

Curriculum for

BS MECHANICAL ENGINEERING

» BUIITEMS, Quetta «

Effective Spring 2026

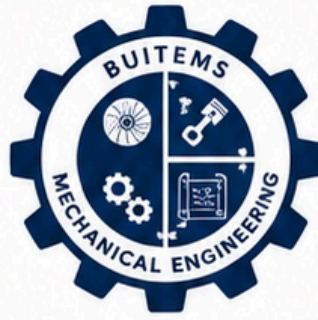


Department of Mechanical Engineering

Balochistan University of Information Technology,
Engineering and Management Sciences

BUIITEMS, Quetta





BUITEMS

BS Mechanical Engineering Curriculum



Department of Mechanical Engineering

Faculty of Engineering & Architecture

Balochistan University of Information Technology, Engineering and Management Sciences

The Department of Mechanical Engineering at BUITEMS prepares graduates for modern engineering practice through strong foundations in design, manufacturing, thermofluids, materials, computation, laboratory work, and professional skills. Established in Fall 2014, the department is committed to quality education, innovation, outcome-based learning, and the development of competent engineers for national and global challenges. This is the 4th updated curriculum, and the latest curriculum is effective from Spring 2026.



ESTABLISHED:
Fall 2014



CURRICULUM
REVISIONS:
4 Updates



LATEST CURRICULUM
EFFECTIVE:
Spring 2026



Main Website:
<https://www.buitms.edu.pk/>



Department of Mechanical Engineering:
<https://buitms.edu.pk/Profile/TKTU/Faculty/FOE/DPMCE>



Faculty of Engineering & Architecture:
<https://www.buitms.edu.pk/Profile/TKTU/Faculty/FOE>

Message by the Vice Chancellor

It is with great pleasure that I welcome you to the Balochistan University of Information Technology, Engineering and Management Sciences (BUIITEMS). We take immense pride in being a premier institution dedicated to delivering high-quality education, underpinned by a distinguished research faculty and state-of-the-art infrastructure.

Our mission is to cultivate new knowledge through rigorous research and innovative practices that carry profound local, regional, and global impact. At BUIITEMS, we seamlessly integrate academic learning with real-world

experience, ensuring our students are prepared for the 'Future of Work'. Our laboratories are equipped with cutting-edge technologies to meet industrial demands, while our esteemed faculty offers high-quality research, specialized consulting, and professional development courses to businesses and public entities. Our classroom instruction is continuously enriched by contemporary research and global best practices. We bolster student development through guest lectures, workshops, vocational training, and career seminars focused on essential employability skills. Consequently, our graduates emerge as visionary leaders, fully equipped to provide innovative solutions to complex business, societal, and industrial challenges.

Beyond academics, BUIITEMS offers national-level sports facilities, high-quality accommodation, and reliable transport services to ensure a holistic campus experience. Our strategic proximity to the Quetta Airport further enhances our connectivity, providing seamless access to national and global opportunities.

Under the esteemed guidance of the Honorable Governor of Balochistan, our Chancellor, we remain steadfast in our commitment to supporting and mentoring our students, empowering them to become highly successful professionals and responsible global citizens. I eagerly look forward to welcoming you to our vibrant academic community.



Khalid Hafeez PhD (TI)

Professor of Digital Transformation

Fellow Royal Society of Arts (RSA-UK), Fellow Chartered Management Institute (CMI-UK),
Senior Fellow Higher Education Academy (SFHEA-UK), Certified Six Sigma Master Black Belt (SSMBB-US),
Certified European Foundation of Quality Management (EFQM-Brussels-Belgium),
Certified Lean Systems and Process Manager (Herrington Institute-US),
Certified Project Manager (Herrington Institute-US),
Certified Natural Linguistic Programming (NLP-UK)

Message by the Pro Vice Chancellor

Welcome to BUIEMS, a vibrant institution steadfastly committed to fostering academic excellence, critical thinking, and social responsibility. As you embark on your educational journey, our goal is to provide a dynamic environment that nurtures innovation, leadership, and global awareness. We aim to equip you with the knowledge and resilience required to make meaningful contributions to society.

Profile of the Pro Vice Chancellor

Prof. Dr. Mirwais Kasi has been an integral part of the University of Balochistan since 2003, making significant contributions to the field of International Relations and Social Sciences. He graduated from Government College Lahore and earned his MSc in International Relations from Quaid-e-Azam University, Islamabad. He obtained his M.Phil degree from the Area Study Center for Middle East & Arab Countries, UOB, researching the “Indo-Israel Nexus: Threats and Options for Pakistan,” and completed his PhD in International Relations from UOB, focusing on the regional and global implications of Pakistan-China relations. Additionally, he holds an LLB degree and is an IVLP-alumnus specializing in US Foreign Policy. Dr. Kasi has held several prominent leadership roles, notably serving as the Chairperson of the Department of International Relations for seven consecutive years, where he played a crucial role in shaping the curriculum and driving research output[cite: 1]. He also served as the Director of the Area Study Center for Middle East and Arab Countries (UOB), which is recognized as Pakistan’s only policy think tank focusing on Middle Eastern issues. His extensive teaching portfolio includes serving at BUIEMS, SBKWU, Law College Quetta, and City Law College Quetta.

As an active member of the advisory boards for numerous prominent journals, Dr. Kasi has authored numerous articles and papers addressing critical geopolitical and social issues[cite: 1]. For the past two years, he has served as an external expert for curriculum development at the National Defence University Islamabad for Command & Staff College Quetta[cite: 1]. Having supervised a significant number of M.Phil and PhD students, he is dedicated to fostering the next generation of scholars.

In addition to his academic contributions, Dr. Kasi has facilitated international educational opportunities as a focal person for the Erasmus Mundus Scholarship from Balochistan[cite: 1]. Beyond academia, he is a dynamic sportsman with a passion for water sports, particularly canoeing, where he has won numerous medals in various competitions[cite: 1].



Prof. Dr. Mirwais Kasi

Pro Vice Chancellor, BUIEMS

Message by the Dean

Welcome to the Faculty of Engineering and Architecture, a place where innovation seamlessly meets excellence.

Our faculty is steadfastly committed to providing a rigorous academic environment that bridges strong theoretical foundations with cutting-edge research and real-world practice. We offer dynamic programs designed to inspire curiosity, foster critical thinking, and equip our students with the advanced skills necessary to address the multi-disciplinary challenges of tomorrow.

At both the undergraduate and postgraduate levels, we actively cultivate a culture of creativity, collaboration, and continuous research. Our dedicated faculty members serve not only as educators but as mentors and active researchers, guiding students to explore, innovate, and excel in their respective fields. In perfect alignment with the university's overarching mission, we place a strong emphasis on instilling ethical values, professional integrity, and a profound sense of social responsibility. These principles are essential cornerstones as we prepare the next generation of engineers and architects to make meaningful, sustainable contributions to society.

As Dean, I warmly invite you to join us on this exciting educational journey. Embrace the academic challenges, engage deeply with your studies, and contribute actively to the vibrant community we are building together. I am confident that your time here will be both transformative and deeply rewarding, paving the way for a bright and highly impactful professional future.



Engr. Dr. Ghulamullah Kakar

Dean, Faculty of Engineering and Architecture

Ph.D. Mechanical Engineering (University of Malaya, Malaysia)

M.Engg. Chemical Engineering (UKM, Malaysia)

B.E. Chemical Engineering (NED UET, Pakistan)

ghulamullah@buitms.edu.pk

Message by the Chairperson

Welcome to the Department of Mechanical Engineering at BUITEMS. Our department is deeply committed to delivering a forward-looking education that equips our students with the analytical prowess, innovative mindset, and practical skills required to excel in today's rapidly evolving industrial landscape. We pride ourselves on cultivating a robust culture of research, technical excellence, and hands-on learning.

Profile of the Chairperson

Dr. Ali Nawaz Mengal earned his Ph.D. in Mechanical Engineering, specializing in Alternative Energy, from Universiti Teknologi Petronas, Malaysia. He also holds an M.Sc.

in Mechanical Engineering Design from NED UET, Karachi, and a B.E. from UET Taxila, Pakistan. With over 21 years of distinguished academic and professional experience, he serves as a Professor of Mechanical Engineering at BUITEMS, Quetta, having previously held the esteemed positions of Dean of Engineering and Department Chair. In 2019, Dr. Mengal was appointed as the founding Vice Chancellor of Mir Chakar Khan Rind University, Sibi, successfully overseeing its comprehensive academic and administrative establishment. As a Principal Investigator, he has spearheaded high-impact research projects focusing on composite materials and renewable energy. His research excellence has secured worldwide recognition, highlighted by more than 40 peer-reviewed publications and a published book chapter.

His extensive global engagement includes participating in faculty development programs in the USA and Malaysia, presenting at numerous national and international conferences, and facilitating critical academic-industry Memorandums of Understanding (MoUs). Furthermore, he actively contributes to the broader academic community through rigorous thesis evaluations, leading program accreditation efforts, and serving as a frequent peer reviewer for esteemed scientific journals.



Prof. Dr. Ali Nawaz Mengal

Chairperson, Department of Mechanical Engineering

ali.nawaz@buitms.edu.pk

External Expert on Board of Studies

Prof. Dr. Ahmad Hussain is a distinguished academic and mechanical engineer with over 30 years of experience in teaching, research, and university administration. He currently serves as a Professor in the Department of Mechanical Engineering and as the Dean of the Faculty of Engineering and Applied Sciences at DHA Suffa University (DSU) in Karachi, Pakistan. He holds a Ph.D. in Mechanical Engineering (Thermo-fluids) from University Technology Malaysia, Johor, which he completed under a Commonwealth Scholarship in 2006.



His foundational academic background includes an M.Sc. in Nuclear Engineering from the Centre for Nuclear Studies (affiliated with PIEAS) in 1991, and a B.E. in Mechanical Engineering from NED University of Engineering & Technology in 1989. Over his extensive career, Dr. Hussain has held numerous leadership and research positions. Previously, he served as the Director of the Office of Research, Innovation and Commercialization (ORIC) at SZABIST and as a Tenure Track Professor at NED University. Internationally, he worked as an Advisor and Researcher at King Abdulaziz University (KAU) in Saudi Arabia, where he secured research grants, contributed to QS Ranking advancements, and participated in ABET accreditation processes. Earlier in his career, he spent two decades at the Karachi Institute of Power Engineering (KINPOE) as a faculty member addressing design issues for Pakistan's first installed nuclear power plant.

Dr. Hussain specializes in Thermofluids, Pyrolysis, combustion, and computational fluid dynamics (CFD). He has published over 100 papers in peer-reviewed international journals. According to Google Scholar, he maintains a high-impact academic profile with over 4,300 citations, an h-index of 24, and an i10-index of 56. Among his most notable publications are a highly cited 2012 paper in **Bioresource Technology** on the pyrolysis of date palm biomass and a 2014 study in **Energy Conversion and Management** regarding date palm waste gasification.

Bridging academia and practical engineering, Dr. Hussain holds a recognized US Patent and is officially recognized by the Higher Education Commission (HEC) of Pakistan as an approved Ph.D. supervisor. As a Life Member of the Pakistan Engineering Council (PEC), he serves on the Accreditation Committee for Outcome-Based Education (OBE) evaluation visits. Globally, he maintains active memberships in the American Society of Mechanical Engineers (ASME), the Society of Petroleum Engineers (SPE), and the International Association of Science and Technology for Development (IASTED).

Prof. Dr. Ahmad Hussain

Dean FEAS & Professor Mechanical Engineering, DSU Karachi

External Expert on Board of Studies

Dr. Mirza Jahanzaib is a distinguished academic and mechanical engineer currently serving as a Full Professor in the Department of Industrial Engineering at the University of Engineering and Technology (UET), Taxila. With a profound commitment to engineering education and industrial advancement, his academic foundation is deeply rooted at UET Taxila, where he earned his Bachelor of Science in Mechanical Engineering in 1996. He subsequently



pursued specialized studies in Industrial and Manufacturing Engineering, completing his Master of Science in 2001 and his Ph.D. in 2008. Over his extensive career, he has taken on significant leadership roles within the university, including acting as the Head of the Industrial Engineering Department and serving as a core member of the Higher Education Commission's (HEC) National Curriculum Revision Committee, where he helped align Pakistan's industrial engineering curricula with international standards. As a highly prolific researcher, Dr. Jahanzaib maintains an impressive academic footprint with over 2,670 citations, an h-index of 30, and an i10-index of 66 according to Google Scholar metrics. His core research interests intersect traditional mechanical engineering with modern sustainability frameworks, focusing heavily on advanced and non-conventional manufacturing processes, sustainable manufacturing, and energy policy. His highly influential published work includes the development of decision support systems for wastewater treatment technologies, the optimization of cellular manufacturing systems using hybrid genetic algorithms, and the parametric analysis of high-strength low-alloy (HSLA) steel under green machining conditions. Furthermore, his research lab actively investigates multi-criteria decision-making (MCDM) in complex systems, discrete parts simulation, and process optimization for joining dissimilar metals.

Beyond the university campus, Dr. Jahanzaib actively bridges the gap between academic theory and practical industrial application. He is an HEC-approved Ph.D. supervisor and a registered Professional Engineer (P.E.) with the Pakistan Engineering Council (PEC). On a global scale, he maintains active memberships in the Institute for Operations Research and the Management Sciences (INFORMS), the System Dynamics Society, and the International Society on Multicriteria Decision Making. Dedicated to community service and national socio-economic development, he regularly consults with industries to streamline production operations through time studies, develop cost-effective process optimizations, and design robust energy models for power generation, transmission, and distribution.

Prof. Dr. Mirza Jahanzaib

Professor Mechanical & Industrial Engineering UET Taxila

Engr. Muhammad Altaf (Member Industrial Advisory Board)

Engr. Muhammad Altaf is a seasoned petroleum and gas engineering professional with over 30 years of extensive experience in Pakistan's oil and gas sector. He holds a B.Sc. in Petroleum and Gas Engineering from the University of Engineering and Technology (UET), Lahore, and is registered with the Pakistan Engineering Council (PEC) under Registration No. 88-PET-920.



His areas of expertise include oil and gas identification and exploration, hydrocarbon processing, natural gas transmission and distribution, and customer service operations within the energy sector. Throughout his distinguished career, he has contributed significantly to the development and management of Pakistan's gas industry.

In addition to his technical expertise, Engr. Altaf has served as a trainer at Sui Southern Gas Company Limited (SSGC) and is a motivational speaker, regularly delivering lectures and professional development sessions at universities, educational institutions, and industry forums.

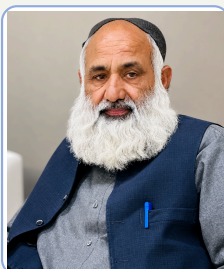
He is currently serving as Deputy Advisor at the Wafaqi Mohtasib Secretariat, Regional Office, Aumangli Road, Quetta, where he continues to apply his engineering knowledge and administrative experience in public service.

Contact Information

Engr. Muhammad Altaf

Member, Industrial Advisory Board

Members of Industrial Advisory Board



Engr. Muhammad Altaf

PEC Registration No.: 88-PET-920

Engr. Muhammad Altaf is a seasoned petroleum and gas engineering professional with over 30 years of experience in Pakistan's oil and gas sector. He holds a B.Sc. in Petroleum and Gas Engineering from UET Lahore and is registered with PEC under Registration No. 88-PET-920. His expertise includes oil and gas exploration, Natural Gas processing, gas transmission and distribution, and customer service operations. He has also served as a trainer at SSGC and regularly delivers motivational and professional development lectures. Currently, he is serving as Deputy Advisor at the Wafaqi Mohtasib Secretariat, Regional Office, Quetta.



Engr. Muhammad Anss

PEC Registration No.: MECH/30560

Engr. Muhammad Anss is a Mechanical Engineer graduated from the University of Engineering and Technology (UET), Lahore. He is currently serving as an Assistant Director at the Pakistan Standards and Quality Control Authority (PSQCA), Ministry of Science and Technology, Government of Pakistan. Previously, he served as a Lecturer in the Department of Mechanical Engineering at BUITEMS. He has academic, professional, and research experience in the field of mechanical engineering. He published a research paper in IOP Conference Series: Materials Science and Engineering in 2018.



Engr. Usama Bin Riaz

PEC Registration No.: MECH / 28346

Engr. Usama Bin Riaz is a Mechanical Engineer from UET Lahore and currently serves in a leadership role at OGDCL. He has over 11 years of diversified experience in academia, fertilizer industry, and the oil and gas sector. He holds PMP® and CMRP® certifications, along with ISO 14001 and ISO 45001 auditor certifications. His expertise includes mechanical engineering, maintenance, reliability, project management, and management systems. He brings valuable industrial insight, leadership, and technical expertise to academic and professional forums.



Engr. Bilal Khan Daavi

PEC Registration No.: MECH/47071

Engr. Bilal Khan proudly serves as an Assistant Mechanical Engineer at Mari Energies (formerly MPCL), a leading Pakistani oil and gas company now expanding into the mining and IT sectors. He brings extensive practical experience in the operation, maintenance, and materials management of production facilities. His expertise spans rotary equipment, compressors, turnarounds, and NDT inspections, alongside handling SAP MM workflows, RFQs, and critical spares management, allowing him to contribute valuable industrial insights to engineering forums.

Preface

The curriculum for the BS Mechanical Engineering program at the Balochistan University of Information Technology, Engineering and Management Sciences (BUITEMS) is continuously evolving to meet the dynamic demands of modern industry and the rigorous standards of Outcome-Based Education (OBE). As mandated by the Pakistan Engineering Council (PEC) and aligned with the latest International Engineering Alliance (IEA) Washington Accord guidelines, this document represents a comprehensive effort to bridge the gap between theoretical foundations and practical, challenge-driven engineering solutions.

The revisions encapsulate a forward-looking approach, integrating modern tools, sustainable practices, and socio-technological competencies. It aims to foster an academically stimulating environment that produces competent, socially responsible, and ethically sound mechanical engineers ready to contribute to regional and global technological advancements.

Introduction to the 4th Board of Studies

The Board of Studies (BOS) serves as the core academic body responsible for the continuous review, refinement, and validation of the departmental curriculum. Comprising esteemed internal faculty, external academic experts, and key industry representatives from the Industrial Advisory Board (IAB), the BOS ensures that the BS Mechanical Engineering program remains technically sound, outcome-based, and industry-relevant.

Through the systematic application of the Plan-Do-Check-Act (PDCA) cycle, the BOS actively monitors curriculum delivery, assessment results, and stakeholder feedback to drive Continuous Quality Improvement (CQI). By mapping Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs) and aligning them with the United Nations Sustainable Development Goals (SDGs), the BOS guarantees a holistic educational framework. This framework is meticulously designed to cultivate graduate attributes such as complex problem analysis, modern tool usage, and lifelong learning, ensuring graduates are well-equipped to navigate the competitive professional world.

Abbreviations Used

BOS	Board of Studies
BUIITEMS	Balochistan University of Information Technology, Engineering and Management Sciences
CEP	Complex Engineering Problem
CLO	Course Learning Outcome
CQI	Continuous Quality Improvement
DQEC	Departmental Quality Enhancement Cell
EC	Engineering Competence
FYDP	Final Year Design Project
IAB	Industrial Advisory Board
IEA	International Engineering Alliance
LMS	Learning Management System
OBE	Outcome-Based Education
OEL	Open-Ended Lab
PDCA	Plan-Do-Check-Act
PEC	Pakistan Engineering Council
PLO	Program Learning Outcome
SDG	Sustainable Development Goal
WK	Knowledge Profile

Administrative & Official Records

This section outlines the formal proceedings, agendas, and documented changes sanctioned by the Board of Studies (BOS) for the Mechanical Engineering department.

Agenda of the Board of Studies Meeting

The primary agenda of the BOS meeting was to comprehensively review and update the BS Mechanical Engineering curriculum in accordance with the latest Pakistan Engineering Council (PEC) Outcome-Based Education (OBE) manual and Higher Education Commission (HEC) guidelines. Key discussion points included the integration of emerging technologies (such as Artificial Intelligence and Machine Learning), alignment of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs), integration of Sustainable Development Goals (SDGs), and the incorporation of feedback from the Industrial Advisory Board (IAB).

Summary of Proposed Changes

To bridge the gap between academia and industry, several strategic modifications were made to the curriculum. Outdated content was streamlined to make room for modern engineering tools and software applications. Specifically, courses related to Climate Change, Risk Management, and Mechatronics were significantly updated. Furthermore, the assessment mechanisms were revised to ensure that Complex Engineering Problems (CEPs) and Open-Ended Labs (OELs) are rigorously evaluated using standardized master rubrics, ensuring a verifiable attainment of professional competencies.

Program Structure & Academic Policies

The BS Mechanical Engineering program at BUITEMS is structured to provide a balanced integration of core engineering principles, applied sciences, computing, and humanities, adhering strictly to HEC and PEC credit hour frameworks.

Admission and Eligibility Criteria

Admission to the BS Mechanical Engineering program is highly competitive and strictly merit-based. Applicants must have completed their Higher Secondary School Certificate (HSSC) Pre-Engineering or an equivalent qualification (such as A-Levels with Mathematics, Physics, and Chemistry) with a minimum of 60% overall marks. Additionally, candidates must successfully pass the university's mandatory entrance test or an approved centralized engineering entry test.

Grading System & Evaluation Policy

The department employs a rigorous evaluation system based on the official BUITEMS grading policy. Student performance is assessed through a combination of direct methods (midterm exams, final exams, quizzes, assignments, CEPs, and OELs) and indirect methods (course-end surveys). A minimum passing grade is required in both the theoretical and practical components of a course. The program strictly enforces the calculation of Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA), with academic probation policies in place for students falling below the minimum threshold.

OBE Framework & Practical Training

Practical exposure and continuous assessment are the cornerstones of the Outcome-Based Education (OBE) philosophy, ensuring graduates are industry-ready and possess the required professional attributes.

Continuous Quality Improvement (CQI) Process

The department actively maintains a robust Continuous Quality Improvement (CQI) loop at both the micro (course) and macro (program) levels. At the end of each semester, CLO attainment data is analyzed by the respective instructors. If a course cohort falls below the 50% attainment threshold, a CQI action plan is formulated—such as revising teaching methodologies, updating laboratory equipment, or restructuring assessments. These course-level interventions feed into the broader PLO attainment analysis, guiding structural changes to the curriculum during subsequent Board of Studies meetings.

Industrial Training & Final Year Design Project (FYDP)

To foster hands-on industrial experience, students are mandated to complete a 6-to-8 week summer internship at a recognized engineering firm or manufacturing plant. This exposure bridges theoretical knowledge with field realities. Furthermore, the capstone Final Year Design Project (FYDP) spans the final two semesters. Students must identify a complex, real-world engineering problem, propose a methodology, and design a functional prototype or simulation. FYDPs are evaluated rigorously against specific PLOs (such as Project Management, Modern Tool Usage, and Impact on Society) by a panel of internal faculty and external industry experts.

Departmental Resources

A world-class engineering curriculum requires state-of-the-art infrastructure and highly qualified human capital. The Mechanical Engineering department is equipped to support advanced learning and research.

Laboratories & Facilities

The department boasts a comprehensive suite of modern laboratories tailored to meet the psychomotor requirements of the curriculum. Key facilities include the Thermodynamics & Power Plants Lab, Fluid Mechanics Lab, Mechanics of Materials Lab, Manufacturing Processes & CNC Lab, and the Computer-Aided Design (CAD) & Simulation Lab. These spaces are continuously upgraded with industrial-grade equipment, data acquisition systems (DAQ), and advanced simulation software (such as ANSYS, SolidWorks, and MATLAB) to facilitate Open-Ended Labs and faculty-led research.

