	**Stream:**	EM
Domain:	Management	**Knowledge Area:**	Major Based Core (Breadth)

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Show** the details of a project using project management software	Cognitive	3	1
2	**Use** project management software to effectively plan and control a project	Cognitive	3	11
3	**Contribute** as an effective team member for assigned task	Cognitive	3	9

Course Objective and Contents:

The course enables the students to understand and implement modern project management techniques using software. The major areas of focus include: project management concepts, project proposals and feasibility, initiating, planning, execution, monitoring and control, closing and exit strategy. Knowledge areas are covered as per PMBOK/PRINCE-2. The course gives students hands-on exposure to a state-of-the-art project management software using case studies.

Suggested Labs:

The lab should focus on using software like MS Project or Primavera to plan, monitor, and control a project. The use of case studies for this purpose is recommended.
A complex engineering problem within the domain of the course will be assigned to the students (preferably working in groups) by the lab instructor.

IEM-448: ENTREPRENEURSHIP

Credit Hours:	3	**Contact Hours:**	48
Pre-requisite:	Nil	**Stream:**	EM
Domain:	Management	**Knowledge Area:**	Major Based Core (Breadth)

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Identify** business opportunities using various methods	Cognitive	2	2
2	**Survey** the market to rapidly develop and test ideas and gather quick customer feedback	Cognitive	3	7
3	**Develop** and communicate a new business concept in an efficient, effective and compelling manner	Cognitive	4	10
4	**Develop** the ability to translate a business idea into marketing and financial plans	Cognitive	5	12

Course Objective and Contents:

After studying this course, the students should be able to evaluate and improve their entrepreneurial potential and be able to generate and test innovative ideas suitable for commercialization. Topics covered include: The role of entrepreneurship in economic development, characteristics of successful entrepreneurs, types of start-ups; Creativity, methods of generating innovative ideas; Legal issues including patents, trademarks, copyrights, trade secrets, licensing, liability, insurance, contracts etc.; The concept of planning model, pre-start-up stage, start-up stage, early growth stage, later growth stage, fundamentals of a feasibility plan; Role of manufacturing, products and technology, identifying opportunities. Students will also be exposed to basic concepts of industrial marketing like: segmentation, targeting, differentiation and positioning; marketing strategies; 4Ps of marketing; and digital marketing.

Recommended Books:

Teachers are recommended to use the latest edition of the following books

1. Entrepreneurship by Hisrich, Peters and Shepherd
2. Effectual Entrepreneurship by S. Read, S. Saraswathy, N. Dew and R. Wittbank
3. Fundamentals of Entrepreneurship by S. Ariffin, I. A. Wahab, Z. Hambali
4. Entrepreneurship by Bruce Barringer
5. Entrepreneurship and new value creation by Fayolle A.
6. Marketing Management by Philip T. Kotler and Kevin Lane Keller
7. Marketing Management by Mark Johnston and Greg Marshall

IEM-461 L: FINAL YEAR PROJECT PHASE-I

Credit Hours:	3	**Contact Hours:**	144
Pre-requisite:	Nil	**Stream:**	N/A
Domain:	Engineering	**Knowledge Area:**	N/A

FYP PHASE I: PRESENTATION RUBRIC

Batch:		**Supervisor:**
Title:		
Group Members	**Roll No**	**Name of Student**

Sr#	Domains	Rubrics for Evaluation	Scale 1	2	3	4	5	PLO	Final Weightage
P1 PR1	Technical Domain (60%)	1. Identification of the problem						PLO-02 Problem Analysis	35%
		2. Review of the relevant literature regarding tools/techniques							
		3. Identifying the gap							
		4. Defining the problem statement							
		5. Formulation of the project objectives							
P1 PR2		1. Understanding the methods applied to solve the problem						PLO-01 Engineering Knowledge	25%
		2. Proposing the methodology							
		3. Applying relevant technical knowledge							
P1 PR3	Professional Domain (40%)	1. Understanding of the SDGs						PLO-07 Environment & Sustainability	5%
		2. Mapping of relevant SDGs with the selected problem							
		3. Level of concerned SDGs							
		4. Mapping with relevant PLOs, WKs, ECs, and SDGs*							
P1 PR4		1. Overall behaviour of the students						PLO-08 Ethics	5%
		2. Similarity report / Authenticity of the work							
		3. Authenticity of data collected (Picture, Video etc)							
P1 PR5		1. Work effectively as a team/ team player.						PLO-09 Individual & Teamwork	5%
		2. Actively contributes to support collective decision-making.							
P1 PR6		1. Readability of graphs, figures, and tables						PLO-10 Communication	10%
		2. Presentation (appearance, eye contact, body language, etc.)							
		3. React effectively to the Q/A							
P1 PR7		1. Formulating the Gantt Chart						PLO-11 Project Management	10%
		2. Follow the timelines of the Gantt Chart							
		3. Expected Cost Calculation							
		4. Resource Management							
P1 PR8		1. Recognising the importance of lifelong learning						PLO-12 Lifelong Learning	5%
		2. Pursuing lifelong learning in the context of technical development.							