Faculty Profiles

The strength of the program lies in its diverse and highly qualified faculty. The academic staff comprises foreign-qualified PhDs and MS degree holders with specializations ranging from thermal-fluids and manufacturing to applied AI, robotics, and solid mechanics. Faculty members are actively engaged in industrial consultation, research publications, and continuous pedagogical training, ensuring that state-of-the-art knowledge and contemporary engineering practices are effectively transferred to the student body.

Departmental Quality Enhancement Cell (DQEC)

The Departmental Quality Enhancement Cell (DQEC) acts as the internal auditing and regulatory body, ensuring that all academic activities strictly comply with institutional standards and PEC accreditation requirements.

Role and Mission of the DQEC

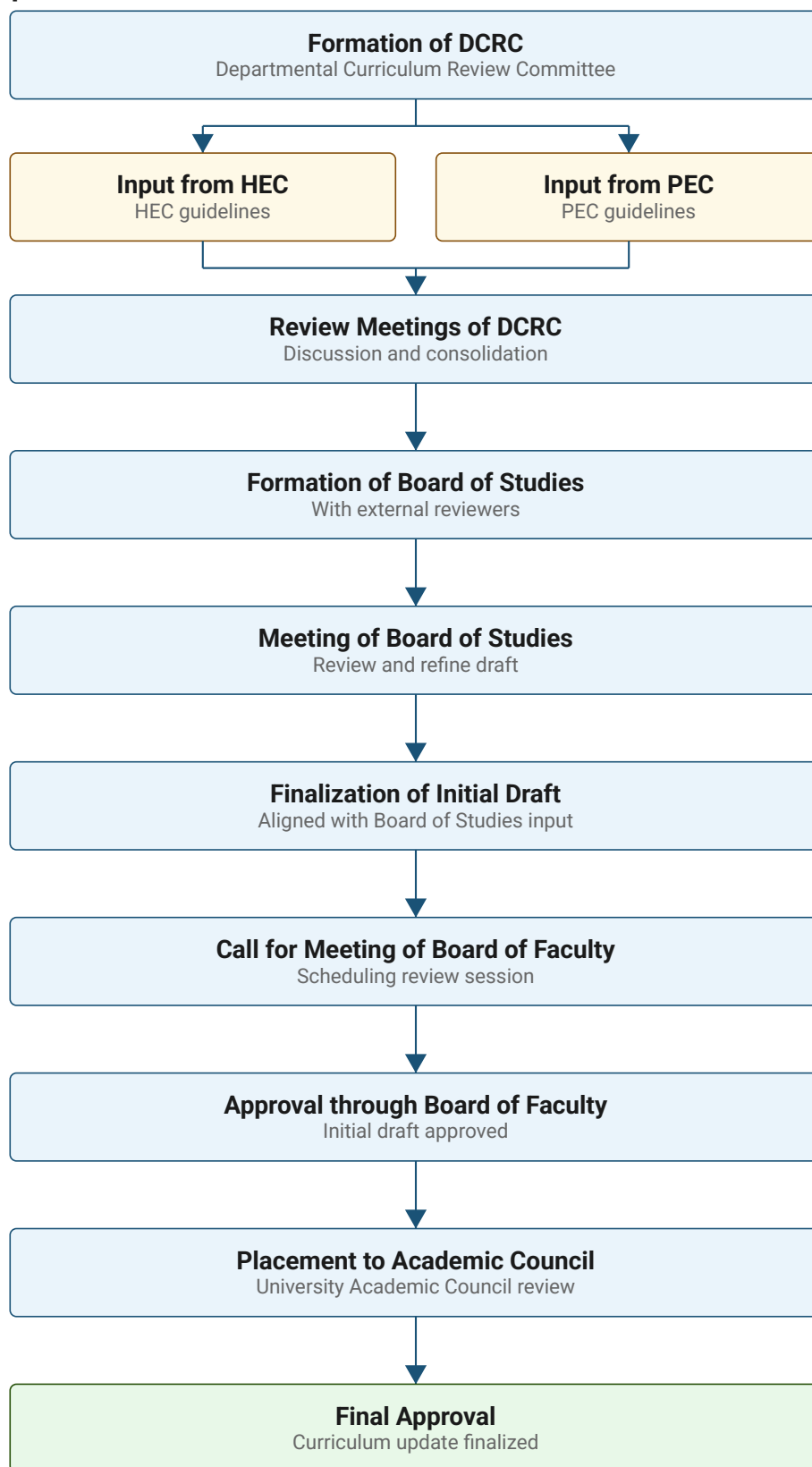
The DQEC is instrumental in institutionalizing a culture of academic excellence and accountability within the Mechanical Engineering department. Its primary mission is to oversee the seamless implementation of the Outcome-Based Education (OBE) system. The cell acts as a bridge between the faculty, the university's central Quality Enhancement Directorate, and external accreditation bodies like the Pakistan Engineering Council (PEC).

Core Responsibilities and Operations

The DQEC is tasked with several critical operational responsibilities to maintain academic rigor:

- Course File Audits:** At the conclusion of every semester, the DQEC rigorously audits course files to ensure they contain complete evidence of CLO-PLO mapping, attendance records, assessment samples, and grading rubrics.
- Assessment Review:** Before midterm and final examinations, the cell reviews question papers to verify that they are appropriately mapped to the designated Cognitive Levels (Bloom's Taxonomy) and course outcomes.
- Attainment Verification:** The DQEC cross-verifies the CLO and PLO attainment reports generated by instructors, ensuring data integrity and correct application of calculation formulas.
- CQI Monitoring:** It oversees the Continuous Quality Improvement (CQI) reports, tracking whether the corrective actions proposed by faculty in previous semesters have been successfully implemented.
- Accreditation Readiness:** The cell maintains a state of continuous readiness for PEC accreditation visits by organizing departmental data, tracking Industrial Advisory Board (IAB) interactions, and ensuring all safety and academic protocols are strictly enforced.

1. Curriculum Update Process





Approval Process Flow of Board of Studies with CLO - PLO Mapping



TAXONOMY REFERENCE

1 Bloom's Taxonomy - Cognitive Domain

C1	Remember
C2	Understand
C3	Apply
C4	Analyze
C5	Evaluate
C6	Create

2 Psychomotor Domain

P1	Imitation
P2	Manipulation
P3	Precision
P4	Articulation
P5	Naturalization

3 Affective Domain

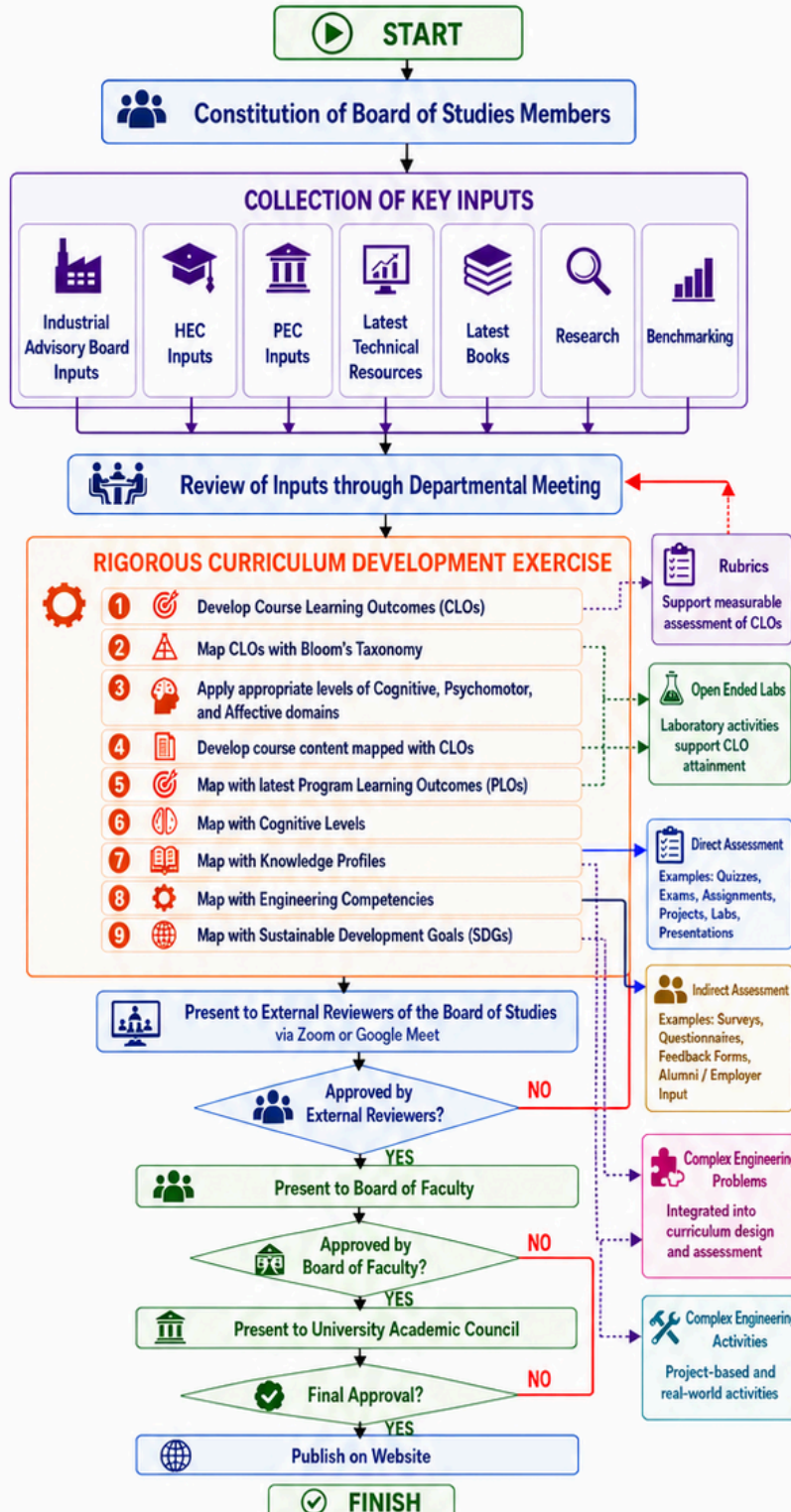
A1	Receiving
A2	Responding
A3	Valuing
A4	Organization
A5	Characterization

LEGEND

■	Inputs
■	Internal Development Work
■	External Review & Approval
■	Final Approval & Publication
→	Flow
→	YES (Forward)
→	NO (Return / Loop)
...	Supporting QA Elements

ABBREVIATIONS

PLOs	= Program Learning Outcomes
SDGs	= Sustainable Development Goals
ECs	= Engineering Competencies
PI-PS	= Psychomotor Levels
C1-C6	= Cognitive Levels
A1-A5	= Affective Levels
PEC	= Pakistan Engineering Council
HEC	= Higher Education Commission



11 PLOs

1	PLO-1
2	PLO-2
3	PLO-3
4	PLO-4
5	PLO-5
6	PLO-6
7	PLO-7
8	PLO-8
9	PLO-9
10	PLO-10
11	PLO-11

17 SDGs

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17			

9 KNOWLEDGE PROFILES

WK-1	WK-2	WK-3
WK-4	WK-5	WK-6
WK-7	WK-8	WK-9

ENGINEERING COMPETENCIES

Code	Competency Area
EC-1	Mathematics
EC-2	Natural Sciences
EC-3	Engineering Fundamentals
EC-4	Specialized Engineering Knowledge
EC-5	Problem Analysis
EC-6	Design / Development of Solutions
EC-7	Investigation
EC-8	Modern Tool Usage
EC-9	The Engineer and Society
EC-10	Environment & Sustainability
EC-11	Ethics
EC-12	Individual & Teamwork

SAMPLE CLO - PLO MAPPING (EXAMPLE)

CLO	PLOs	ECs	WKs	CL	SDGs
CLO-1 Understand the concepts of three-dimensional geometry, including vector and scalar products, and solve problems involving lines/planes.	PLO1	EC1	WK1 WK2	C2	SDG 4
1 Definition and application of vector and scalar products.	2 Parametric and vector forms of lines in 3D space.	4 Solving geometric problems involving projections and angles between vectors.			
3 Equation of a plane using a normal					



COLLABORATE
with Stakeholders



DESIGN
Quality Curriculum



DELIVER
Academic Excellence



DRIVE
Sustainable Impact



APPROVAL PROCESS FLOW OF BOARD OF STUDIES

WITH CLO – PLO MAPPING

QUALITY • RELEVANCE • ALIGNMENT • EXCELLENCE

14 PUBLISH & IMPLEMENT

- Publish on University Website
- Communicate to Stakeholders
- Implement & Monitor
- Continuous Improvement

UNIVERSITY ACADEMIC COUNCIL (UAC)

- Final review of curriculum
- Ensure policy alignment
- Final Approval

BOARD OF FACULTY (BoF)

- Present BoS recommendations
- Detailed review & deliberation
- Obtain Approval

EXTERNAL REVIEW (BoS External Reviewers)

- Present via Zoom / Google Meet
- Get feedback & suggestions
- Incorporate improvements
- Obtain Approval

10 PREPARE COMPREHENSIVE CURRICULUM DOCUMENT

- CLOs with Bloom Levels
- Mapping: PLOs, WPs, ECs, SDGs
- Course structure & details
- Assessment plan refinement
- Rubrics
- Direct Assessment
- Indirect Assessment

Direct Assessment

- Quizzes / Exams
- Projects / Reports
- Labs / Presentations

Indirect Assessment

- Surveys / Questionnaires
- Feedback Forms
- Alumni / Employer Input

MAP TO SUSTAINABLE DEVELOPMENT GOALS (SDGs 1-17)

- Map CLOs to relevant SDGs
- Promote global responsibility
- Contribute to sustainability

(See SDGs Table)

MAP TO ENGINEERING COMPETENCIES (EC1-EC12)

- Map CLOs to 12 ECs
- Technical & Professional skills
- Industry & Society alignment

(See ECs Table)

MAP TO KNOWLEDGE PROFILES (WK1-WK9)

- Map CLOs to 9 Knowledge Profiles
- Ensure knowledge depth
- Strengthen employability

(See WK Table)

MAP TO PLOs & COGNITIVE LEVELS

- Map each CLO to relevant PLO(s)
- Assign Cognitive Level (C1-C6)
- Ensure adequate PLO coverage

(See PLOs Table)

KNOWLEDGE PROFILES (WK1 – WK9)	
Code	Knowledge Profile
WK1	Mathematics & Natural Sciences
WK2	Engineering Fundamentals
WK3	Specialized Engineering Knowledge
WK4	Engineering Design
WK5	Computing & ICT
WK6	Engineering Practice & Skills
WK7	Management & Business
WK8	Professional & Ethical Practice
WK9	Societal, Environmental & Global Context

(Use in Step 7 for Mapping to WPs)

ENGINEERING COMPETENCIES (EC1 – EC12)	
Code	Competency
EC1	Engineering Knowledge Application
EC2	Problem Analysis & Solving
EC3	Design & Development of Solutions
EC4	Investigation & Research
EC5	Modern Tools & Techniques
EC6	Project Management
EC7	Communication
EC8	Teamwork & Leadership
EC9	Ethics & Professionalism
EC10	Environment & Sustainability
EC11	Lifelong Learning
EC12	Innovation & Entrepreneurship

(Use in Step 8 for Mapping to ECs)

PROGRAM LEARNING OUTCOMES (PLOs)	
No.	PLO STATEMENT
PLO1	Engineering Knowledge Apply knowledge of mathematics, science & engineering.
PLO2	Problem Analysis Identify, formulate & analyze engineering problems.
PLO3	Design / Development of Solutions Design solutions to complex engineering problems.
PLO4	Investigation Conduct investigations of complex problems using research-based knowledge.
PLO5	Modern Tool Usage Create, select & apply appropriate techniques, resources & modern engineering tools.
PLO6	The Engineer & Society Apply reasoning informed by contextual knowledge to assess societal impacts.
PLO7	Environment & Sustainability Understand environmental & sustainability challenges.
PLO8	Ethics Apply ethical principles & commit to professional ethics & responsibilities.
PLO9	Individual & Team Work Function effectively as an individual & as a member in diverse teams.
PLO10	Communication Communicate effectively with diverse audiences.
PLO11	Project Management & Lifelong Learning Demonstrate project management & engage in lifelong learning.

(Use in Step 6 for Mapping CLOs to PLOs)

BLOOM TAXONOMY LEVELS – USE IN STEP 4		
COGNITIVE DOMAIN (C1 – C6)	PSYCHOMOTOR DOMAIN (P1 – P5)	AFFECTIVE DOMAIN (A1 – A5)
C1 Remember	P1 Initiation	A1 Receiving
C2 Understand	P2 Manipulation	A2 Responding
C3 Apply	P3 Precision	A3 Valuing
C4 Analyze	P4 Articulation	A4 Organizing
C5 Evaluate	P5 Naturalization	A5 Characterizing
C6 Create		

(Use in Step 4 for Mapping CLOs to Bloom Levels)

CLO – PLO MAPPING EXAMPLE (Illustrative)	
CLO-1: Three-Dimensional Geometry & Vectors Understand the concepts of three-dimensional geometry, including vector and scalar products, dot and cross products involving investigations.	
CLOs	PLO1 PLO3 EC WK CL(Cognitive) SDGs
CLO-1	✓ – EC1 WK1 WK2 C2 SDG 4
1. Definition and application of vector and scalar products. 2. Parametric and vector forms of lines in 3D space. 3. Equation of a plane using a normal vector and its geometric interpretations. 4. Solving geometric problems involving projections and angles between vectors.	

(Use in Step 6 & 7 – PLO Mapping & Cognitive Level)

PROGRAM LEARNING OUTCOMES (PLOs)	
No.	PLO STATEMENT
PLO1	Engineering Knowledge Apply knowledge of mathematics, science & engineering.
PLO2	Problem Analysis Identify, formulate & analyze engineering problems.
PLO3	Design / Development of Solutions Design solutions to complex engineering problems.
PLO4	Investigation Conduct investigations of complex problems using research-based knowledge.
PLO5	Modern Tool Usage Create, select & apply appropriate techniques, resources & modern engineering tools.
PLO6	The Engineer & Society Apply reasoning informed by contextual knowledge to assess societal impacts.
PLO7	Environment & Sustainability Understand environmental & sustainability challenges.
PLO8	Ethics Apply ethical principles & commit to professional ethics & responsibilities.
PLO9	Individual & Team Work Function effectively as an individual & as a member in diverse teams.
PLO10	Communication Communicate effectively with diverse audiences.
PLO11	Project Management & Lifelong Learning Demonstrate project management & engage in lifelong learning.

RUBRICS

- Clear criteria & levels
- Performance descriptors
- Consistent scoring

DIRECT ASSESSMENT

- Quizzes / Exams
- Projects / Reports
- Labs / Presentations

INDIRECT ASSESSMENT

- Surveys / Questionnaires
- Feedback Forms
- Alumni / Employer Input

OPEN-ENDED LABS

- Inquiry-based experiments
- Real-world scenarios
- Design & discovery

COMPLEX ENGINEERING PROBLEMS

- Ill-structured problems
- Multiple constraints
- Realistic context

COMPLEX ENGINEERING ACTIVITIES

- Design projects
- Case studies
- Team-based solutions

SUSTAINABLE DEVELOPMENT GOALS (SDGs)															
1 NO POVERTY	2 ZERO HUNGER	3 GOOD HEALTH & WELL-BEING	4 QUALITY EDUCATION	5 GENDER EQUALITY	6 CLEAN WATER & SANITATION	7 AFFORDABLE AND CLEAN ENERGY	8 DECENT WORK AND ECONOMIC GROWTH	9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	10 REDUCED INEQUALITIES	11 SUSTAINABLE CITIES AND COMMUNITIES	12 RESPONSIBLE CONSUMPTION AND PRODUCTION	13 CLIMATE ACTION	14 LIFE BELOW WATER	15 LIFE ON LAND	16 PEACE, JUSTICE AND STRONG INSTITUTIONS

(Use in Step 9 for Mapping to SDGs)

ASSESSMENT PLAN REFINEMENT

- Align assessments with CLOs & PLOs
- Use rubrics for consistency
- Include Direct & Indirect assessments
- Review & update regularly
- Drive continuous improvement



Board of Studies Comparison

BS Mechanical Engineering — 3rd BoS 2021 vs 4th BoS 2025

64 → 73

COURSES

136 → 140

CREDIT HOURS

+4

NET CH CHANGE

85

COMPARISON ROWS

§ Executive Overview

At a glance

21

New Courses

38 CH introduced in 2025

8

Removed Courses

17 CH dropped from 2021

12

Merged Entries

21 CH consolidated to 11 CH

9

CH Revisions

26 CH trimmed to 19 CH

Change Composition — 85 rows



Same — 16 Renamed — 19 CH changed — 9
Merged — 12 Removed — 8 New — 21

The 2025 scheme adds breadth (ICT, AI/ML, FEM, product design, aerodynamics, HEC general-education courses) while consolidating overlapping cores and trimming several 3-CH theory courses to 2 CH.

Category Summary — Credit-Hour Movement

Category	Rows	2021 CH	2025 CH	Δ CH
Same	16	35	35	0
Renamed	19	37	37	0
CH Changed	9	26	19	-7
Merged	12	21	11	-10
Removed	8	17	0	-17
New	21	0	38	+38
Total	85	136	140	+4

Section Index

1 Retained / Same CH 16 courses

2 Renamed Courses 19 courses

3 Credit Hour Changes 9 courses

4 Merged / Restructured 12 entries

5 Removed Courses 8 courses

6 New Courses 2025 21 courses

1 Retained / Same Credit Hours

16 courses · 35 CH

Courses carried over unchanged in credit hours. Several rows show semester movement or minor title normalization.

2021 Course	CH / Sem	2025 Course	CH / Sem	Change Details
Applied Chemistry (LEC)	2 / S1	Applied Chemistry (LEC)	2 / S1	
Calculus & Analytical Geometry (LEC)	3 / S1	Calculus and Analytical Geometry (LEC)	3 / S1	
Islamic Studies (LEC)	2 / S2	Islamic Studies/ Ethics (LEC)	2 / S1	Moved Sem 2 → 1; title now includes Ethics option
Pakistan Studies (LEC)	2 / S3	Pakistan Studies (LEC)	2 / S1	Moved Sem 3 → 1
Thermodynamics-I (LEC)	3 / S2	Thermodynamics-I (LEC)	3 / S2	
Electrical Engineering (LEC)	2 / S3	Electrical Engineering (LEC)	2 / S2	Moved Sem 3 → 2
Computer Aided Drawing (LAB)	1 / S2	Computer Aided Drawing (LAB)	1 / S3	Moved Sem 2 → 3
Engineering Mechanics (LAB)	1 / S3	Engineering Mechanics (LAB)	1 / S3	
Fluid Mechanics-I (LEC)	3 / S3	Fluid Mechanics-I (LEC)	3 / S3	
Numerical Analysis (LEC)	2 / S5	Numerical Analysis (LEC)	2 / S5	
Numerical Analysis (LAB)	1 / S5	Numerical Analysis (LAB)	1 / S5	
Heat & Mass Transfer (LEC)	3 / S6	Heat & Mass Transfer (LEC)	3 / S5	Moved Sem 6 → 5
Engineering Economics (LEC)	2 / S4	Engineering Economics (LEC)	2 / S5	Moved Sem 4 → 5
Internal Combustion Engines (LEC)	2 / S6	Internal Combustion Engines (LEC)	2 / S7	Moved Sem 6 → 7
Applied Statistics (LEC)	3 / S6	Applied Statistics (LEC)	3 / S7	Moved Sem 6 → 7
Mechanical Vibrations (LEC)	3 / S8	Mechanical Vibrations (LEC)	3 / S6	Moved Sem 8 → 6

2 Renamed Courses

19 courses · 37 CH

Courses continued with updated titles or revised nomenclature.

2021 Course	CH / Sem	2025 Course	CH / Sem	Change Details
Engineering Mechanics: Statics (LEC)	3 / S2	Engineering (Statics) (LEC)	3 / S2	Renamed
Mechanical Workshop (LAB)	2 / S1	Workshop Practice (LAB)	2 / S1	Renamed
Introduction to Computer Programming (LEC)	2 / S1	Computer Systems and Programming (LEC)	2 / S3	Renamed; moved Sem 1 → 3
Introduction to Computer Programming (LAB)	1 / S1	Computer Systems and Programming (LAB)	1 / S3	Renamed; moved Sem 1 → 3
Solid Mechanics-I (LEC)	3 / S3	Mechanics of Materials-I (LEC)	3 / S3	Renamed
Solid Mechanics-II (LEC)	3 / S5	Mechanics of Materials-II (LEC)	3 / S4	Renamed; moved Sem 5 → 4
Solid Mechanics-II (LAB)	1 / S5	Mechanics of Materials (LAB)	1 / S4	Renamed; moved Sem 5 → 4
Basic Electronics (LEC)	2 / S2	Electronics Engineering (LEC)	2 / S5	Renamed; moved Sem 2 → 5
Thermodynamics-II (LAB)	1 / S4	Thermodynamics (LAB)	1 / S3	Renamed; moved Sem 4 → 3
Fluid Mechanics-II (LAB)	1 / S4	Fluid Mechanics (LAB)	1 / S4	Renamed
Mechanical Instrumentation & Control (LEC)	2 / S5	Instrumentation and Control Engineering (LEC)	2 / S5	Renamed (merged M&I + Control Engg per HEC/PEC 2024)
Mechanical Instrumentation & Control (LAB)	1 / S5	Instrumentation and Control Engineering (LAB)	1 / S5	Renamed
Refrigeration & Air Conditioning (LEC)	3 / S7	Heating, Ventilating, and AC (HVAC) (LEC)	3 / S6	Renamed; moved Sem 7 → 6
Health, Safety & Environment (LEC)	1 / S7	Occupational Health & Safety (LEC)	1 / S8	Renamed; moved Sem 7 → 8
Automation & Robotics (LEC)	2 / S8	Mechatronics & Robotics Engineering (LEC)	2 / S8	Renamed
Automation & Robotics (LAB)	1 / S8	Mechatronics & Robotics Engineering (LAB)	1 / S8	Renamed
Project Part-I (LAB)	3 / S7	Final Year Design Project-I (LAB)	3 / S7	Renamed
Project Part-II (LAB)	3 / S8	Final Year Design Project-II (LAB)	3 / S8	Renamed

2021 Course	CH / Sem	2025 Course	CH / Sem	Change Details
Professional Ethics & Entrepreneurship (LEC)	2 / S8	Entrepreneurship (LEC)	2 / S8	Renamed; ethics now covered in Islamic Studies/Ethics

3 Credit Hour Changes

9 courses · 26 → 19 CH

Courses whose credit hours changed between the 2021 and 2025 schemes.

2021 Course	CH / Sem	2025 Course	CH / Sem	Change Details
English-I (LEC)	2 / S1	Functional English (LEC)	3 / S1	CH 2 → 3; renamed
Engineering Materials and Metallurgy (LEC)	3 / S2	Materials Engineering (LEC)	2 / S2	CH 3 → 2; renamed
Engineering Mechanics: Dynamics (LEC)	3 / S3	Engineering Mechanics-II: Dynamics (LEC)	2 / S3	CH 3 → 2
Thermodynamics-II (LEC)	3 / S4	Thermodynamics-II (LEC)	2 / S3	CH 3 → 2; moved Sem 4 → 3
Fluid Mechanics-II (LEC)	3 / S4	Fluid Mechanics-II (LEC)	2 / S4	CH 3 → 2
Machine Design-I (LEC)	3 / S4	Machine Design-I (LEC)	2 / S4	CH 3 → 2
Machine Design-II (LEC)	3 / S5	Machine Design-II (LEC)	2 / S6	CH 3 → 2; moved Sem 5 → 6
Mechanics of Machines (LEC)	3 / S6	Mechanics of Machines (LEC)	2 / S5	CH 3 → 2; moved Sem 6 → 5
Project Management (LEC)	3 / S7	Project Management (LEC)	2 / S5	CH 3 → 2; moved Sem 7 → 5

4 Merged / Restructured Courses

12 entries · 21 → 11 CH

Merging, restructuring, or consolidation of earlier courses/labs into updated 2025 offerings.

2021 Course	CH / Sem	2025 Course	CH / Sem	Change Details
Differential Equations (LEC)	3 / S3	Linear Algebra & Differential Equations (LEC)	3 / S2	Two math courses (6 CH) merged into one (3 CH)
Linear Algebra and Transforms (LEC)	3 / S4	↑ merged into same course as above	S2	Transforms content now in new Complex Variable and Transform
Mechanical Engineering Drawing (LAB)	2 / S1	Engineering Drawing and Graphics (LEC 1 + LAB 1)	2 / S1	Restructured: split into LEC + LAB
Basic Electronics (LAB)	1 / S2	Electrical and Electronics Engineering (LAB)	1 / S5	Electrical + Electronics labs combined
Electrical Engineering (LAB)	1 / S3	↑ merged into same course as above	S5	
Manufacturing Processes-I (LEC)	3 / S5	Manufacturing Processes (LEC)	2 / S6	MP-I + MP-II (6 CH) merged into one course (2 CH)
Manufacturing Process-II (LEC)	3 / S6	↑ merged into same course as above	S6	
Manufacturing Process-II (LAB)	1 / S6	Manufacturing Processes (LAB)	1 / S6	Renamed after merge
Heat & Mass Transfer (LAB)	1 / S6	HVAC and H&M (LAB)	1 / S7	HMT + Refrigeration/AC labs combined
Refrigeration & Air Conditioning (LAB)	1 / S7	↑ merged into same course as above	S7	
Mechanics of Machines (LAB)	1 / S6	Mechanisms and Mechanical Vibration Lab (LAB)	1 / S6	MoM + Mechanical Vibrations labs combined
Mechanical Vibrations (LAB)	1 / S8	↑ merged into same course as above	S6	

5 Removed Courses

8 courses · -17 CH

Courses from the 2021 scheme not retained as independent courses in the 2025 scheme.

2021 Course	CH / Sem	2025 Course	CH / Sem	Change Details
Applied Physics (LEC)	2 / S1	—		Dropped from 2025 scheme
Applied Physics (LAB)	1 / S1	—		Dropped from 2025 scheme

2021 Course	CH / Sem	2025 Course	CH / Sem	Change Details
Communication Skills (LEC)	3 / S2	—		Replaced by Expository Writing (new)
Technical Report Writing & Presentation Skills (LEC)	2 / S4	—		Replaced by Expository Writing (new)
Computer Aided Engineering (LAB)	1 / S5	—		Replaced by Finite Element Methods (new)
Maintenance Engineering (LEC)	2 / S7	—		Dropped from 2025 scheme
Renewable Energy & Sustainability (LEC)	3 / S7	—		Replaced by Climate Change and Risk Management (new)
Power Plants (LEC)	3 / S8	—		Dropped from 2025 scheme

6 New Courses in 2025 Scheme

21 courses · +38 CH

Newly introduced courses/labs, largely reflecting updated HEC/PEC requirements and program needs.

2021 Course	CH / Sem	2025 Course	CH / Sem	Change Details
—		Applied Chemistry (LAB)	1 / S1	New lab added to Applied Chemistry
—		Applications of ICT (LEC)	2 / S1	New — HEC/PEC 2024
—		Applications of ICT (LAB)	1 / S1	New — HEC/PEC 2024
—		Civics and Community Engagement (LEC)	2 / S2	New — HEC/PEC 2024
—		Ideology and Constitution of Pakistan (LEC)	2 / S2	New — HEC/PEC 2024
—		Gender Equality (LEC)	2 / S2	New — HEC policy 2025
—		Fehm-e-Quran I (LEC)	1 / S3	New — HEC/NCRC 2025
—		Muslim Heritage (LEC)	2 / S3	New — BUIITEMS
—		Complex Variable and Transform (LEC)	3 / S4	New (covers transforms from old Linear Algebra and Transforms)
—		Applied Artificial Intelligence & Machine Learning (LEC)	2 / S4	New — HEC/PEC 2024
—		Applied Artificial Intelligence & Machine Learning (LAB)	1 / S4	New — HEC/PEC 2024
—		Expository Writing (LEC)	3 / S4	New (replaces Communication Skills / Technical Report Writing)
—		Fehm-e-Quran II (LEC)	1 / S4	New — HEC/NCRC 2025
—		Finite Element Methods (LEC)	2 / S6	New (replaces Computer Aided Engineering)
—		Finite Element Methods (LAB)	1 / S6	New
—		Product Design and Development (LEC)	2 / S7	New — HEC/PEC 2024
—		Product Design and Development (LAB)	1 / S7	New
—		Climate Change and Risk Management (LEC)	3 / S7	New (replaces Renewable Energy & Sustainability)
—		Reverse Engineering and Inspection Techniques (LEC)	2 / S8	New — HEC/PEC 2024
—		Reverse Engineering and Inspection Techniques (LAB)	1 / S8	New — HEC/PEC 2024
—		Aerodynamics (LEC)	3 / S8	New — HEC/PEC 2024

UNDERGRADUATE PROGRAM

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1.1 ISLAMIC STUDIES (LEC)

1.3 FUNCTIONAL ENGLISH (LEC)

1.5 APPLIED CHEMISTRY (LAB)

1.7 APPLICATION OF ICT (LAB)

1.9 MECHANICAL ENGG DRAWING & GRAPHICS (LAB)

1.11 PAK STUDIES (LEC)

1.2 CALCULUS AND ANALYTICAL GEOMETRY (LEC)

1.4 APPLIED CHEMISTRY (LEC)

1.6 APPLICATION OF ICT (LEC)

1.8 MECHANICAL ENGG DRAWING & GRAPHICS (LEC)

1.10 MECHANICAL WORKSHOP (LAB)

SEM 2 Second Semester

2.1 LINEAR ALGEBRA AND DIFFERENTIAL EQ (LEC)

2.3 ENGINEERING MECHANICS-I (STATICS) (LEC)

2.5 MATERIALS ENGINEERING (LEC)

2.7 IDEOLOGY AND CONSTITUTION OF PAK-ISTAN (LEC)

2.2 ELECTRICAL ENGINEERING (LEC)

2.4 THERMODYNAMICS - I (LEC)

2.6 CIVICS AND COMMUNITY ENGAGEMENT (LEC)

2.8 GENDER EQUALITY (LEC)

SEM 3 Third Semester

3.1 COMPUTER AIDED DRAWING (LAB)

3.3 MECHANICS OF MATERIAL - I (LEC)

3.5 COMPUTER SYSTEM AND PROGRAMMING (LAB)

3.7 THERMODYNAMICS-II (LEC)

3.2 ENGG MECHANICS-II DYNAMICS (LEC)

3.4 COMPUTER SYSTEM AND PROGRAMMING (LEC)

3.6 FLUID MECHANICS - I (LEC)

3.8 ENGINEERING MECHANICS (LAB)

3.9 THERMODYNAMICS (LAB)**3.10** FEHME QURAN I (LEC)**3.11** MUSLIM HERITAGE (LEC)**SEM 4 Fourth Semester****4.1** COMPLEX VARIABLES & TRANSFORMS (LEC)**4.2** MECHANICS OF MATERIALS-II (LEC)**4.3** MECHANICS OF MATERIALS-II (LAB)**4.4** FLUID MECHANICS-II (LEC)**4.5** FLUID MECHANICS (LAB)**4.6** MACHINE DESIGN -I (LEC)**4.7** APPLIED AI & MACHINE LEARNING (LEC)**4.8** APPLIED AI & MACHINE LEARNING (LAB)**4.9** EXPOSITORY WRITING (LEC)**4.10** FEHME QURAN II (LEC)**SEM 5 Fifth Semester****5.1** PROJECT MANAGEMENT (LEC)**5.2** MECHANICS OF MACHINES (LEC)**5.3** INSTRUMENTATION AND CONTROL ENGG (LEC)**5.4** INSTRUMENTATION AND CONTROL ENGG (LAB)**5.5** HEAT & MASS TRANSFER (LEC)**5.6** ELECTRONICS ENGINEERING (LEC)**5.7** ELECTRICAL AND ELECTRONICS ENGG (LAB)**5.8** NUMERICAL ANALYSIS (LEC)**5.9** NUMERICAL ANALYSIS (LAB)**5.10** ENGINEERING ECONOMICS (LEC)**SEM 6 Sixth Semester****6.1** HEATING, VENTILATION & AIR COND. (LEC)**6.2** MANUFACTURING PROCESSES (LEC)**6.3** MANUFACTURING PROCESSES (LAB)**6.4** MACHINE DESIGN-II (LEC)**6.5** FINITE ELEMENT METHODS (LEC)**6.6** FINITE ELEMENT METHODS (LAB)**6.7** MECHANICAL VIBRATIONS (LEC)**6.8** MECHANISMS AND MECHANICAL VIBRATION (LAB)**SEM 7 Seventh Semester****7.1** INTERNAL COMBUSTION ENGINES (LEC)**7.2** HVAC AND HEAT & MASS TRANSFER (LAB)**7.3** PRODUCT DESIGN AND DEVELOPMENT (LEC)**7.4** PRODUCT DESIGN AND DEVELOPMENT (LAB)

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Contribution Role of Board of Studies Members

BS Mechanical Engineering Curriculum Review and Approval

The Board of Studies members contributed to the review, refinement, validation, and recommendation of the BS Mechanical Engineering curriculum. Their role included academic review, technical input, OBE alignment, curriculum relevance, quality assurance, and consideration of industrial and professional requirements.

S. No.	Name	Status	Designation / Affiliation	Contribution Role
1	Mr. Arshad Ali	Chairperson	Assistant Professor / Chairperson, Department of Mechanical Engineering, BUITEMS	Chaired the Board of Studies meeting, coordinated curriculum review, guided discussion on program structure, and ensured alignment with departmental mission, PEC requirements, OBE framework, and stakeholder needs.
2	Dr. Ali Nawaz Mengal	Member	Professor, Department of Mechanical Engineering, BUITEMS	Provided senior academic input on mechanical engineering core areas, reviewed course contents, assessed curriculum depth, and contributed to the improvement of technical breadth and academic quality.
3	Dr. Azmatullah Khan	Member	Professor, Department of Mechanical Engineering, BUITEMS	Reviewed the suitability of course sequencing, engineering fundamentals, laboratory components, and discipline-specific content to strengthen curriculum coherence and graduate competency.
4	Dr. Mirza Jahanzaib	Member	Professor, Industrial Engineering Department, UET, Taxila	Contributed external academic expertise, particularly in industrial engineering, manufacturing systems, productivity, design improvement, and curriculum relevance to national engineering education standards.
5	Dr. Ahemd Hussain	Member	Dean, Engineering and Applied Sciences, DHA Suffa University, Karachi	Provided external review and strategic guidance on engineering education, interdisciplinary relevance, innovation, sustainability, and benchmarking of the curriculum with contemporary academic practices.
6	Dr. Muhamamd Siddique	Member	Assistant Professor, Department of Chemical Engineering, BUITEMS	Provided interdisciplinary input related to process engineering, applied sciences, sustainability, safety, and integration of supporting engineering knowledge within the mechanical engineering curriculum.
7	Mr. Qamaruddin Abid	Member	Lecturer, Department of Mechanical Engineering, BUITEMS	Assisted in curriculum documentation, course-level review, CLO–PLO mapping support, laboratory considerations, and compilation of departmental academic recommendations.
8	Dr. Bilal Sarwar	Non-Voting Member	Professor / Director, Quality Enhancement & Accreditation, BUITEMS	Provided quality assurance and accreditation-related guidance, reviewed OBE compliance, and supported alignment of curriculum documentation with institutional QA and PEC accreditation expectations.

Role of Board of Faculty Members and All Faculty Members of Mechanical Engineering

All faculty members of the Department of Mechanical Engineering contributed to the curriculum development process through subject-level input, review of course contents, preparation and refinement of CLOs, mapping of CLOs with PLOs, identification of knowledge profiles, review of laboratory requirements, assessment planning, and discussion of Continuous Quality Improvement needs. Their collective contribution ensured that the curriculum remains technically sound, outcome-based, industry-relevant, and suitable for producing competent Mechanical Engineering graduates.

Contribution Role of Industrial Advisory Board Members

BS Mechanical Engineering Curriculum Review and Industry Alignment

Department of Mechanical Engineering, BUIITEMS

The Industrial Advisory Board members contributed to the review and improvement of the BS Mechanical Engineering curriculum by providing industry feedback, professional guidance, employability requirements, industrial safety considerations, modern engineering practices, and recommendations for strengthening the linkage between academia and industry.

S. No.	Name / Affiliation	Category	Role	Contribution Role
1	Engr. Usama Riaz Assistant Engineer, Static & Piping Engineer, OGDCL Building, Blue Area, Islamabad	Industry Rep	Convener	Convened the Industrial Advisory Board discussion and provided technical input from oil and gas, static equipment, piping systems, maintenance, reliability, safety, and field engineering practices. Guided the curriculum review toward practical industrial needs and employability skills.
2	Engr. Muhammad Altaf Deputy Advisor, WMS Quetta	Industry Rep	Member	Provided industry-based feedback related to workshop practices, mechanical maintenance, fabrication, manufacturing processes, field operations, and the practical competencies required from Mechanical Engineering graduates in local and regional industries.
3	Engr. Muhammad Anss Field Officer, PSQCA Ministry of Science & Technology (MoST)	Industry Rep	Member	Contributed guidance related to quality standards, inspection, testing, certification, compliance, standardization, and regulatory requirements. Supported the inclusion of quality assurance, professional responsibility, and standards-based engineering practices in the curriculum.
4	Engr. Bilal Khan Davi Assistant Mechanical Engineer, Mari Energies	Alumni Rep	Member	Provided alumni and industry feedback regarding the transition from academic learning to professional engineering practice. Shared practical recommendations on mechanical systems, energy sector requirements, field exposure, teamwork, communication, and graduate readiness.
5	Arshad Ali Chairperson Dept. of Mechanical Engg.	Academic Rep	Member	Represented the Department of Mechanical Engineering and coordinated academic discussion with industry representatives. Ensured that the Industrial Advisory Board feedback was considered for curriculum improvement, OBE implementation, PEC requirements, and departmental academic planning.
6	Engr. Qamaruddin Abid OBE Coordinator Dept. of Mechanical Engg.	Internal Rep	Member / Sec.	Recorded and compiled advisory input, supported CLO-PLO and OBE-related documentation, coordinated curriculum feedback, and assisted in translating industry recommendations into measurable academic actions, assessment practices, and Continuous Quality Improvement records.

Collective Contribution of the Industrial Advisory Board

The Industrial Advisory Board collectively reviewed the curriculum from the perspective of industry needs, graduate employability, professional skills, safety culture, standards and codes, communication ability, teamwork, practical training, internships, modern tools, sustainability, and ethical engineering practice. Their feedback helped strengthen the relevance of the BS Mechanical Engineering curriculum to real-world mechanical, manufacturing, energy, quality, maintenance, and process-related sectors.

Overall Contribution: The Industrial Advisory Board supported the department in aligning the BS Mechanical Engineering curriculum with current industrial practices, professional expectations, PEC accreditation requirements, OBE-based education, and the evolving needs of mechanical engineering employers.

Department of Mechanical Engineering

Balochistan University of Information Technology, Engineering and Management Sciences

The Mechanical Engineering Department at BUITEMS is committed to providing a challenge-driven academic environment to young professionals. The department facilitates men and women in building their capacity and preparing them for the competitive professional world. Keeping foreign-qualified faculty updated with state-of-the-art techniques is among the department's top priorities. The department also aims to maintain its standing as the first choice for meritorious students.

Mechanical engineering is a stream of engineering that provides solutions for the development of processes and products, ranging from small component design to extremely large plants, machinery, and vehicles.

Mechanical engineering is at the forefront of developing new technologies for many industries, including transport, healthcare, construction, and robotics. Mechanical engineers design, develop, build, and test mechanical and thermal sensors and devices.

Mechanical engineering covers all stages of a product, from research and development to design and manufacturing, installation, and commissioning. Several industries rely on mechanical systems, and mechanical engineering is considered one of the most diverse engineering disciplines.

Due to this diversity, there are numerous job opportunities in mechanical engineering across a broad range of sectors such as manufacturing, power, construction, medical, aerospace, process, and oil industries. Moreover, mechanical engineers can also contribute to resource management and the development of new technologies.

Vision

To be a highly reputed Mechanical Engineering faculty that offers its own unique blend of technical specializations and research opportunities.

Mission

To provide a modern academically stimulating environment that produces socially responsible young professionals who can solve mechanical engineering challenges and serve ethically.

Mechanical Engineering for innovation, sustainability, ethics, and professional excellence.

Program Educational Objectives

BS Mechanical Engineering

Department of Mechanical Engineering

The Program Educational Objectives (PEOs) describe the expected achievements of BS Mechanical Engineering graduates within a few years after graduation. These objectives are aligned with the program mission, stakeholder needs, and the requirements of Outcome-Based Education (OBE) and engineering accreditation.

1

PEO-1: Mechanical Engineering Fundamentals

Provide solutions to the problems associated with design, manufacturing, and energy systems using fundamentals of mechanical engineering.

2

PEO-2: Design, Investigation, and Modern Techniques

Design and investigate the mechanical systems by using analytical and modern techniques for innovation, technological development, and sustainability.

3

PEO-3: Ethics, Professional Skills, and Socio-Technological Competency

Acquire the competency to address the real-world problems in the socio-technological areas through ethical values and professional skills.

PEO	Main Focus Area
PEO-1	Design, manufacturing, energy systems, and mechanical engineering fundamentals
PEO-2	Mechanical system design, investigation, modern tools, innovation, and sustainability
PEO-3	Real-world socio-technological problems, ethics, professional skills, and lifelong competency

These PEOs provide a broad framework for preparing Mechanical Engineering graduates who are technically competent, professionally responsible, ethically aware, and capable of contributing to industrial, technological, and societal development.

PEO–PLO Mapping Matrix

BS Mechanical Engineering Program

Mapping of Program Educational Objectives with Program Learning Outcomes

Legend:

D = Direct / Strong Mapping

S = Supporting Mapping

2. Program Educational Objectives

PEO	Statement
PEO-1	Provide solutions to the problems associated with design, manufacturing, and energy systems using fundamentals of mechanical engineering.
PEO-2	Design and investigate the mechanical systems by using analytical and modern techniques for innovation, technological development, and sustainability.
PEO-3	Acquire the competency to address the real-world problems in the socio-technological areas through ethical values and professional skills.