***This mapping is with reference to PEC manual 2019 3rd edition**

FYP PHASE I: PRESENTATION=60% **Sub-Total=_____**

5 (Excellent) = All criteria are met or followed with rare mistakes.

4 (Good) = Most criteria are met with only a few mistakes.

3 (Fair) = Many criteria are not met and/or there are many mistakes.

2 (Poor) = Most criteria are not met.

1 (No effort) = No effort to meet criteria.

Assessor Name & Signature

FYP PHASE I: REPORT RUBRICS

Batch:	**Supervisor:**
Title:	

Group Members	**Roll No**	**Name of Student**

Sr#	Domains	Rubrics for Evaluation	Scale 1	2	3	4	5	PLO	Final Weightage
P1 RR1	Technical Domain (60%)	1. Identification of the problem						PLO-02 Problem Analysis	35%
		2. Review of the relevant literature regarding tools/techniques							
		3. Identifying the gap							
		4. Defining the problem statement							
		5. Formulation of the project objectives							
		6. Mapping with relevant PLOs, WKs, ECs, SDG and CEP Attributes*							
P1 RR2		1. Understanding the methods applied to solve the problem						PLO-01 Engineering Knowledge	25%
		2. Proposing the methodology							
		3. Applying relevant technical knowledge							
		4. Mapping with relevant PLOs, WKs, ECs, SDG and CEP Attributes*							
P1 RR3	Professional Domain (40%)	1. Understanding of the SDGs						PLO-07 Environment & Sustainability	5%
		2. Mapping of relevant SDGs with the selected problem							
		3. Level of concerned SDGs							
		4. Mapping with relevant PLOs, WKs, ECs, SDG and CEP Attributes*							
P1 RR4		1. Overall behaviour of the students						PLO-08 Ethics	5%
		2. Similarity report / Authenticity of the work							
		3. Authenticity of data collected (Picture, Video etc)							
		4. Mapping with relevant PLOs, WK, ECs and SDG*							
P1 RR5		1. Work effectively as a team/ team player.						PLO-09 Individual & Teamwork	5%
		2. Actively contributes to support collective decision-making.							
		3. Mapping with relevant PLOs, WK, ECs and SDG*							
P1 RR6		1. Organization of report (Intro., Literature Review, Proposed methodology)						PLO-10 Communication	10%
		2. Report format and style							
		3. English grammar and language							
		4. Readability of graphs, figures, and tables							
		5. Mapping with relevant PLOs, WKs, ECs and SDG*							
P1 RR7		1. Formulating the Gantt Chart						PLO-11 Project Management	10%
		2. Follow the timelines of the Gantt Chart							
		3. Expected Cost Calculation							
		4. Resource Management							
		5. Mapping with relevant PLOs, WKs, ECs and SDG*							
P1 RR8		1. Recognising the importance of lifelong learning						PLO-12 Lifelong Learning	5%
		2. Pursuing lifelong learning in the context of technical development.							
		3. Mapping with relevant PLOs, WKs, ECs and SDG*							

***This mapping is with reference to PEC manual 2019 3rd edition**

FYP PHASE I: REPORT= 40% **Sub-Total=_____**

5 (Excellent) = All criteria are met or followed with rare mistakes.

4 (Good) = Most criteria are met with only a few mistakes.

3 (Fair) = Many criteria are not met and/or there are many mistakes.

2 (Poor) = Most criteria are not met.

1 (No effort) = No effort to meet criteria.

Assessor Name & Signature

Description:

Students have to work in groups to undertake a project within the domain of industrial engineering and management or an inter- or multi-disciplinary area involving the application of IEM tools, techniques, and concepts both in depth and breadth.

The project will span over a period of one year, starting from 7th semester (phase I) and continuing in 8th semester (phase II). Evaluation of students' performance will be carried out at different stages using criteria and procedure as approved by the Institute.