3. PEO–PLO Mapping Matrix

PLOs	PEO-1	PEO-2	PEO-3
PLO-1 Engineering Knowledge	D	S	
PLO-2 Problem Analysis	D	D	S
PLO-3 Design/Development of Solutions	D	D	S
PLO-4 Investigation	S	D	
PLO-5 Tool Usage	D	D	S
PLO-6 The Engineer and the World	S	D	D
PLO-7 Ethics		S	D
PLO-8 Individual and Team Work	S	S	D
PLO-9 Communication	S	S	D
PLO-10 Project Management & Finance	S	D	D
PLO-11 Lifelong Learning		D	D

4. Justification of Mapping

4.1. Justification for PEO-1

PEO-1: Provide solutions to the problems associated with design, manufacturing, and energy systems using fundamentals of mechanical engineering.

PEO-1 is strongly mapped with **PLO-1, PLO-2, PLO-3, and PLO-5** because solving problems in design, manufacturing, and energy systems requires sound engineering knowledge, problem analysis, solution development, and the use of modern engineering tools. It is also supported by **PLO-4, PLO-6, PLO-8, PLO-9, and**

PLO-10, as mechanical engineering problems may involve investigation, sustainability concerns, teamwork, communication, and basic project and economic considerations.

Strong Mapping	PLO-1, PLO-2, PLO-3, PLO-5
Supporting Mapping	PLO-4, PLO-6, PLO-8, PLO-9, PLO-10

4.2. Justification for PEO-2

PEO-2: Design and investigate the mechanical systems by using analytical and modern techniques for innovation, technological development, and sustainability.

PEO-2 is strongly mapped with **PLO-2, PLO-3, PLO-4, PLO-5, PLO-6, PLO-10, and PLO-11** because it focuses on analysis, design, investigation, modern tools, sustainability, project management, innovation, and continuous technological learning. It is also supported by **PLO-1, PLO-7, PLO-8, and PLO-9**, because engineering knowledge, ethical practice, teamwork, and communication are necessary for effective design and investigation of mechanical systems.

Strong Mapping	PLO-2, PLO-3, PLO-4, PLO-5, PLO-6, PLO-10, PLO-11
Supporting Mapping	PLO-1, PLO-7, PLO-8, PLO-9

4.3. Justification for PEO-3

PEO-3: Acquire the competency to address the real-world problems in the socio-technological areas through ethical values and professional skills.

PEO-3 is strongly mapped with **PLO-6, PLO-7, PLO-8, PLO-9, PLO-10, and PLO-11** because it emphasizes real-world socio-technological problems, ethical values, professional skills, teamwork, communication, management, and lifelong learning. It is also supported by **PLO-2, PLO-3, and PLO-5**, since addressing real-world engineering problems requires analysis, solution development, and appropriate use of modern tools.

Strong Mapping	PLO-6, PLO-7, PLO-8, PLO-9, PLO-10, PLO-11
Supporting Mapping	PLO-2, PLO-3, PLO-5

5. Final Summary Table

PEO	Directly Mapped PLOs	Supporting PLOs
PEO-1	PLO-1, PLO-2, PLO-3, PLO-5	PLO-4, PLO-6, PLO-8, PLO-9, PLO-10
PEO-2	PLO-2, PLO-3, PLO-4, PLO-5, PLO-6, PLO-10, PLO-11	PLO-1, PLO-7, PLO-8, PLO-9
PEO-3	PLO-6, PLO-7, PLO-8, PLO-9, PLO-10, PLO-11	PLO-2, PLO-3, PLO-5

This mapping is balanced because all **11 PLOs** are covered. Technical PLOs are strongly linked with **PEO-1** and **PEO-2**, while professional, ethical, societal, communication, management, and lifelong learning PLOs are strongly linked with **PEO-3**.

PLO Frequency Matrix

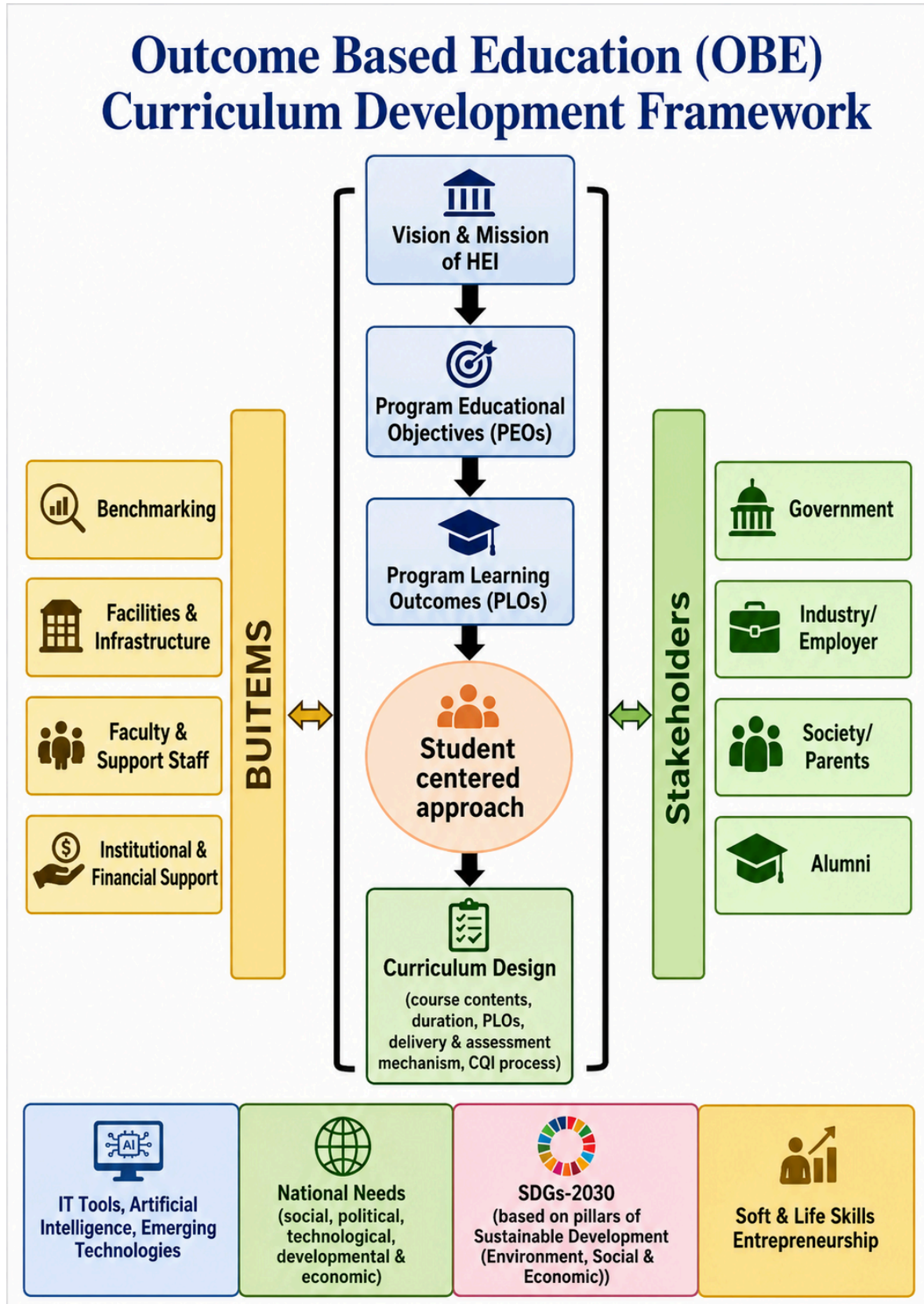
BS Mechanical Engineering

Subject	PLO-1 Engineering Knowledge	PLO-2 Problem Analy- sis	PLO-3 Design / Solu- tions	PLO-4 Investigation	PLO-5 Tool Usage	PLO-6 Engineer World &	PLO-7 Ethics	PLO-8 Team Work	PLO-9 Communica- tion	PLO-10 Project Mgmt & Finance	PLO-11 Lifelong Learn- ing
1.1 ISLAMIC STUDIES (LEC)	1					2	2	1	1		
1.2 CALCULUS AND ANALYTICAL GEOMETRY (LEC)	1	2	1								
1.3 FUNCTIONAL ENGLISH (LEC)		1				1			2		
1.4 APPLIED CHEMISTRY (LEC)	1	1		1		1					
1.5 APPLIED CHEMISTRY (LAB)	1	2		3	2		2	1		1	
1.6 APPLICATION OF ICT	1	1			1			1			
1.7 APPLICATION OF ICT (LAB)			1	1					1	1	
1.8 MECHANICAL ENGINEERING DRAWING s GRAPHICS (LEC)	4	1	1		2						
1.9 MECHANICAL ENGINEERING DRAWING s GRAPHICS (LAB)		1	1	1		1					
1.10 MECHANICAL WORKSHOP (LAB)	1		1					1	1	1	
1.11 PAK STUDIES (LEC)	3					3	3	2			1
2.1 LINEAR ALGEBRA AND DIFFERENTIAL EQUATIONS (LEC)	4	2	3	1	2						
2.2 ELECTRICAL ENGINEERING (LEC)	2	1		1							
2.3 ENGINEERING MECHANICS-I (STATICS) (LEC)	2	3	2		1						
2.4 THERMODYNAMICS - I (LEC)	1	4	1	3	1						
2.5 MATERIALS ENGINEERING (LEC)	4	1		1	1		1				
2.6 CIVICS AND COMMUNITY ENGAGEMENT (LEC)	2					3	1	1	1		
2.7 IDEOLOGY AND CONSTITUTION OF PAKISTAN (LEC) (LEC)	2					4	2	2			2
2.8 GENDER EQUALITY (LEC)						2	2	2	1	1	
3.1 COMPUTER AIDED DRAWING (LAB)	1	1	2								
3.2 ENGINEERING MECHANICS-II DYNAMICS (LEC)	4	3	1								
3.3 MECHANICS OF MATERIAL - I (LEC)	2	4	2	1							
3.4 COMPUTER SYSTEM AND PROGRAMMING (LEC)	3	3			2						
3.5 COMPUTER SYSTEM AND PROGRAMMING (LAB)	2	3	2		1						
3.6 FLUID MECHANICS - I (LEC)	2	4	2	2	1						
3.7 THERMODYNAMICS-II (LEC)	2	3	2	1	1		2				1
3.8 ENGINEERING MECHANICS (LAB)	1	1	1	1							
3.9 THERMODYNAMICS (LAB)	1	1	1		1						
3.10 FEHME QURAN I (LEC)	3					4	2	1			2
3.11 MUSLIM HERITAGE (LEC)	2						1	1	1	1	1
4.1 COMPLEX VARIABLES s TRANSFORMS (LEC)	3	2	1	2							
4.2 Mechanics of Materials-II (LEC)	1	4	1	2							
4.3 Mechanics of Materials-II (LAB)	2	1	2	1	1	1					
4.4 FLUID MECHANICS-II (LEC)	4	4	2	2							
4.5 FLUID MECHANICS (LAB)	2	1	2	1	1	1					
4.6 MACHINE DESIGN -I (LEC)	1	4	4	1	1						
4.7 APPLIED ARTIFICIAL INTELLIGENCE s MACHINE LEARNING (LEC)	2	3	2	2	1		1				
4.8 APPLIED ARTIFICIAL INTELLIGENCE s MACHINE LEARNING (LEC)	1	1	1		1						
4.9 EXPOSITORY WRITING (LEC)	2	1	1	1	2	1					
4.10 FEHME QURAN II (LEC)	3					3	2	1			3
5.1 ROJECT MANAGEMENT (LEC)	1	1		1					1		
5.2 MECHANICS OF MACHINES (LEC)	4	2	1	2							
5.3 Instrumentation and Control Engineering (LEC)	1	2	2	1	1		1				
5.4 Instrumentation and Control Engineering (LAB)	2	2	1	1	1						1
5.5 HEAT s MASS TRANSFER (LEC)	1	1	1	1							
5.6 ELECTRONICS ENGINEERING (LEC)	3	3	3								
5.7 ELECTRICAL AND ELECTRONICS ENGINEERING (LAB)	3	1	2	1	1						
5.8 NUMERICAL ANALYSIS (LEC)	2	4	1	2							
5.9 NUMERICAL ANALYSIS (LAB)	1	1	1		1						
5.10 ENGINEERING ECONOMICS (LEC)	1	1	1	1			1		1		2
6.1 HEATING, VENTILATION s AIR CONDITIONING (LEC)	1	1	1	1							
6.2 MANUFACTURING PROCESSES (LEC)	2	1	3		1	1					
6.3 MANUFACTURING PROCESSES (LAB)	2	1	1	1	1	1	1				
6.4 MACHINE DESIGN-II (LEC)	2	1	3		1	1					
6.5 FINITE ELEMENT METHODS (LEC)	1	1	3	1	1	1					
6.6 FINITE ELEMENT METHODS (LAB)	4	4		2	2						
6.7 MECHANICAL VIBRATIONS (LEC)	2	4	1	2	2		1				
6.8 MECHANISMS AND MECHANICAL VIBRATION (LAB)	4	4									
7.1 INTERNAL COMBUSTION ENGINES (LEC)	3	2		3	2	1					
7.2 HVAC and HsM (LAB)	4	4		2			1				
7.3 PRODUCT DESIGN AND DEVELOPMENT (LEC)	1	2	1	2	1	1				1	1
7.4 PRODUCT DESIGN AND DEVELOPMENT (LAB)	1	2		2	2	1					1
7.5 FINAL YEAR DESIGN PROJECT – I (LAB)	1	1		1		1					
7.6 Climate change and Risk Management (LEC)	3	2			1	2	2				1
7.7 APPLIED STATISTICS (LEC)	2	1	2	1	1	1					
8.1 OCCUPATIONAL HEALTH s SAFETY (LEC) (LEC)	1	1		1		1					
8.2 REVERSE ENGINEERING AND INSPECTION TECHNIQUES (LEC)	1	2	1	2	1	1	2		1		
8.3 REVERSE ENGINEERING AND INSPECTION TECHNIQUES (LAB)	2	1	2	1	2	1			2		
8.4 MECHATRONICS s ROBOTICS ENGINEERING (LEC)	4	4	2	1							
8.5 MECHATRONICS s ROBOTICS ENGINEERING (LAB)	3	3	2	1	3						
8.6 AERODYNAMICS (LEC)	4	3									
8.7 ENTREPRENEURSHIP (LEC)	1	1	1			1					
8.8 Final Year Design Project-II (LAB)	1	1		1		1					

Note: One PLO-12 entry appears in the source mapping, but it is not included here because the requested matrix contains only the 11 PLOs listed in the header.

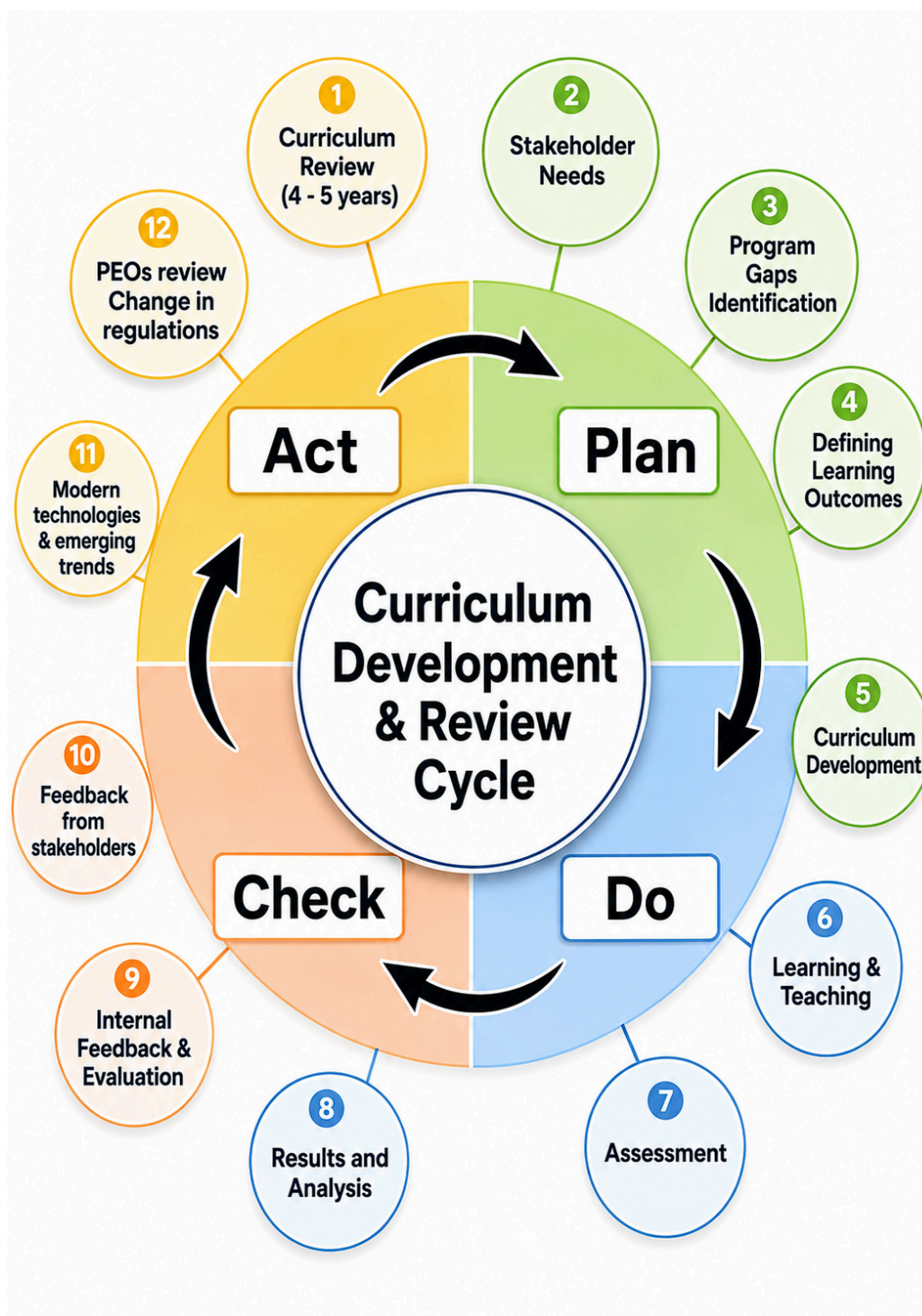
OBE Based Curriculum Development Framework

Outcome Based Education (OBE) is an approach of teaching and learning that focuses on what students should be able to attain at the end of the educational program. OBE is a student's centered system which concerns what the students will know and be able to do as learning outcomes. The curriculum development under OBE is therefore an integration of graduates attributes and stakeholders' feedback in cognizance with institution's Vision and Mission.

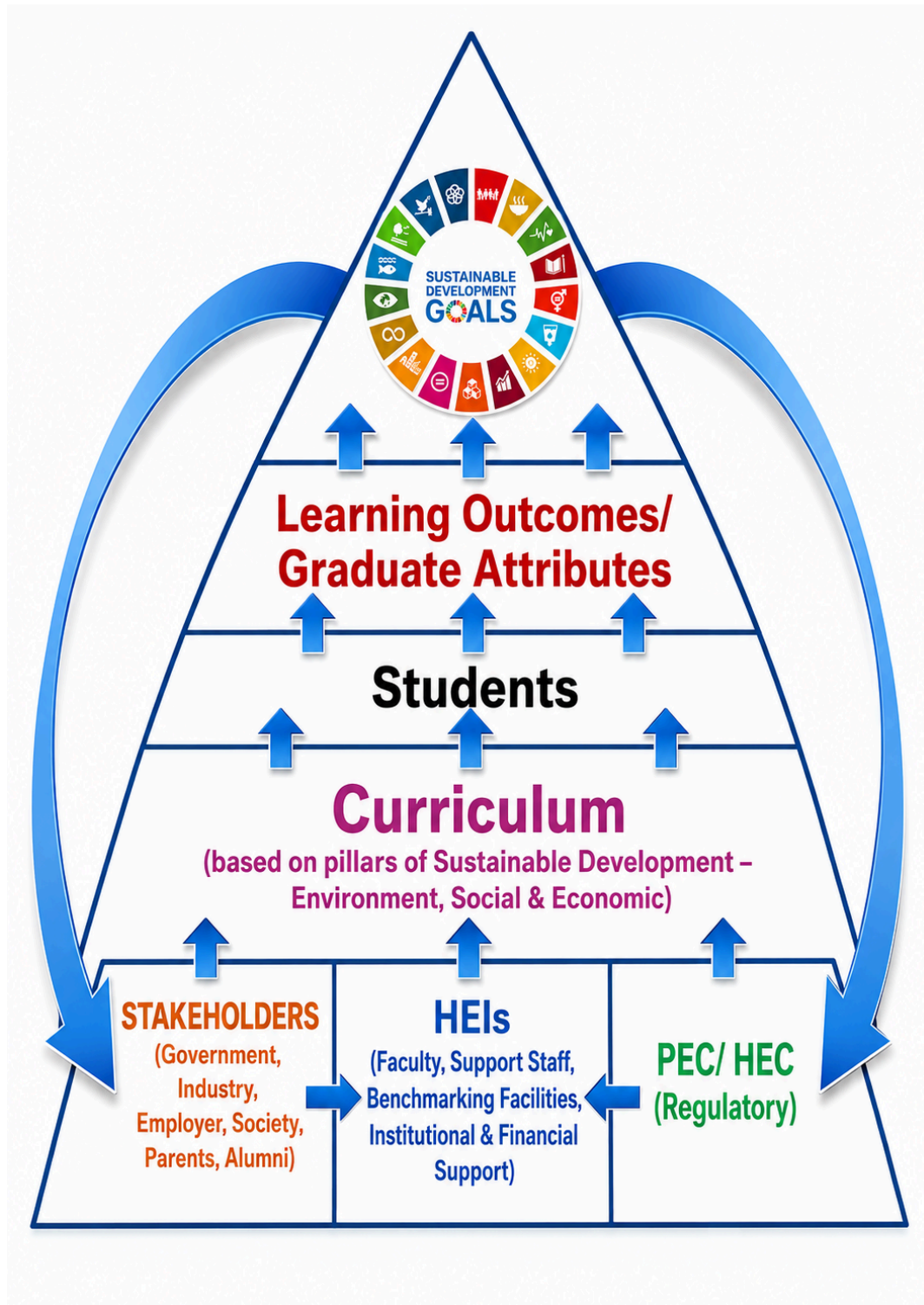


PDCA Approach to Curriculum Design and Development

The process of curriculum design and development constitutes various interconnected elements with the objective of achieving the intended purpose of the program. The Plan-Do-Check-Act approach (PDCA) as explained below has been followed in the curriculum development and review process.



- **Plan.** This stage begins with an analysis of the stakeholders' needs of faculty, current and past students, employers and society in general. The stakeholders' needs are translated into human resource terminology i.e. graduate competencies which in turn translated into educational taxonomy and learning outcomes. Based on the learning outcomes, curriculum is designed backward to meet PLOs.
- **Do.** The Do plan stage is implemented where curriculum is delivered and learning outcomes are assessed to gauge the achievement of PLOs.
- **Check.** This stage involves the analysis of Assessment results and feedback from students and faculty. Areas for improvement are also identified during this stage.
- **Act.** When the learning outcomes are achieved, the curriculum, learning and teaching strategies and assessment methods are standardized. Best practices are shared and improvement is made for the next cycle of PDCA.

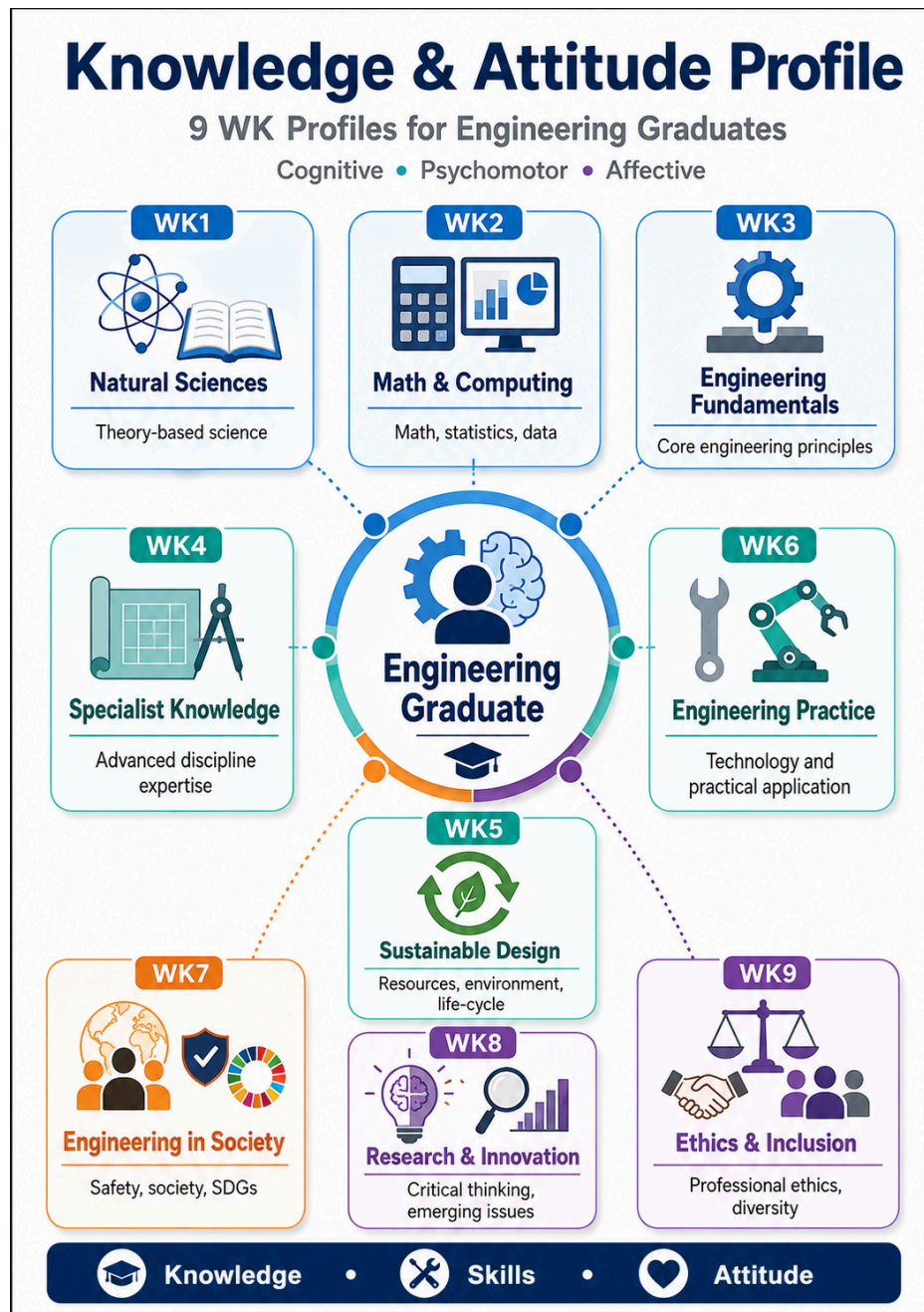




- | | |
|---|--|
| 1. No Poverty | 12. Responsible Consumption and Production |
| 2. Zero Hunger | 13. Climate Action |
| 3. Good Health and Well-being | 14. Life Below Water |
| 4. Quality Education | 15. Life on Land |
| 5. Gender Equality | 16. Peace, Justice and Strong Institutions |
| 6. Clean Water and Sanitation | 17. Partnerships for the Goals |
| 7. Affordable and Clean Energy | |
| 8. Decent Work and Economic Growth | |
| 9. Industrial Innovation and Infrastructure | |
| 10. Reduced Inequalities | |
| 11. Sustainable Cities and Communities | |

Knowledge and Attitude Profile

The process of curriculum design and development constitutes various interconnected elements with the objective of achieving the intended purpose of the program. The Plan-Do-Check-Act approach (PDCA) as explained below has been followed in the curriculum development and review process.



WK1: Theory-based understanding of natural and social sciences.

WK2: Mathematics, data analysis, and computing for detailed modelling.

WK3: Formulation of core engineering fundamentals.

WK4: Specialist engineering knowledge and theoretical frameworks.

WK5: Sustainable design, environmental impact, and resource efficiency.

WK6: Knowledge of practical engineering technologies.

WK7: Societal role, public safety, and UN-SDG responsibilities.

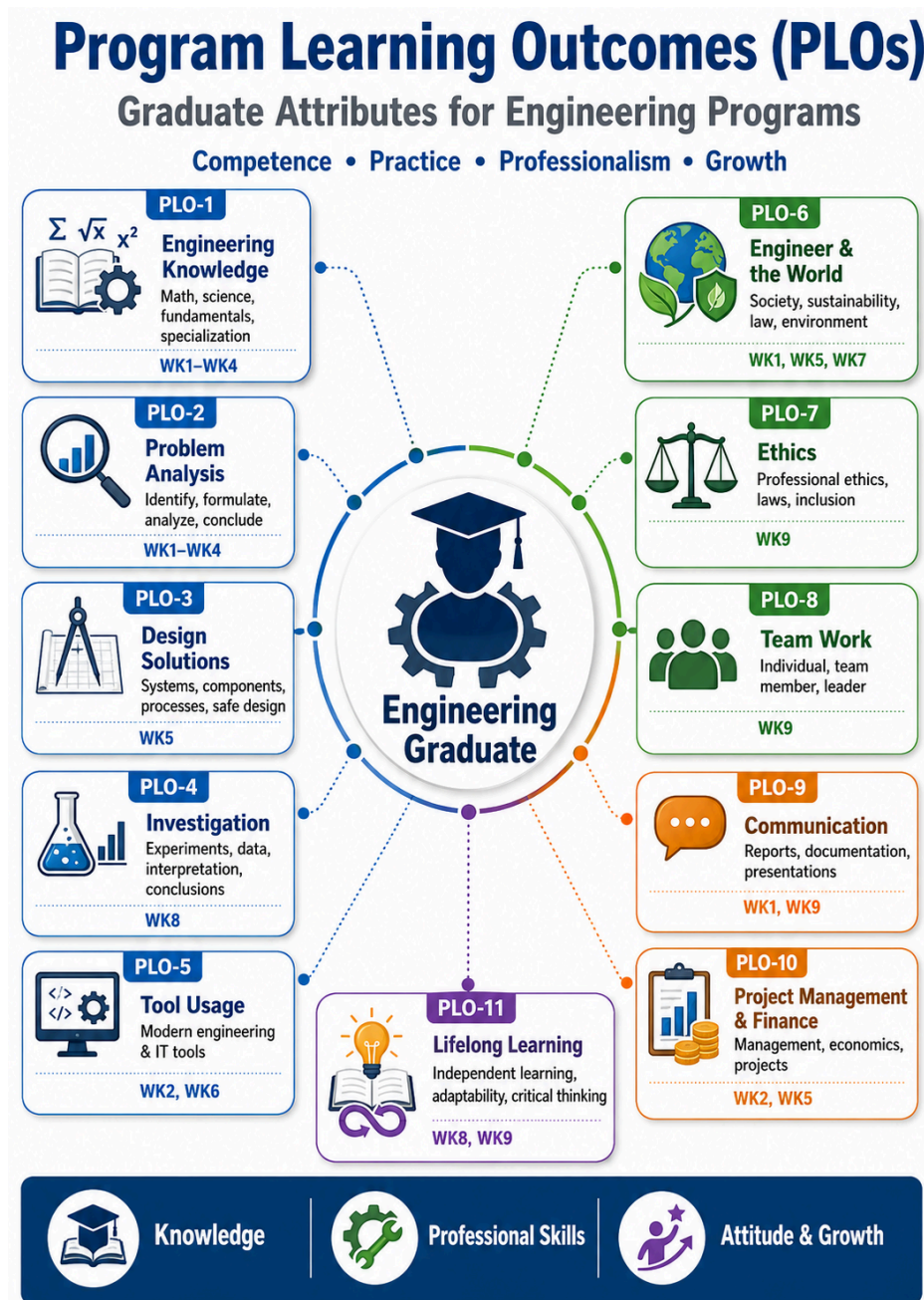
WK8: Engagement with research, critical thinking, and emerging issues.

WK9: Professional ethics, inclusive behavior, and diversity awareness.

Graduate Attribute Profiles (GAs)/ Program Learning Outcomes (PLOs)

Purpose of GAs & PLOs: Graduate Attributes (GAs) and Program Learning Outcomes (PLOs) define the essential knowledge, skills, and attitudes engineering students must acquire by graduation to prove their professional competence. IEA Version 4.0 Updates: The International Engineering Alliance (IEA) recently updated the framework. The most significant change was merging the previous “Society” and “Environment/Sustainability” attributes into a single new attribute: “The Engineer and the World.”

Curriculum & Assessment: Engineering programs use their curriculum to groom students across 11 core GAs. Programs must mathematically demonstrate that all graduating students have achieved these outcomes. Performance Thresholds: The minimum acceptable Key Performance Indicator (KPI) for PLO attainment is 50%. However, programs are expected to raise this baseline over time through Continuous Quality Improvement (CQI).



PLO-1 Engineering Knowledge: Apply math, science, and engineering fundamentals to solve complex problems (WK1-WK4).

PLO-2 Problem Analysis: Identify, research, and analyze complex problems using first principles (WK1-WK4).

PLO-3 Design/Development of Solutions: Design systems or processes meeting specific needs with public and environmental considerations (WK5).

PLO-4 Investigation: Conduct research, experiments, and data analysis to draw valid conclusions for complex problems (WK8).

PLO-5 Tool Usage: Select and apply modern engineering, IT tools, and modeling techniques, understanding their limits (WK2, WK6).

PLO-6 The Engineer and the World: Evaluate sustainable development, societal, and environmental impacts while solving problems (WK1, WK5, WK7).

PLO-7 Ethics: Commit to professional ethics, laws, and norms, while demonstrating diversity and inclusion (WK9).

PLO-8 Individual and Team Work: Function effectively as an individual, team member, or leader in diverse settings (WK9).

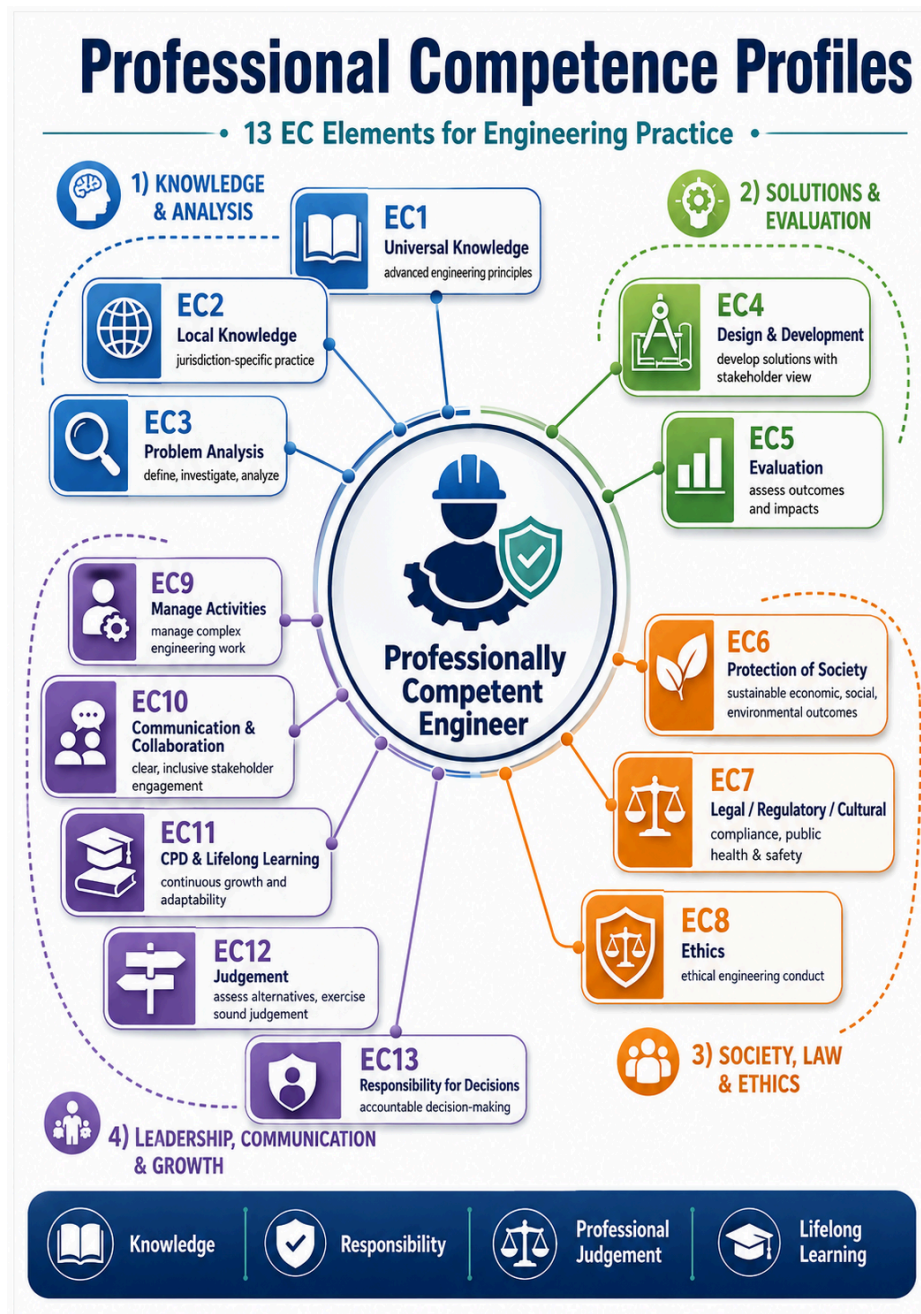
PLO-9 Communication: Communicate effectively and inclusively through reports and presentations across diverse groups (WK1, WK9).

PLO-10 Project Management & Finance: Apply engineering management and economic principles to manage multidisciplinary projects (WK2, WK5).

PLO-11 Lifelong Learning: Maintain independent learning, technological adaptability, and critical thinking (WK8, WK9).

Professional Competence Profiles

Definition & Assessment: Professional competence is the ability to independently perform engineering work to expected industry standards. Unlike Graduate Attributes (GAs) which are assessed individually, professional competence requires taking real-world responsibility and must be assessed holistically.



EC1 Comprehend and apply universal knowledge: Comprehend and apply advanced Engineering knowledge of the widely-applied principles underpinning good practices.

EC2 Comprehend and apply local knowledge: Comprehend and apply advanced Engineering knowledge of the widely-applied principles underpinning good practice specific to the jurisdiction of practices.

EC3 Problem analysis: Define, investigate and analyze complex Engineering problems using data and information technologies where applicable.

EC4 Design and development of solutions: Design or develop solutions to complex Engineering problems considering a variety of perspectives and taking account of stakeholder views.

EC5 Evaluation: Evaluate the outcomes and impacts of complex Engineering activities.

EC6 Protection of society: Recognize the foreseeable economic, social, and environmental effects of complex Engineering activities and seek to achieve sustainable outcomes.

EC7 Legal, regulatory, and cultural: Meet all legal, regulatory, and cultural requirements and protect public health and safety in the course of all Engineering activities.

EC8 Ethics: Conduct Engineering activities ethically.

EC9 Manage engineering activities: Manage part or all of one or more complex Engineering activities.

EC10 Communication and Collaboration: Communicate and collaborate using multiple media clearly and inclusively with a broad range of stakeholders in the course of all Engineering activities.

EC11 Continuing Professional Development (CPD) and Lifelong learning: Undertake CPD activities to maintain and extend competences and enhance the ability to adapt to emerging technologies and the ever-changing nature of work.

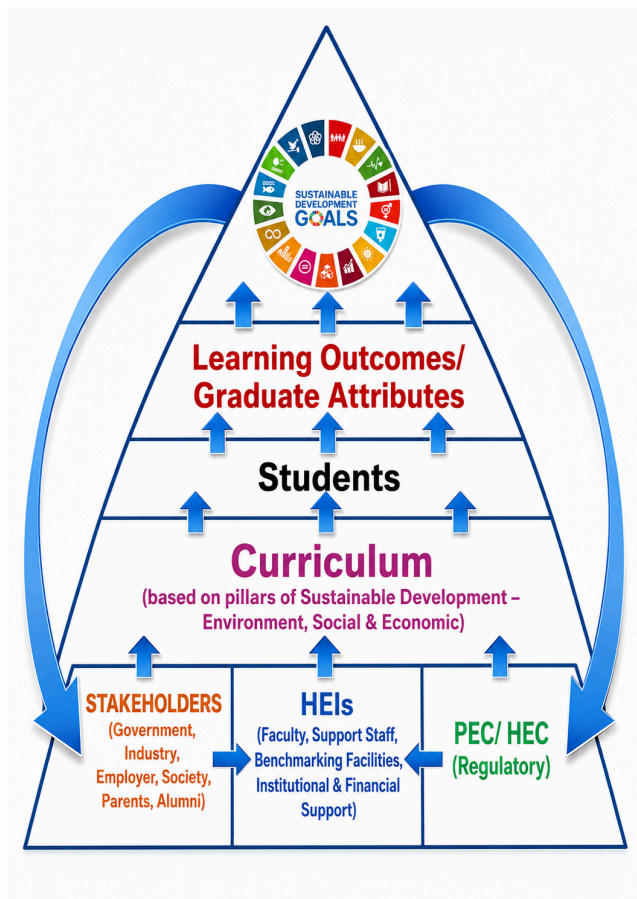
EC12 Judgement: Recognize complexity and assess alternatives in light of competing requirements and incomplete knowledge. Exercise sound judgement in the course of all complex Engineering activities.

EC13 Responsibility for decisions: Be responsible for making decisions on part or all of complex Engineering activities.

Universal Application: These profiles are generic and apply to all engineering disciplines. While specific industries or jurisdictions can amplify or emphasize certain elements to fit their context, the core substance of these competences cannot be ignored or altered.

Mapping of Bachelors of Engineering Program with UN SDGs

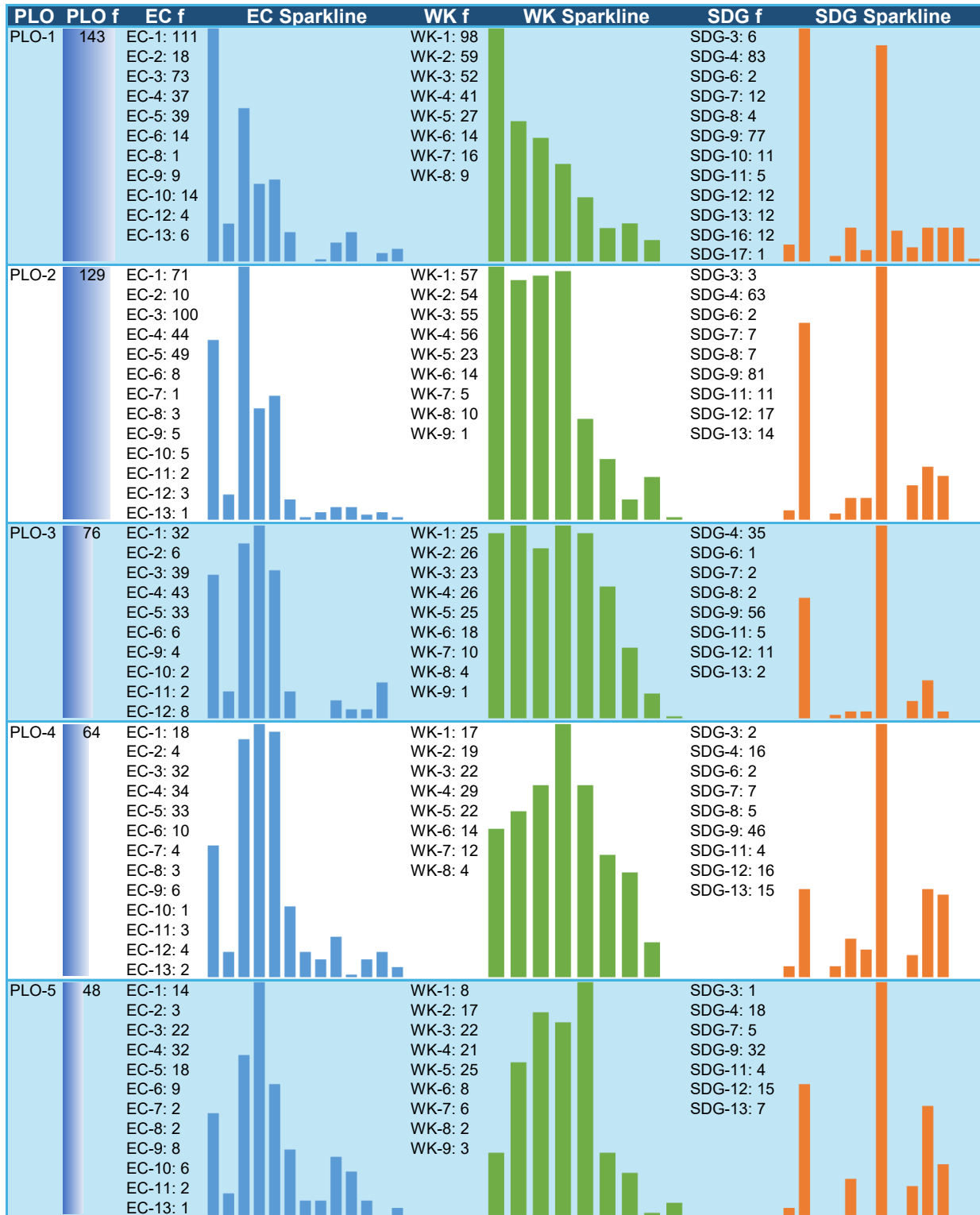
- 1. Academic Curriculum:** SDGs should be directly linked to course descriptions, objectives, learning outcomes, syllabus contents, class activities, and prerequisite courses.
- 2. Beyond the Classroom:** Co-curricular and extracurricular activities must be intentionally designed to align with and support relevant SDGs.
- 3. Institutional Alignment:** The Higher Education Institution (HEI) charter—specifically the overarching vision and mission—should be mapped to the SDGs to reflect institutional commitment at the program level.