8th SEMESTER

IEM-426 T: DATA SCIENCE

Credit Hours:	3	**Contact Hours:**	48
Pre-requisite:	IEM-213, IND-255	**Stream:**	SD
Domain:	Engineering	**Knowledge Area:**	Major Based Core (Depth)

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Explain** the importance of data science and its applications in different fields	Cognitive	2	1
2	**Analyze** data and results using a vast array of real-world examples	Cognitive	3	4
3	**Use** data patterns to make decisions and predictions with real-world examples	Cognitive	3	12

Course Objective and Contents:

This course is designed to provide an introduction to the emerging field of data science. It combines three perspectives: inferential thinking, computational thinking, and real-world applications. Given data arising from some real-world phenomenon, students are taught to analyze that data so as to understand that phenomenon. The course builds on critical concepts and skills in computer programming, statistical inference and machine learning, in conjunction with hands-on analysis of real-world data sets such as economic data, document collections, geographical data, and social networks. The course will also have at least one project that addresses a hot data science problem.

Recommended Books:

Teachers are recommended to use the latest edition of the following books

1. An Introduction to Data Science by Jeffrey S. Saltz, Jeffrey M. Stanton
2. Data Science by John D. Kelleher, Brendan Tierney
3. Numsense! Data Science for the Layman: No Math Added by Annalyn Ng, Kenneth Soo
4. The Art of Data Science by Roger Peng, Elizabeth Matsui
5. Big Data Science & Analytics: A Hands-On Approach by Arshdeep Bahga, Vijay Madisetti

IEM-426 L: DATA SCIENCE

Credit Hours:	1	**Contact Hours:**	48
Pre-requisite:	IEM-213, IND-255	**Stream:**	SD
Domain:	Engineering	**Knowledge Area:**	Major Based Core (Depth)

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Load** and clean real-world complex or noisy data	Cognitive	4	5
2	**Analyze** big data using programming language and principles of data science	Cognitive	4	4
3	**Employ** appropriate methodologies in order to extract meaningful information for decision making	Cognitive	3	4

Course Objective and Contents:

This course is designed to provide an introduction to the emerging field of data science. It combines three perspectives: inferential thinking, computational thinking, and real-world applications. Given data arising from some real-world phenomenon, students are taught to analyze that data so as to understand that phenomenon. The course builds on critical concepts and skills in computer programming, statistical inference and machine learning, in conjunction with hands-on analysis of real-world data sets such as economic data, document collections, geographical data, and social networks. The course will also have at least one project that addresses a hot data science problem.

Suggested Labs:

The lab enables students to use programming language like R or Python to visualize large data sets and extract information for meaningful decision making.

A complex engineering problem within the domain of the course will be assigned to the students (preferably working in groups) by the lab instructor.

IEM-427: HEALTH, SAFETY, AND ENVIRONMENT

Credit Hours:	3	**Contact Hours:**	48
Pre-requisite:	Nil	**Stream:**	SD
Domain:	Engineering	**Knowledge Area:**	Major Based Core (Breadth)

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Identify** the importance of health and safety management in industries	Cognitive	2	1
2	**Calculate** quantitative risks and apply various accident investigation techniques	Cognitive	3	7
3	**Apply** the general hierarchy of controls	Cognitive	3	7
4	**Analyze** the hazards associated with variety of industrial operations and equipment	Cognitive	4	6
5	**Analyze** various standards and systems developed for the well being of society and their effectiveness	Cognitive	4	7

Course Objective and Contents:

This course introduces students to the importance of occupational health and safety and how to develop health and safety program. The course will cover hazard identification and analysis, hazard reporting system, types of accidents, accident investigation, occupational injuries and illnesses, industrial hygiene, intervention, control, and prevention of occupational accidents, injuries, and illnesses, safety and health training, OSHA compliance, ergonomics and safety, behavior-based safety. Issues, challenges, and case studies of occupational health and safety in Pakistani context. The course also covers ISO 45001 standard.