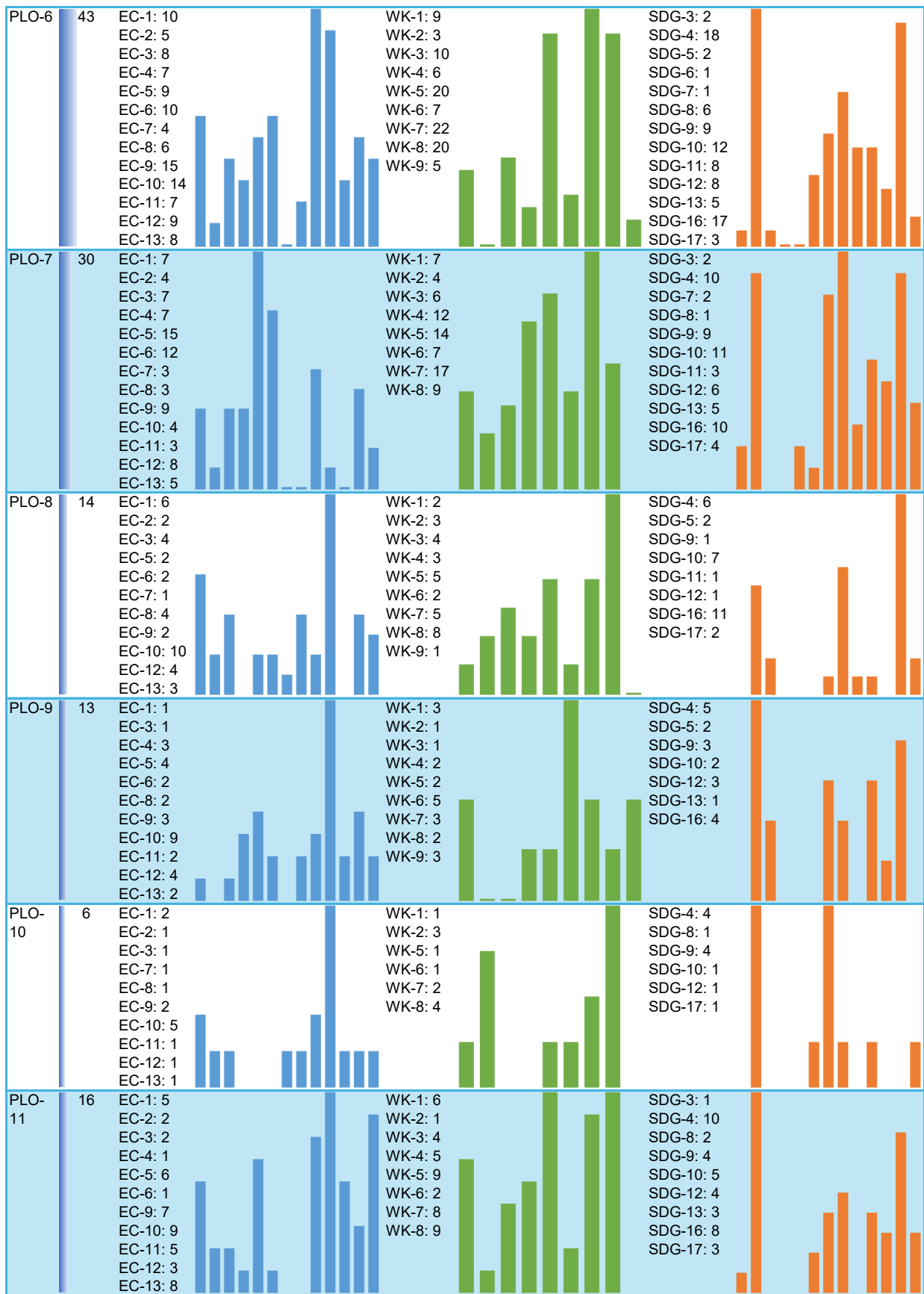


Correlation Matrix PLOs-ECs-WKs-SDGs

PLO-wise EC, WK and SDG Frequency Summary with Sparklines

BS Mechanical Engineering – BUIITEMS, Quetta | Effective Spring 2026

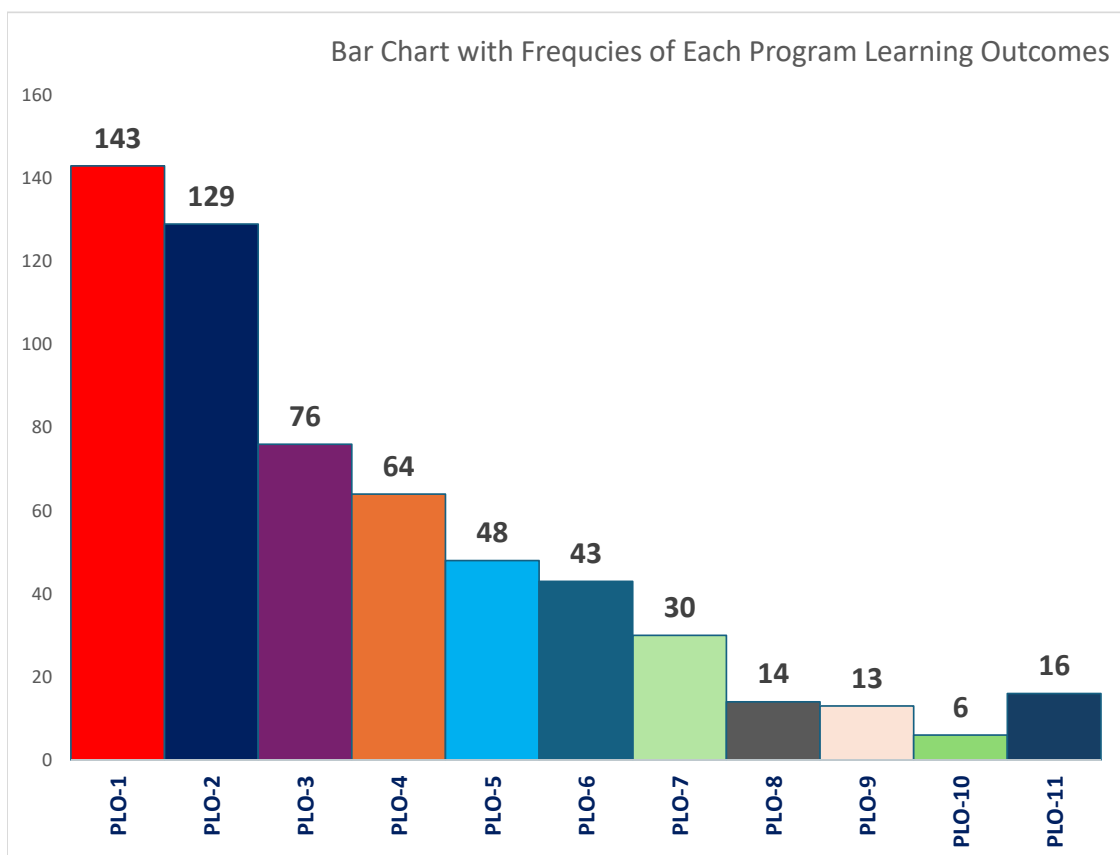




PLO Frequency Distribution (PLO-1 to PLO-11)

Source: PLO Summary (PLO f)

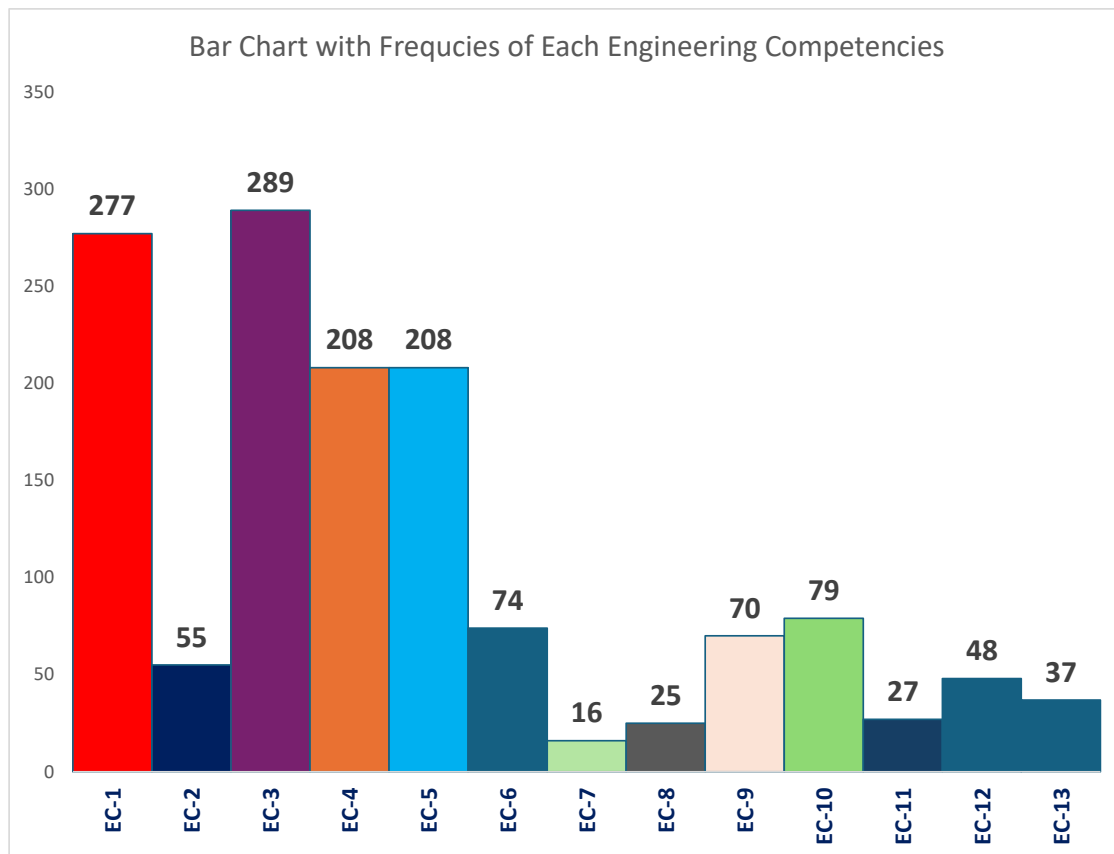
PLO Code	Frequency	Relative Frequency	Cumulative Frequency	Cumulative %
PLO-1	143	24.6%	143	24.6%
PLO-2	129	22.2%	272	46.7%
PLO-3	76	13.1%	348	59.8%
PLO-4	64	11.0%	412	70.8%
PLO-5	48	8.2%	460	79.0%
PLO-6	43	7.4%	503	86.4%
PLO-7	30	5.2%	533	91.6%
PLO-8	14	2.4%	547	94.0%
PLO-9	13	2.2%	560	96.2%
PLO-10	6	1.0%	566	97.3%
PLO-11	16	2.7%	582	100.0%
Total	582	100.0%		



EC Frequency Distribution (EC-1 to EC-13)

Source: PLO Summary | Counts summed across PLO-1 to PLO-11

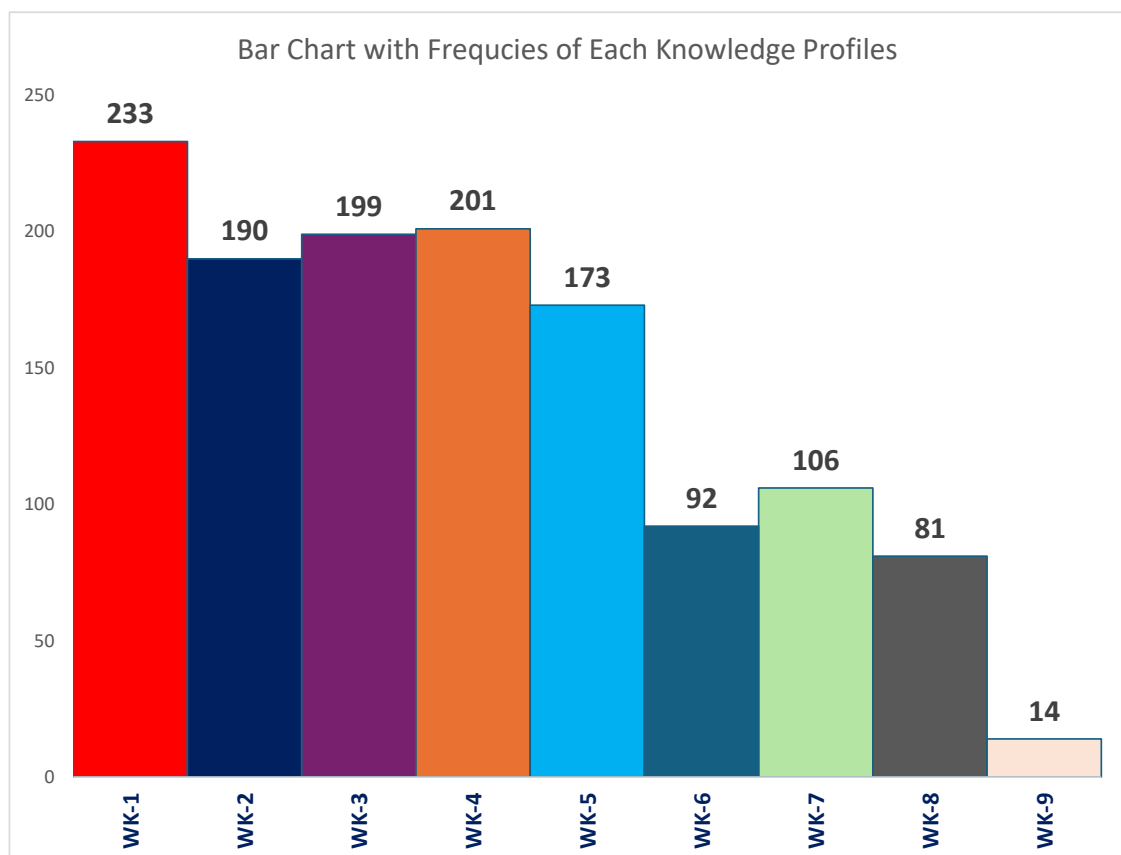
EC Code	Frequency	Relative Frequency	Cumulative Frequency	Cumulative %
EC-1	277	19.6%	277	19.6%
EC-2	55	3.9%	332	23.5%
EC-3	289	20.5%	621	43.9%
EC-4	208	14.7%	829	58.7%
EC-5	208	14.7%	1,037	73.4%
EC-6	74	5.2%	1,111	78.6%
EC-7	16	1.1%	1,127	79.8%
EC-8	25	1.8%	1,152	81.5%
EC-9	70	5.0%	1,222	86.5%
EC-10	79	5.6%	1,301	92.1%
EC-11	27	1.9%	1,328	94.0%
EC-12	48	3.4%	1,376	97.4%
EC-13	37	2.6%	1,413	100.0%
Total	1,413	100.0%		



WK Frequency Distribution (WK-1 to WK-9)

Source: PLO Summary | Counts summed across PLO-1 to PLO-11

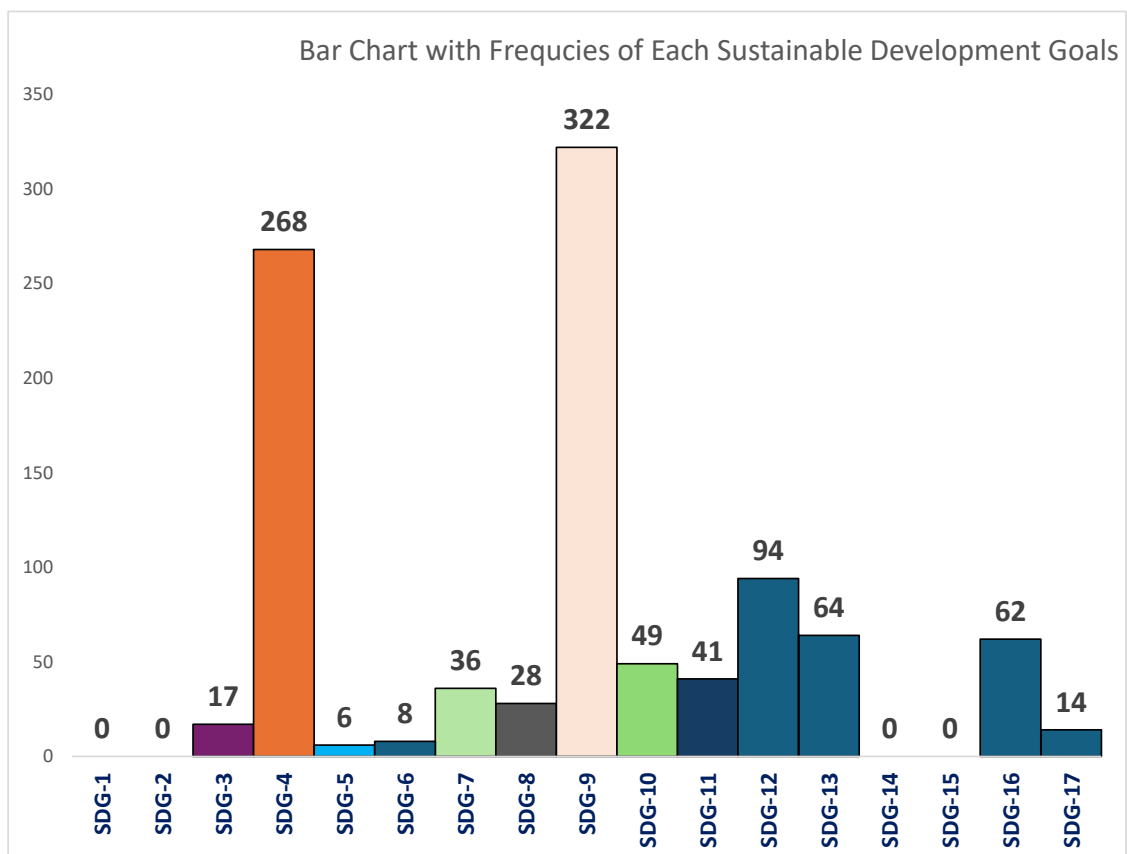
WK Code	Frequency	Relative Frequency	Cumulative Frequency	Cumulative %
WK-1	233	18.1%	233	18.1%
WK-2	190	14.7%	423	32.8%
WK-3	199	15.4%	622	48.3%
WK-4	201	15.6%	823	63.8%
WK-5	173	13.4%	996	77.3%
WK-6	92	7.1%	1,088	84.4%
WK-7	106	8.2%	1,194	92.6%
WK-8	81	6.3%	1,275	98.9%
WK-9	14	1.1%	1,289	100.0%
Total	1,289	100.0%		



SDG Frequency Distribution (SDG-1 to SDG-17)

Source: PLO Summary | Counts summed across PLO-1 to PLO-11 (SDGs absent from data show 0)

SDG Code	Frequency	Relative Frequency	Cumulative Frequency	Cumulative %
SDG-1	0	0.0%	0	0.0%
SDG-2	0	0.0%	0	0.0%
SDG-3	17	1.7%	17	1.7%
SDG-4	268	26.6%	285	28.2%
SDG-5	6	0.6%	291	28.8%
SDG-6	8	0.8%	299	29.6%
SDG-7	36	3.6%	335	33.2%
SDG-8	28	2.8%	363	36.0%
SDG-9	322	31.9%	685	67.9%
SDG-10	49	4.9%	734	72.7%
SDG-11	41	4.1%	775	76.8%
SDG-12	94	9.3%	869	86.1%
SDG-13	64	6.3%	933	92.5%
SDG-14	0	0.0%	933	92.5%
SDG-15	0	0.0%	933	92.5%
SDG-16	62	6.1%	995	98.6%
SDG-17	14	1.4%	1,009	100.0%
Total	1,009	100.0%		



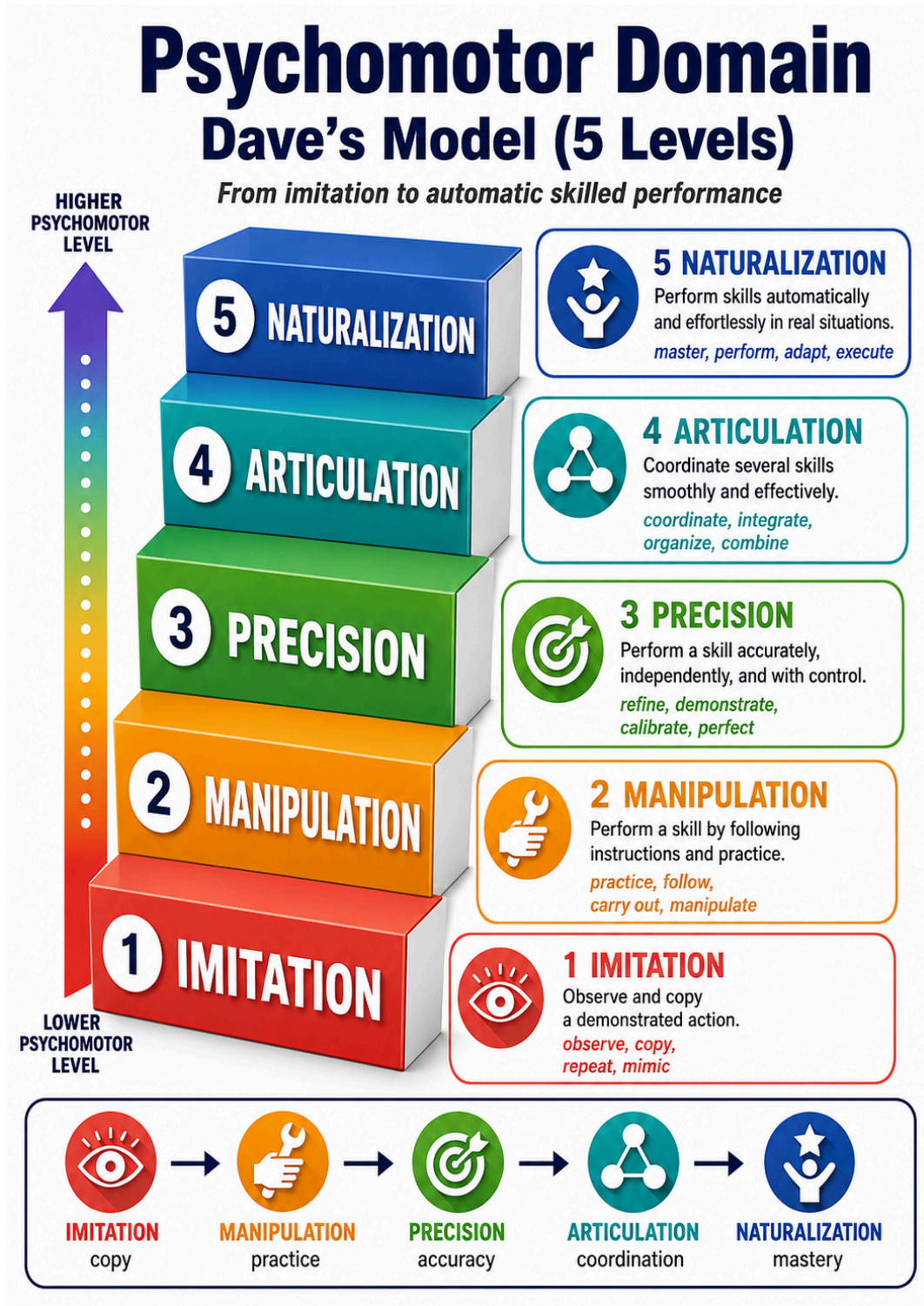
Bloom's Taxonomy

LEARNING OUTCOME VERBS

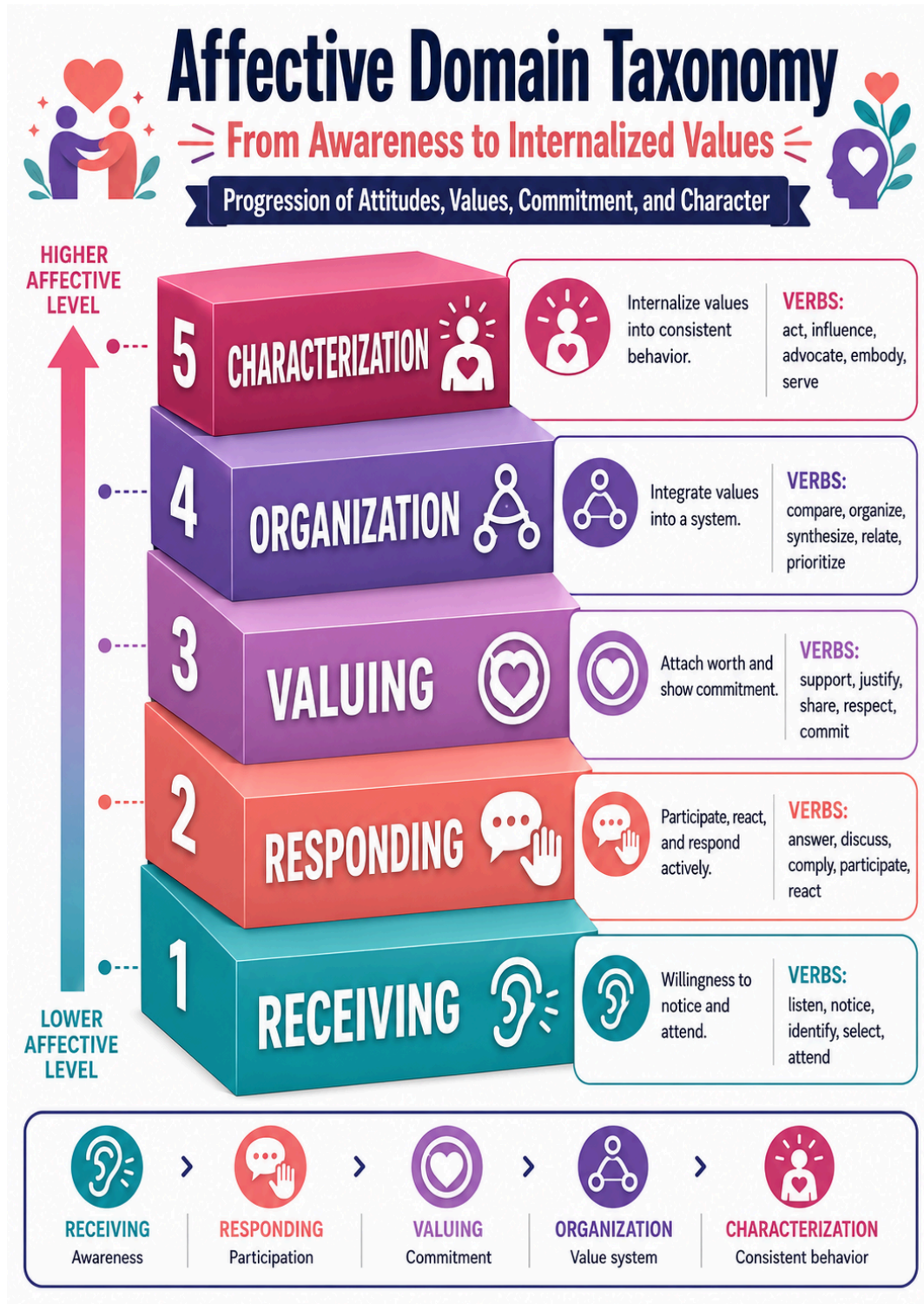
From lower-order to higher-order thinking



Cognitive Domain: The cognitive domain is related to the development of knowledge, understanding, and thinking skills. It helps students move from simply remembering facts to understanding concepts, applying knowledge in real situations, analyzing problems, evaluating solutions, and creating new ideas. This domain is important because it improves problem-solving ability, decision-making, logical thinking, and academic performance.



Psychomotor Domain: The psychomotor domain focuses on practical, physical, and hands-on skills. In Dave's 5-level model, students begin by imitating a skill, then practice it with guidance, perform it accurately, combine different skills smoothly, and finally perform it naturally and confidently. This domain is important because it prepares students to use tools, equipment, machines, software, and laboratory techniques effectively in real-life professional work.



Affective Domain: The affective domain deals with attitude, values, emotions, discipline, responsibility, and professional behavior. It helps students learn how to receive information positively, respond actively, value good practices, organize their beliefs, and finally make ethical and responsible behavior part of their personality. This domain is important because knowledge and skills are not enough unless students also develop teamwork, commitment, respect, confidence, and professional ethics.

UNDERGRADUATE PROGRAM

1st Semester

Course Syllabi & Outlines

SEM 1 First Semester**1.1** ISLAMIC STUDIES (LEC)**1.3** FUNCTIONAL ENGLISH (LEC)**1.5** APPLIED CHEMISTRY (LAB)**1.7** APPLICATION OF ICT (LAB)**1.9** MECHANICAL ENGG DRAWING & GRAPHICS (LAB)**1.11** PAK STUDIES (LEC)**1.2** CALCULUS AND ANALYTICAL GEOMETRY (LEC)**1.4** APPLIED CHEMISTRY (LEC)**1.6** APPLICATION OF ICT (LEC)**1.8** MECHANICAL ENGG DRAWING & GRAPHICS (LEC)**1.10** MECHANICAL WORKSHOP (LAB)

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1.1 ISLAMIC STUDIES (LEC)

Course Syllabus & Outline

INFO Course Description

This course is designed to provide students with a comprehensive overview of the fundamental aspects of Islam, its beliefs, practices, history and influence on society. It will further familiarize students with a solid foundation in understanding the religion of Islam from an academic and cultural perspective. Through this course, students will have an enhanced understanding of Islam's multifaceted dimensions which will enable them to navigate complex discussions about Islam's historical and contemporary role, fostering empathy, respect, and informed dialogue.

CLO-1 Understand the Core Beliefs of Islam

CLO-1	PLOs	ECs	Wks	CL	SDGs
Understand the core beliefs of Islam, including theological concepts, the Quran, Hadith, and Sunnah.	PLO 1	EC1 EC2 EC10	WK1 WK2	C1 C2	SDG 4

- 1 Introduction to Islam:** Definition and core beliefs.
- 2 The Holy Quran:** Introduction, revelation, and compilation.
- 3 Hadith and Sunnah:** Compilation, classification, and significance.
- 4 Theological Concepts:** Key concepts such as Tawhid, Prophethood, and Akhirah.

CLO-2 Life and Legacy of the Holy Prophet (PBUH)

CLO-2	PLOs	ECs	Wks	CL	SDGs
Analyze the life and legacy of the Holy Prophet (PBUH) as a role model and its significance in Islamic teachings.	PLO 6 PLO 8	EC1 EC3 EC8 EC12	WK3	C3 C4	SDG 16

- 1 Uswa-i-Hasana:** The life and legacy of the Holy Prophet (PBUH).
- 2 Diverse Roles of the Holy Prophet:** Analyzing his roles as an individual, educator, peace maker, and leader.

- 3 Sirah and Leadership:** The impact of the Prophet's leadership on Islamic civilization and community.

- 4 Prophet's Contribution to Society:** Understanding the social and moral lessons derived from the Sirah.

CLO-3 Islamic History and Civilization

CLO-3	PLOs	ECs	Wks	CL	SDGs
Evaluate the contributions of Islamic history and civilization to global knowledge, culture, and governance.	PLO 6 PLO 7	EC4 EC6 EC9 EC11	WK5 WK6	C5	SDG 11

- 1 World before Islam:** Understanding the global context before the rise of Islam.
- 2 Rashidun Caliphate:** Study of Islamic rule expansion and governance under the Rashidun Caliphate.
- 3 Muslim Contributions:** Contributions to philosophy, science, medicine, and culture.
- 4 Islamic Civilization:** How Islamic culture influenced global civilization and knowledge.

CLO-4 Islamic Jurisprudence and Modern Applications

CLO-4	PLOs	ECs	Wks	CL	SDGs
Explore Islamic Jurisprudence, its sources, and applications in modern social and financial contexts.	PLO 7 PLO 9	EC5 EC10 EC12 EC13	WK7	C4 C6	SDG 10

- 1 Islamic Jurisprudence:** Fundamental sources and the significance of Ijtihad.
- 2 Pillars of Islam:** Understanding their importance in Islamic law and society.
- 3 Islamic Finance:** Islamic financing structures and the stability of the Islamic financial system.
- 4 Modern Islamic Responses:** Islamic responses to modern societal, ethical, and technological challenges.

READ Books / Reading Materials

- 1** "The Five Pillars of Islam: A Journey Through the Divine Acts of Worship" by Muhammad Mustafa Al-Azami.
- 2** "The Five Pillars of Islam: A Framework for Islamic Values and Character Building" by Musharraf Hussain.
- 3** "Towards Understanding Islam" by Abul A' la Mawdudi.
- 4** "Islami Nazria e Hayat" by Khurshid Ahmad.
- 5** "An Introduction to Islamic Theology" by John Renard.
- 6** "Islamic Civilization Foundations Belief C Principles" by Abul A' la Mawdudi.
- 7** "Women and Social Justice: An Islamic Paradigm" by Dr. Anis Ahmad.
- 8** "Islam: Its Meaning and Message" by Khurshid Ahmad.

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1.2 CALCULUS AND ANALYTICAL GEOMETRY (LEC)

Course Syllabus & Outline

INFO Course Description

Calculus and Analytical Geometry offers a comprehensive exploration of mathematical principles, covering analytical geometry with vector and scalar products, three-dimensional coordinates, and the equations of lines and planes. The course delves into functions, limits, continuity, and differentiation, including higher-order derivatives and applications like optimization and curvature. Integration techniques are examined in depth, along with their applications to areas, volumes, and center of mass calculations. Additionally, the course covers improper integrals, infinite sequences and series, and power and Taylor series, providing a robust foundation in calculus and its practical applications.

CLO-1 Three-Dimensional Geometry & Vectors

CLO-1	PLOs	ECs	Wks	CL	SDGs
Understand the concepts of three-dimensional geometry, including vector and scalar products, and solve problems involving lines/planes.	PL01	EC1	WK1 WK2	C2	SDG 4

- | | |
|---|---|
| <ol style="list-style-type: none"> 1 Definition and application of vector and scalar products. 3 Equation of a plane using a normal vector and its geometric interpretations. | <ol style="list-style-type: none"> 2 Parametric and vector forms of lines in 3D space. 4 Solving geometric problems involving projections and angles between vectors. |
|---|---|

CLO-2 Functions, Limits, and Differentiation

CLO-2	PLOs	ECs	Wks	CL	SDGs
Apply the principles of functions, limits, continuity, and differentiation, including higher-order derivatives, to optimization/curvature.	PL02	EC3 EC4	WK2	C3	SDG 8

- | | |
|--|--|
| <ol style="list-style-type: none"> 1 Techniques for calculating limits and L'Hôpital's Rule. 3 Applications of higher-order derivatives in real-world scenarios. | <ol style="list-style-type: none"> 2 Conditions for continuity and differentiability of functions. 4 Optimization and curvature analysis using first and second derivatives. |
|--|--|

CLO-3 Integration Techniques and Applications

CLO-3	PLOs	ECs	Wks	CL	SDGs
Analyze and apply integration techniques to compute areas, volumes, and center of mass in engineering contexts.	PL03	EC4 EC5	WK1 WK3	C4	SDG 9

- 1 Methods for evaluating definite and indefinite integrals.
- 2 Application of integrals to compute areas under curves and volumes.
- 3 Calculating the center of mass using integrals in engineering problems.
- 4 Evaluating improper integrals in physical and engineering applications.

CLO-4 Improper Integrals, Sequences, and Series

CLO-4	PLOs	ECs	Wks	CL	SDGs
Evaluate improper integrals, infinite sequences, series, and power/Taylor series to understand their convergence and applications.	PL02	EC3	WK2	C5	SDG 4

- 1 Convergence criteria for improper integrals and their applications.
- 2 Understanding and testing convergence of infinite sequences and series.
- 3 Expanding functions using power and Taylor series.
- 4 Applications of series expansions in engineering and signal processing.

READ Books / Reading Materials

- 1 George B. Thomas, Jr., Maurice D. Weir, Joel R. Hass, Thomas' Calculus, Pearson, USA.
- 2 Swokowski, Onlinick C Pence, Calculus.
- 3 Robert T. Smith C Roland B. Minton, Calculus.
- 4 James Stewart, Calculus: Early Transcendentals, Brooks/Cole, USA.

HUM-163 (000003-18/U) · CREDITS: 3

1.3 FUNCTIONAL ENGLISH (LEC)

Course Syllabus & Outline

INFO Course Description

This course is designed to equip students with essential language skills for effective communication in diverse real-world scenarios. It focuses on developing proficiency in English language usage: word choices, grammar and sentence structure. In addition, the course will enable students to grasp nuanced messages and tailor their communication effectively through application of comprehension and analytical skills in listening and reading. Moreover, the course encompasses a range of practical communication aspects including professional writing, public speaking, and everyday conversation, ensuring that students are equipped for both academic and professional spheres. An integral part of the course is fostering a deeper understanding of the impact of language on diverse audiences. Students will learn to communicate inclusively and display a strong commitment to cultural awareness in their language use.

CLO-1 English Communication Skills

CLO-1	PLOs	ECs	Wks	CL	SDGs
Apply enhanced English communication skills through effective use of word choices, grammar, and sentence structure.	PLO-9	EC10	WK1	C3	SDG 4

- Vocabulary Building and Word Formation:** Contextual usage, synonyms, antonyms, idiomatic expressions; affixation, compounding, clipping, and back formation.
- Communicative Grammar:** Subject-verb agreement, verb tenses, sentence fragments, run-ons, articles, modifiers, etc.
- Sentence Structure:** Understanding simple, compound, complex, and compound-complex sentence types.
- Sound Production and Pronunciation:** Basics of phonetics and pronunciation skills.

CLO-2 Comprehension and Analysis

CLO-2	PLOs	ECs	Wks	CL	SDGs
Comprehend a variety of literary/non-literary written and spoken texts in English.	PLO-2	EC3	WK1	C2	SDG 4

- 1 Understanding Purpose, Audience, and Context:** Analyzing texts based on their purpose and intended audience.
- 3 Reading Strategies:** Techniques like skimming, scanning, SQ4R, and critical reading.

- 2 Contextual Interpretation:** Identifying tones, biases, stereotypes, assumptions, and making inferences.
- 4 Active Listening:** Overcoming barriers and practicing focused listening for effective comprehension.

CLO-3 Effective Expression

CLO-3	PLOs	ECs	Wks	CL	SDGs
Effectively express information, ideas, and opinions in written and spoken English.	PLO-9	EC10	WK1 WK9	C6	SDG 4

- 1 Principles of Effective Communication:** Clarity, coherence, conciseness, correctness, and courtesy in communication.
- 2 Document Structuring:** Structuring documents effectively with introductions, body, and conclusions.
- 3 Public Speaking and Presentation Skills:** Overcoming stage fright, voice modulation, body language, organizing content, using visual aids, and engaging the audience.
- 4 Professional Writing:** Business emails, memos, reports, formal letters, and other professional documentation.

CLO-4 Inter-Cultural Communication

CLO-4	PLOs	ECs	Wks	CL	SDGs
Recognize inter-cultural variations in the use of English language and adapt communication accordingly.	PLO-6	EC6	WK9	C4	SDG 4

- 1 Inclusivity in Communication:** Using gender-neutral language and avoiding stereotypes in cross-cultural communication.
- 2 Varieties of English:** World Englishes, British vs. American conventions, and regional variations in vocabulary and usage.
- 3 Non-Verbal Communication Across Cultures:** Cultural differences in gestures, eye contact, personal space, and etiquette.
- 4 Barriers to Inter-Cultural Communication:** Ethnocentrism, cultural assumptions, and strategies for adapting communication to diverse audiences.

READ Books / Reading Materials

- | | |
|---|---|
| 1 "Understanding and Using English Grammar" by Betty Schramper Azar. | 2 "English Grammar in Use" by Raymond Murphy. |
| 3 "The Blue Book of Grammar and Punctuation" by Jane Straus. | 4 "English for Specific Purposes: A Learning-Centered Approach" by Tom Hutchinson and Alan Waters. |
| 5 "Cambridge English for Job-hunting" by Colm Downes. | 6 "Practical English Usage" by Michael Swan. |
| 7 "Reading Literature and Writing Argument" by Missy James and Alan P. Merickel. | 8 "Communication Skills for Business Professionals" by J.P Verma and Meenakshi Raman. |

Abbreviations:

PLOs: Program Learning Outcomes, **CLOs:** Course Learning Outcomes, **ECs:** Engineering Competencies, **WKs:** Knowledge Profiles, **CL:** Cognitive Levels, **SDGs:** Sustainable Development Goals

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1.4 APPLIED CHEMISTRY (LEC)

Course Syllabus & Outline

INFO Course Description

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

CLO-1 Foundational Processes and Analytical Methods

CLO-1	PLOs	ECs	Wks	CL	SDGs
Explain the foundational processes, primary raw materials, and analytical methods used in major inorganic and chemical process industries.	PLO 1	EC1	WK1 WK3	C2	SDG 9

- 1 Process Industry:** Overview of the Chemical Process Industry and Primary Raw Materials.
- 2 Sulfur & Nitrogen:** Industrial Aspects and Production Methods of the Sulfur and Nitrogen Industries.
- 3 Other Processes:** Industrial Processes for Phosphorus, Chloralkaline, and Titanium Oxide.
- 4 Analysis:** Principles and Techniques of Industrial Chemical Analysis.

CLO-2 Organic Processes and Industrial Applications

CLO-2	PLOs	ECs	Wks	CL	SDGs
Apply reaction mechanisms of fundamental organic processes (e.g., sulfonation, nitration, hydrogenation) to their specific industrial applications.	PLO 2	EC3	WK4	C3	SDG 9 SDG 12

- 1 Organic Mechanisms:** Fundamentals of Organic Reaction Mechanisms in Chemical Manufacturing.
- 2 Specific Applications:** Industrial Applications of Sulfonation, Nitration, and Amination.
- 3 Hydrogenation:** Industrial Hydrogenation and Halogenation Processes.
- 4 Oxidation:** Oxidation Mechanisms and their Role in Industrial Chemical Production.

CLO-3 Synthetic Polymers and Polymeric Materials

CLO-3	PLOs	ECs	WKs	CL	SDGs
Analyze the synthesis, properties, and reactions of synthetic polymers and polymeric materials, including the chemical mechanisms of corrosion.	PLO 4	EC4	WK4	C4	SDG 9

- 1 Introduction:** Synthesis and Basic Polymerization Reactions.
- 2 Properties & Processing:** Properties, Processing, and Applications of Advanced Polymeric Materials.
- 3 Explosives:** Chemical Explosives and Propellants: Chemistry and Applications.
- 4 Corrosion:** Chemical Mechanisms of Corrosion and Chemical Analyses of Materials.

CLO-4 Paints, Pigments, and Pollution Prevention

CLO-4	PLOs	ECs	WKs	CL	SDGs
Evaluate the synthesis, characterization, and applications of paints, pigments, and dyes with respect to industrial manufacturing and pollution prevention strategies.	PLO 6	EC5 EC6	WK5 WK7	C5	SDG 9 SDG 12 SDG 13

- 1 Dye Chemistry:** Synthesis and Industrial Applications.
- 2 Paints & Pigments:** Synthesis and Characterization of Improved Paints and Pigments.
- 3 Coatings:** Formulation and Application of Industrial Coatings.
- 4 Sustainability:** Industrial Pollution Prevention and Sustainable Chemical Manufacturing Methods.

READ Books / Reading Materials

- 1** Applied Chemistry and Chemical Engineering by A. K. Haghi, Devrim Balkose, Omari V. Mukbaniani, Andrew G. Mercader, Apple Academic Press, 2018.
- 2** Comprehensive Analytical Chemistry; Molecular Characterization and Analysis of Polymer, John M. Chalmers, Elsevier (2008).
- 3** Green Chemistry in industry Mark Anthony Benvenuto, Heinz Plaumann, De Gruyter, Volume 3, 2018.
- 4** Polymers, Polymer Blends, Polymer Composites and Filled Polymers, G. E. Zaikov, Nova (2006).
- 5** Sustainable Industrial Chemistry: Principles, Tools and Industrial Examples.
- 6** Pavia, Lampman, Introduction to Spectroscopy, 4 edition, Brooks/Cole, 2009.
- 7** H. Kuhn, Principles of Physical Chemistry, 2nd edition, Wiley, 2009.
- 8** Gary Wulfsberg, Foundations of Inorganic Chemistry, University Science Books, 2017. David Klein, Organic Chemistry, Wiley, 2017.

CHE-102 (667860-1/U) · CREDITS: 1

1.5 APPLIED CHEMISTRY (LAB)

Course Syllabus & Outline

INFO Course Description

This laboratory course is designed to develop practical competence in applied chemistry through safe laboratory work, accurate measurement, chemical analysis, instrument handling, data interpretation, and scientific reporting. Students will learn laboratory safety, chemical handling, waste disposal, glassware use, calibration, titration, pH and conductivity measurement, spectroscopic and chromatographic techniques, and selected experiments related to water, food, pharmaceutical, environmental, and material samples.

CLO-1 Laboratory Safety and Fundamental Techniques

CLO-1	PLOs	ECs	Wks	CL	SDGs
Apply laboratory safety protocols, chemical handling procedures, waste disposal practices, and basic laboratory techniques in applied chemistry experiments.	PLO 4	EC4	WK4	C2	SDG 3
	PLO 5	EC5	WK5	C3	SDG
	PLO 7	EC7	WK7		12

- 1 Safety:** Laboratory safety protocols, PPE, emergency response, and risk assessment.
- 2 Chemical Handling:** Chemical labels, SDS, safe storage, chemical handling, and disposal procedures.
- 3 Equipment:** Laboratory equipment, glassware, instrumentation, calibration, and maintenance.
- 4 Basic Techniques:** Weighing, solution preparation, filtration, heating, dilution, and standardization.

CLO-2 Wet-Chemical and Electrochemical Analysis

CLO-2	PLOs	ECs	Wks	CL	SDGs
Perform standard qualitative and quantitative analyses of water, food, and pharmaceutical samples using appropriate wet-chemical and electrochemical methods.	PLO 1	EC1	WK1	C3	SDG 3
	PLO 2	EC2	WK2	C4	SDG 6
	PLO 4	EC4	WK4		SDG 12

- 1 Water Analysis:** Determination of pH, acidity, alkalinity, hardness, and total dissolved solids.
- 2 Food Analysis:** Determination of sugar content, acidity, additives, and selected preservatives.

- 3 Pharmaceutical Analysis:** Estimation of active pharmaceutical ingredients and analysis of formulations.

- 4 Titration & Electrochemical:** Acid-base, redox, complexometric titration, pH meter, and potentiometry.

CLO-3 Instrumental Techniques and Characterization

CLO-3	PLOs	ECs	Wks	CL	SDGs
Use instrumental techniques for chemical analysis and material characterization, including spectroscopy, chromatography, and electrochemical measurements.	PLO 4	EC4	WK4	C3	SDG 9
	PLO 5	EC5	WK5	C4	SDG
	PLO 7	EC7	WK7		12

- 1 Environmental Analysis:** Determination of selected air, water, soil, and sediment pollutants.
- 3 Spectroscopy:** UV-Vis, IR, and introductory NMR applications in chemical analysis.

- 2 Material Science:** Synthesis and characterization of polymers, coatings, or nanomaterials.
- 4 Chromatography:** GC, HPLC, conductivity, and potentiometric measurements.