Recommended Books:

Teachers are recommended to use the latest edition of the following books

1. Occupational Safety and Health for Technologists, Engineers, and Managers by David L. Goetsch
2. Occupational Health and Safety for the 21st Century by Robert H. Friis
3. Fundamentals of Occupational Safety and Health by Mark A. Friend, James P. Kohn
4. Occupational Safety and Health by Charles D. Reese

IEM-449: TECHNOLOGY AND INNOVATION MANAGEMENT

Credit Hours:	2	**Contact Hours:**	32
Pre-requisite:	Nil	**Stream:**	EM
Domain:	Management	**Knowledge Area:**	Major Based Core (Breadth)

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Understand** the role of technology and innovation in product design, development and launch	Cognitive	2	1
2	**Learn** how emerging market firms gain competitive advantage through design and development of locally relevant products	Cognitive	4	2
3	**Apply** strategic and operational management frameworks and tools necessary for innovation leadership and decision making	Cognitive	4	9

Course Objective and Contents:

An effective process for conceiving, developing and launching new products or services is critical to becoming competitive in most industries. This course includes key concepts like new product development strategy, types of product development strategies and steps. This course involves: Organizational integration of the work of functional specialists, industrial designers, and other key participants within the firm; Reducing the time-to-market while meeting cost and quality targets; Managing cross-functional projects and inherent technological risks while keeping a focus on changing customer requirements. These challenges are examined in relation to the business level strategy of the firm, its competitive challenges, the technology life cycle and the product life cycle. We will also focus on the potential for firms to build markets and create demand for new products.

Recommended Books:

Teachers are recommended to use the latest edition of the following books

1. Innovation Management and New Product Development by Paul Trott
2. Product Design and Development by Ulrich, Karl, and Steven Eppinger
3. The Design of Everyday Things: Revised and Expanded Edition by Don Norman, Neil Hellegers, et al.

IND-457: INDUSTRIAL MAINTENANCE

Credit Hours:	3	**Contact Hours:**	48
Pre-requisite:	Nil	**Stream:**	N/A
Domain:	Engineering	**Knowledge Area:**	Inter-Disciplinary Engineering Breadth

Course Learning Outcomes (CLOs):

At the end of this course, students will be able to:

CLOs	Description	Domain	Taxonomy Level	PLOs
1	**Identify** the role of maintenance activities in a modern enterprise	Cognitive	2	7
2	**Use** contemporary maintenance management practices for proper maintenance of equipment	Cognitive	3	5
3	**Employ** the necessary engineering techniques used for maintenance of mechanical equipment	Cognitive	3	5

Course Objective and Contents:

This course covers the fundamentals concepts and techniques of maintenance performed in industrial sector. It covers maintenance engineering roles and responsibilities and different types of maintenance strategies. The basic working principles, possible malfunctions and their causes, and the maintenance techniques for different equipment like shafts, bearings, couplings, gears, compressors, valves, fans, pumps, evaporators, boilers, and heat exchangers is discussed. Course also introduces the basics of lubrication and tribology. Modern topics like condition monitoring, reliability-centered maintenance, and total productive maintenance (TPM) are also covered.

Recommended Books:

Teachers are recommended to use the latest edition of the following books

1. Maintenance Fundamentals by R Keith Mobley
2. Rules of Thumb for Maintenance and Reliability Engineers by Ricky Smith, R. Keith Mobley
3. Maintenance Engineering Handbook by Keith Mobley, Lindley Higgins, Darrin Wikoff

IEM-463 L: FINAL YEAR PROJECT PHASE-II

Credit Hours:	3	**Contact Hours:**	144
Pre-requisite:	Nil	**Stream:**	N/A
Domain:	Engineering	**Knowledge Area:**	N/A

FYP PHASE II: REPORT RUBRICS

Sr #	Domains	Rubrics for Evaluation	Scale 1	2	3	4	5	PLO	Final Weightage
PII RR1	Technical Domain (60%)	1. Design solution/processes for pre-defined objectives						PLO-03 Design and development of Solution	20%
		2. Development of the solution for pre-defined objectives							
		3. Mapping with relevant PLOs, WK, ECs, SDG and CEP Attributes*							
PII RR2		1. The selection of the parameters						PLO-04 Investigation	25%
		2. Analysis of the data & results							
		3. Detailed discussion of the results							
		4. Mapping with relevant PLOs, WK, ECs, SDG and CEP Attributes*							
PII RR3		1. Appropriate tool/technique selection						PLO-05 Modern Tool Usage	15%
		2. Justification of the selected tool/technique							
		3. Application of the tool/technique							
		4. Mapping with relevant PLOs, WKs, ECs, SDG and CEP Attributes*							
PII RR4	Professional Domain (40%)	1. Health & Safety practices						PLO-06 The Engineer & Society	5%
		2. Professional Engineering Practices							
		3. Mapping with relevant PLOs, WKs, ECs, SDG and CEP Attributes*							
PII RR5		1. Mapping of relevant SDG's						PLO-07 Environment & Sustainability	5%
		2. Level of concerned SDG's							
		3. Mapping with relevant PLOs, WKs, ECs, SDG and CEP Attributes*							
PII RR6		1. Overall behaviour of the students						PLO-08 Ethics	5%
		2. Similarity report / Authenticity of the work							
		3. Authenticity of data collected (picture, video etc)							
		4. Mapping with relevant PLOs, WK, ECs and SDG							
PII RR7		1. Work effectiveness as team/ team player						PLO-09 Individual & Teamwork	5%
		2. Actively contributes to support collective decision-making.							
		3. Mapping with relevant PLOs, WK, ECs and SDG*							
PII RR8		1. Organization of report (Introduction, Literature Review, Data Collection, Data Analysis, R&D, Conclusion and Referencing)						PLO-10 Communication	10%
		2. Report style							
		3. Graphs, figure, table are readable							
		4. English grammar							
		5. Proper references							
		6. Mapping with relevant PLOs, WKs, ECs and SDG*							
PII RR9		1. Follow the timelines of the Gantt chart						PLO-11 Project Management	5%
		2. Resource management							
		3. Cost estimation							
		4. Mapping with relevant PLOs, WKs, ECs and SDG*							
PII RR10		1. Recognising the importance of lifelong learning						PLO-12 Lifelong Learning	5%
		2. Pursuing lifelong learning in the context of technical development.							
		3. Mapping with relevant PLOs, WKs, ECs and SDG*							

***This mapping is with reference to PEC manual 2019 3rd edition**

FYP PHASE II: REPORT=60% **Sub-Total=_____**

5 (Excellent) = All criteria are met or followed with rare mistakes.

4 (Good) = Most criteria are met with only a few mistakes.

3 (Fair) = Many criteria are not met and/or there are many mistakes.

2 (Poor) = Most criteria are not met.

1 (No effort) = No effort to meet criteria.

Assessor Name & Signature

FYP PHASE II: VIVA VOCE RUBRICS

Sr. #	Domains	Rubrics for Evaluation	Scale					PLO	Final Weightage
			1	2	3	4	5		
PII VR1	Technical Domain (60%)	1. Design solution/processes for pre-defined objectives						PLO-03 Design and development of Solution	20%
		2. Development of the solution for pre-defined objectives							
PII VR2		1. The selection of the parameters						PLO-04 Investigation	25%
		2. Analysis of the data & results							
		3. Detailed discussion of the results							
PII VR3		1. Appropriate tool/technique selection						PLO-05 Modern Tool Usage	15%
		2. Justification of the selected tool/technique							
		3. Application of the tool/technique							
PII VR4	Professional Domain (40%)	1. Health & Safety practices						PLO-06 The Engineer & Society	5%
		2. Professional Engineering Practices							
PII VR5		1. Mapping of relevant SDG's						PLO-07 Environment & Sustainability	5%
		2. Level of concerned SDG's							
		3. Mapping with relevant PLOs, WKs, ECs, SDG and CEP Attributes*							
PII VR6		1. Overall behaviour of the students						PLO-08 Ethics	5%
		2. Authenticity of data collected (picture, video etc)							
PII VR7		1. Work effectiveness as team/ team player						PLO-09 Individual & Teamwork	5%
		2. Actively contributes to support collective decision-making							
		3. Authenticity of data collected (picture, video etc)							
PII VR8		1. React effectively to the Q/A						PLO-10 Communication	10%
		2. Spoken and fluency							
		3. Eye contact, body language, etc.							
PII VR9		1. Follow the timelines						PLO-11 Project Management	5%
		2. Resource management							
		3. Cost estimation							
PII VR10		1. Recognising the importance of lifelong learning						PLO-12 Lifelong Learning	5%
		2. Pursuing lifelong learning in the context of technical development.							

***This mapping is with reference to PEC manual 2019 3rd edition**

FYP PHASE II: VIVA VOCE=40% **Sub-Total=_____**

5 (Excellent) = All criteria are met or followed with rare mistakes.
4 (Good) = Most criteria are met with only a few mistakes.
3 (Fair) = Many criteria are not met and/or there are many mistakes.
2 (Poor) = Most criteria are not met.
1 (No effort) = No effort to meet criteria.

Assessor Name & Signature

Description:

Students have to work in groups to undertake a project within the domain of industrial engineering and management or an inter- or multi-disciplinary area involving the application of IEM tools, techniques, and concepts both in depth and breadth.

The project will span over a period of one year, starting from 7th semester (phase I) and continuing in 8th semester (phase II). Evaluation of students' performance will be carried out at different stages using criteria and procedure as approved by the Institute.