CLO-4 Data Analysis and Scientific Reporting

CLO-4	PLOs	ECs	Wks	CL	SDGs
Analyze experimental data, evaluate errors, troubleshoot laboratory results, and communicate findings through well-structured laboratory reports and presentations.	PLO 2	EC2	WK2	C4	SDG 4
	PLO 8	EC8	WK6	C5	SDG 9
	PLO	EC10	WK8		SDG
	10				12

- 1 Data Handling:** Data recording, interpretation, uncertainty, significant figures, and graphical presentation.
- 3 Reporting:** Laboratory report writing, oral presentation, teamwork, and ethical use of data.

- 2 Error Analysis:** Repeatability, accuracy, precision, and troubleshooting of experimental results.
- 4 Green Chemistry:** Waste minimization, safer solvents, and sustainable experiment design.

READ Books / Reading Materials

- 1** Muhammad Raza Shah. Safety in the Chemical Laboratory and Industry: A Practical Guide. Elsevier, 2023.
- 2** Douglas A. Skoog, Donald M. West, F. James Holler, and Stanley R. Crouch. Fundamentals of Analytical Chemistry, 10th Edition. Cengage Learning, 2021.
- 3** Daniel C. Harris and Charles A. Lucy. Quantitative Chemical Analysis, 10th Edition. W. H. Freeman / Macmillan Learning, 2019.
- 4** Donald L. Pavia, Gary M. Lampman, George S. Kriz, and James R. Vyvyan. Introduction to Spectroscopy, 5th Edition. Cengage Learning, 2015.
- 5** Marcello Locatelli and Savas Kaya (eds.). Green Analytical Chemistry: Current Status and Future Perspectives in Sample Preparation. Elsevier, 2024.
- 6** American Chemical Society. Guidelines for Chemical Laboratory Safety in Academic Institutions. ACS Committee on Chemical Safety.

HUM-163 (000003-18/U) · CREDITS: 2

1.6 APPLICATION OF ICT

Course Syllabus & Outline

INFO Course Description

This course is designed to provide students with an exploration of the practical applications of Information and Communication Technologies (ICT) and software tools in various domains. Students will gain hands-on experience with a range of software applications, learning how to leverage ICT to solve daily life problems, enhance productivity and innovate in different fields. Through individual and interactive exercises and discussions, students will develop proficiency in utilizing software for communication, creativity, and more.

CLO-1 Fundamental Components and Emerging Trends

CLO-1	PLOs	ECs	Wks	CL	SDGs
Describe the fundamental components and scope of ICT and analyze emerging trends.	PLO 1	EC1 EC3	WK3	C2	SDG 9

- 1 ICT Basics:** Components of ICT: Basics of hardware, software, ICT platforms, networks, and data storage (local and cloud).
- 2 ICT Scope:** Scope of ICT in various sectors (education, business, governance, health-care, digital media, entertainment).
- 3 Emerging Tech:** Emerging technologies (e.g., AI, IoT, blockchain, 5G, augmented reality).
- 4 Future Trends:** Future trends in ICT and the potential impact on society.

CLO-2 ICT Productivity Tools

CLO-2	PLOs	ECs	Wks	CL	SDGs
Demonstrate proficiency in essential ICT productivity tools for research, communication, and data management.	PLO 2	EC3 EC4	WK4	C3	SDG 4 SDG 9

- 1 Search:** Using search engines effectively (Google, Bing) to explore the World Wide Web.
- 2 Communication:** Professional communication tools and email etiquette (Gmail, Microsoft Outlook).

- 3 Office Suite:** Microsoft Office Suite (Word, Excel, PowerPoint) and Google Workspace (Google Docs, Sheets, Slides).

- 4 Cloud Storage:** Cloud storage and file-sharing applications (Dropbox, Google Drive, OneDrive) and digital organization tools (Evernote, OneNote).

CLO-3 ICT Tools for Learning and Education

CLO-3	PLOs	ECs	Wks	CL	SDGs
Apply ICT tools to enhance learning and explore various educational resources.	PLO 5	EC2 EC4 EC10	WK6	C3	SDG 4

- 1 LMS:** Learning management systems (LMS) like Moodle, Canvas, Google Classroom.

- 3 Interactive Media:** Interactive multimedia and virtual classrooms to facilitate remote learning.

- 2 Online Platforms:** Online educational platforms (Coursera, edX, Udemy, Khan Academy).

- 4 Video Conferencing:** Video conferencing tools (Zoom, Microsoft Teams, Google Meet) for online collaboration.

CLO-4 Ethical Considerations and Digital Citizenship

CLO-4	PLOs	ECs	Wks	CL	SDGs
Evaluate ethical considerations, digital citizenship, and proper online etiquette.	PLO 8	EC6 EC8	WK7	C5	SDG 16

- 1 Digital Identity:** Digital identity, online reputation, and the importance of maintaining a professional online presence.

- 3 Cyber Safety:** Cyberbullying, online harassment, and how to protect against them.

- 2 Netiquette:** Netiquette and principles of respectful online communication.

- 4 Intellectual Property:** Intellectual property, copyright, and avoid plagiarism in content creation.

READ Books / Reading Materials

- 1** "Discovering Computers" by Vernmaat, Shaffer, and Freund.

- 3** "Exploring Microsoft Office" Series by Grauer and Poatsy.

- 5** "Technology in Action" by Evans, Martin and Poatsy.

- 2** "GO! With Microsoft Office" Series by Gaskin, Vargas, and McLellan.

- 4** "Computing Essentials" by Morley and Parker.

HUM-163 (000003-18/U) · CREDITS: 2

1.7 APPLICATION OF ICT (LAB)

Course Syllabus & Outline

INFO Course Description

These CLOs emphasize hands-on practice with commonly used ICT tools and online platforms, preparing students with the essential digital skills required for academic and professional success.

CLO-1 Word Processing, Presentation, and Spreadsheet Software

CLO-1	PLOs	ECs	Wks	CL	SDGs
Demonstrate proficiency in using word processing, presentation, and spreadsheet software for various tasks.	PLO 3	EC1 EC3 EC10	WK5	C3	SDG 4

- Document Formatting:** Creating and editing documents in Microsoft Word, applying styles, formatting text, and adding tables and images.
- Presentation Design:** Developing visually appealing presentations in Microsoft PowerPoint, using slide layouts, animations, and multimedia.
- Data Analysis:** Utilizing Microsoft Excel for basic data entry, formulas, and creating charts/graphs for data visualization.
- Advanced Spreadsheets:** Practicing functions such as VLOOKUP, pivot tables, and conditional formatting to analyze complex data sets.

CLO-2 Digital File Management

CLO-2	PLOs	ECs	Wks	CL	SDGs
Manage and organize digital files effectively using both local and cloud storage systems.	PLO 4	EC3 EC9	WK6	C3	SDG 9

- Local File Management:** Creating and organizing folders and files on a local device, implementing clear naming conventions.
- Cloud Storage Basics:** Uploading, organizing, and sharing files on Google Drive or OneDrive.
- File Synchronization:** Synchronizing files across devices and managing permissions for collaborative work in Google Drive or OneDrive.
- File Compression:** Practicing file compression and creating backups using tools like WinRAR and cloud solutions for data safety.

CLO-3 Learning Management Systems (LMS)

CLO-3	PLOs	ECs	Wks	CL	SDGs
Utilize online Learning Management Systems (LMS) to access course materials, submit assignments, and engage in forums.	PLO 9	EC1 EC10 EC12	WK5	C3	SDG 4

- 1 Course Navigation:** Exploring the structure and features of an LMS (e.g., Moodle or Google Classroom), including course modules and assignment uploads.
- 2 Assignment Submission:** Practicing assignment uploads, downloading feedback, and understanding grading systems on an LMS.
- 3 Discussion Participation:** Engaging in discussion forums, posting responses, and interacting with peers and instructors in a professional manner.
- 4 Quiz Practice:** Taking quizzes or tests on the LMS, reviewing results, and improving time management and test-taking skills.

CLO-4 Online Communication and Collaborative Tools

CLO-4	PLOs	ECs	Wks	CL	SDGs
Apply appropriate online communication and collaborative tools effectively in a virtual workspace.	PLO 10	EC1 EC9 EC10	WK8	C4	SDG 8 SDG 9

- 1 Email Communication:** Sending and managing professional emails, using CC and BCC appropriately, and adhering to email etiquette.
- 2 Calendar Management:** Setting up meetings, using calendar invites, and sharing events in applications like Google Calendar or Outlook.
- 3 Collaborative Editing:** Working collaboratively on Google Docs or Microsoft Word online, tracking changes, and managing document versions.
- 4 Virtual Meetings:** Using Google Meet or Zoom for virtual meetings, managing screen sharing, breakout rooms, and maintaining online meeting etiquette.

MECH-102 (668186-1/U) · CREDITS: 1

1.8 MECHANICAL ENGINEERING DRAWING & GRAPHICS (LEC)**Course Syllabus & Outline****INFO Course Description**

This course equips students with fundamental skills in technical drawing and engineering design. Students learn projection principles, orthographic projections, and isometric drawing techniques. They develop skills in visualizing and representing 3D objects in 2D, analyzing spatial relationships, and creating accurate technical drawings. Upon completion, students can apply their knowledge in mechanical engineering, architectural design, and product design. This foundation prepares them for careers in engineering, design, and technical drafting.

CLO-1 Orthographic Projections

CLO-1	PLOs	ECs	Wks	CL	SDGs
Demonstrate the principles of orthographic projection and their application in engineering drawing.	PLO 1 PLO 5	EC1 EC3	WK1 WK4	C2 C3	SDG 9

- 1 Principles and methods of projection.
- 2 First and third-angle projection techniques.
- 3 Understanding plans of projection and reference lines.
- 4 Applications for orthographic projection in engineering design.

CLO-2 Projection of Points, Lines, and Planes

CLO-2	PLOs	ECs	Wks	CL	SDGs
Apply projection techniques for points, straight lines, and planes in 2D.	PLO 1 PLO 2	EC1 EC3	WK4 WK6	C3 C4	SDG 9

- 1 Projection of points in different quadrants (first, second, third, and fourth).
- 2 Projections of lines parallel, perpendicular, and inclined to planes.
- 3 Methods to determine the true length and traces of lines.
- 4 Projections of different types of planes (oblique, auxiliary, and traces).

CLO-3 Projection of Solids and Sections

CLO-3	PLOs	ECs	Wks	CL	SDGs
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Develop projection drawings of various 3D solids and sections of solids.	PLO 1 PLO 5	EC1 EC4	WK4 WK5	C3 C5	SDG 9
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- 1 Projections of solids with axes inclined to planes (cylinders, cones, spheres, etc.).
- 2 Understanding sections of solids like prisms, pyramids, and cylinders.
- 3 Techniques for the development of lateral surfaces of right solids.
- 4 Triangulation development and applications in solid modeling.

CLO-4 Isometric Projections

CLO-4	PLOs	ECs	WKs	CL	SDGs
Create isometric projections and views of 3D objects for engineering visualization.	PLO 1 PLO 3	EC1 EC4	WK4 WK5	C3 C4	SDG 9

- 1 Understanding isometric axes, lines, planes, and scale.
- 2 Creating isometric drawings of planes, figures, and solids.
- 3 Isometric projections of prisms, pyramids, and cylinders.
- 4 Visualizing and sketching complex solids like cones and spheres in isometric views.

READ Books / Reading Materials

- 1 Thomas Ewing French, Charles J. Vierck, Robert Jay Foster, Engineering Drawing and Graphic Technology, McGraw Hill.
- 2 Frederick E. Giesecke, Ivan L. Hill, Technical Drawing with Engineering Graphics, Peachpit Press.
- 3 David A. Madsen, David P. Madsen, Engineering Drawing and Design, Cengage Learning, 2016.
- 4 Dhananjay Jolhe, Engineering Drawing with an Introduction to AutoCAD, Tata McGraw Hill.

MECH-102 (668186-1/U) · CREDITS: 2

1.9 MECHANICAL ENGINEERING DRAWING & GRAPHICS (LAB)**Course Syllabus & Outline****INFO Course Description**

These CLOs and topics focus on building foundational skills for producing technical drawings, enhancing understanding of design principles, and preparing students for advanced applications in engineering design.

CLO-1 Graphic Instruments and Geometry

CLO-1	PLOs	ECs	Wks	CL	SDGs
Demonstrate proficiency in using graphic instruments and applying fundamental principles of graphic geometry.	PLO 2	EC1 EC10	WK2	P1 P2	SDG 4

- 1 Selection and proper use of graphic instruments (compasses, dividers, rulers, scales).
- 2 Constructing basic geometric shapes and accurate lines.
- 3 Practicing lettering techniques for technical drawings.
- 4 Drafting orthographic projections of simple objects.

CLO-2 Orthographic and Auxiliary Views

CLO-2	PLOs	ECs	Wks	CL	SDGs
Create accurate orthographic and auxiliary views in technical drawings with proper dimensioning and annotation.	PLO 3	EC4 EC5	WK3	P3 P4	SDG 9

- 1 Producing orthographic views of mechanical components.
- 2 Constructing auxiliary views to depict inclined surfaces.
- 3 Adding dimensions, notes, and labels to technical drawings following industry standards.
- 4 Ensuring limits and precision in dimensioning for assembly accuracy.

CLO-3 Sectional Views and Intersections

CLO-3	PLOs	ECs	Wks	CL	SDGs
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Develop sectional views and represent intersections in technical drawings for component analysis.	PLO 4	EC2 EC3	WK4	P3 P5	SDG 8
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- 1 Creating sectional views to reveal internal features of objects.
- 2 Representing conventions for different section types (full, half, offset sections).
- 3 Depicting surface intersections in complex geometries.
- 4 Detailing component specifications using appropriate engineering conventions.

CLO-4 Jigs, Fixtures, and Welding Representation

CLO-4	PLOs	ECs	WKs	CL	SDGs
Design simple jigs, fixtures, and incorporate welding representation into engineering drawings.	PLO 6	EC4 EC9	WK5	P4 P5	SDG 12

- 1 Drafting detailed drawings for basic jigs and fixtures.
- 2 Applying welding symbols and conventions in technical representations.
- 3 Understanding and using tolerance and precision for assembly drawings.
- 4 Creating and interpreting engineering design drawings for construction or fabrication.

READ Books / Reading Materials

- 1 N. D. Bhatt, Engineering Drawing: Plane and Solid Geometry, Charotar Publishing House.
- 2 Frederick E. Giesecke, Alva Mitchell, Henry C. Spencer, Technical Drawing with Engineering Graphics, Pearson.
- 3 Dhananjay Jolhe, Engineering Drawing with an Introduction to AutoCAD, Tata McGraw Hill.
- 4 George Omura, Brian C. Benton, Mastering AutoCAD and AutoCAD LT, Sybex, Wiley.

MECH-101 (667G64-18/U) · CREDITS: 2

1.10 MECHANICAL WORKSHOP (LAB)

Course Syllabus & Outline

INFO Course Description & Content

This laboratory course introduces students to basic manufacturing processes, tools, and practices. Students will gain hands-on experience and apply their knowledge to prepare workpieces across various engineering disciplines, ensuring correct and safe use of workshop equipment.

CLO-1 Introduction

CLO-1	PLOs	ECs	Wks	CL	SDGs
Understand and recognize the basic manufacturing processes, tools and practices.	PLO-1	EC1 EC2	WK4 WK6	C1	SDG 9

- 1 Workshop Introduction:** Layout of workshop sections, general safety rules, and personal protective equipment (PPE).
- 2 Measuring and Marking Tools:** Steel rules, vernier calipers, micrometers, gauges, and marking-out practices.
- 3 Manufacturing Processes Overview:** Casting, machining, joining, and forming processes and their applications.
- 4 Hand Tools and Machine Tools:** Identification, functions, and care of common workshop tools and machines.

CLO-2 Workshop Practice

CLO-2	PLOs	ECs	Wks	CL	SDGs
Apply the knowledge of manufacturing to prepare workpieces/jobs by using techniques, tools or machines.	PLO-3	EC4	WK5	P3	SDG 4 9

- 1 Fitter Shop:** Assembly/disassembly of basic mechanical components, e.g., bearings, keys, belts; filing and sawing practice.
- 2 Machine Shop:** Introduction to machine tools. Basic lathe operations including turning, facing, screw cutting.
- 3 Welding Shop:** Electric arc welding and gas welding of practice jobs.
- 4 Foundry Shop:** Introduction, tools and accessories, moulding, and casting.

CLO-3 Safe Use of Tools & Machines

CLO-3	PLOs	ECs	Wks	CL	SDGs
Demonstrate correct and safe use of hand tools and workshop machines.	PLO-8	EC10	WK9	A2	SDG 5 10 16

- 1 Workshop Safety Practices:** Safe operation of machines, guarding, and use of personal protective equipment.
- 2 Woodwork Shop:** Timber, defects in timber, preservation methods, and safe preparation of different types of wood joints.
- 3 Basics of Electric Shop:** Types and uses of cables, study of household electrical appliances, and safe wiring practices.
- 4 Tool Care and Housekeeping:** Maintenance of tools and machines, safe storage, and workshop housekeeping.

CLO-4 Teamwork & Communication

CLO-4	PLOs	ECs	Wks	CL	SDGs
Work cooperatively with peers to complete workshop tasks and convey workshop procedures, measurements, and operational steps verbally or through lab reports.	PLO-9 PLO-10	EC9 EC10	WK1 WK9	A2	SDG 9 10 16

- 1 Team-Based Workshop Tasks:** Completing machining, fitting, and assembly operations in groups.
- 2 Job Planning and Task Allocation:** Sequencing operations and distributing roles among team members.
- 3 Lab Report Writing:** Recording procedures, measurements, and results in structured lab reports.
- 4 Oral Communication:** Explaining workshop procedures and operational steps during demonstrations and viva.

READ Books / Reading Materials

- 1** Bruce J. Black, Workshop Processes, Practices and Materials.
- 2** C.S. Baladhiya & J.B. Raol, Workshop Practice.
- 3** Workshop Technology, By W. A. J Chapman.
- 4** Electrical Wiring By Richter and Schwan McGraw-Hill.
- 5** Wiring Manual by Pak Cables Limited.

HUM-163 (000003-18/U) · CREDITS: 2

1.11 PAK STUDIES (LEC)

Course Syllabus & Outline

INFO Course Description

This course is designed to provide students with fundamental knowledge about Pakistan Studies, covering the country's historical development, ideological foundations, and governance structure. Topics include the role of key figures in the Pakistan Movement, partition of British India, constitutional developments, and major political events. The course also explores challenges to democracy, population dynamics, education, healthcare, economic development, and foreign policy, including relations with neighboring countries and global powers. Additionally, it examines Pakistan's role in international organizations and the impact of regional conflicts on its geopolitical significance. By the end of this course, students will have a comprehensive understanding of Pakistan's complexities and its position in the global arena.

CLO-1 Historical Foundations and Evolution

CLO-1	POs	ECs	Wks	CL	SDGs
Understand the historical foundations and evolution of Pakistan.	PLO1 PLO6 PLO11	EC1 EC10 EC13	WK1 WK5 WK3	C2 C2 C3	SDG 4 SDG 10 SDG 16

- 1 The role of key figures in the Pakistan Movement (Sir Syed Ahmed Khan, Allama Iqbal, Muhammad Ali Jinnah)
- 2 Partition of British India and the creation of Pakistan
- 3 Ideological foundations of Pakistan
- 4 Impact of the Objectives Resolution and constitutional developments

CLO-2 Governance and Democratic Processes

CLO-2	POs	ECs	Wks	CL	SDGs
Analyze Pakistan's governance structure, political developments, and democratic processes.	PLO6 PLO7 PLO8	EC5 EC9 EC12	WK5 WK4 WK8	C4 C4 C5	SDG 16 SDG

					10 SDG 16
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|--|---|
| <p>1 Structure of the federal and provincial governments in Pakistan</p> <p>3 Role of the military and judiciary in Pakistan's political landscape</p> | <p>2 Major political events and transitions in Pakistan's history</p> <p>4 Challenges to democracy and governance (e.g., political instability, corruption)</p> |
|--|---|

CLO-3 Socio-Economic Issues

CLO-3	PLOs	ECs	Wks	CL	SDGs
Examine Pakistan's socio-economic issues and development strategies.	PL01	EC2	WK1	C3	SDG 3
	PL06	EC6	WK5	C4	SDG 4
	PL07	EC9	WK4	C5	SDG 10

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|---|---|
| <p>1 Population dynamics, urbanization, and demographic challenges</p> <p>3 Healthcare and public health issues</p> | <p>2 Education system in Pakistan and its challenges</p> <p>4 Economic development strategies and issues (agriculture, industry, trade)</p> |
|---|---|

CLO-4 Foreign Policy and Regional Relationships

CLO-4	PLOs	ECs	Wks	CL	SDGs
Assess Pakistan's foreign policy and regional relationships.	PL01	EC1	WK2	C2	SDG 16
	PL07	EC10	WK7	C4	SDG 17
	PL08	EC13	WK4	C5	SDG 10

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|--|---|
| <p>1 Key aspects of Pakistan's foreign policy (relations with neighboring countries, global powers)</p> <p>3 Impact of regional conflicts (e.g., Kashmir dispute, Afghanistan situation)</p> | <p>2 Pakistan's role in international organizations (e.g., UN, OIC)</p> <p>4 Pakistan's geopolitical significance and foreign relations strategy.</p> |
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READ Books / Reading Materials

- | | |
|--|--|
| 1 Akbar, S. Zaidi. Issues in Pakistan's Economy, Oxford University Press | 2 Jalal, Ayesha. The Struggle for Pakistan |
| 3 Jalal, Ayesha. The Oxford Companion to Pakistani History, Oxford University Press | 4 Mehmood, Safdar. Pakistan Political Roots & Development. Lahore |
| 5 Amin, Tahir. Ethno - National Movement in Pakistan | 6 Muhammad Waseem, Pakistan Under Martial Law |
| 7 Burke S. M., C Ziring, Pakistan's Foreign Policy: An Historical Analysis. | 8 Jaffrelot, C A History of Pakistan and Its Origins |
| 9 Ahmed, A.S., Pakistan Society: Islam, Ethnicity and Leadership in South Asia | |

UNDERGRADUATE PROGRAM

2nd Semester

Course Syllabi & Outlines

SEM 2 Second Semester

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|---|--|
| 2.1 LINEAR ALGEBRA AND DIFFERENTIAL EQ (LEC) | 2.2 ELECTRICAL ENGINEERING (LEC) |
| 2.3 ENGINEERING MECHANICS-I (STATICS) (LEC) | 2.4 THERMODYNAMICS - I (LEC) |
| 2.5 MATERIALS ENGINEERING (LEC) | 2.6 CIVICS AND COMMUNITY ENGAGEMENT (LEC) |
| 2.7 IDEOLOGY AND CONSTITUTION OF PAK-ISTAN (LEC) | 2.8 GENDER EQUALITY (LEC) |

MATHP-170 (000762-4/U) · CREDITS: 3

2.1 LINEAR ALGEBRA AND DIFFERENTIAL EQUATIONS (LEC)

Course Syllabus & Outline

INFO Course Description

This course will give students a detailed understanding of Linear Algebra and Differential equations. The course will provide detailed guidance on Linear Algebra and Differential equations employed in the field of Chemical engineering. The main focus on solving the real problems of mechanical engineering using Linear Algebra and Differential equations.

CLO-1 Systems of Linear Equations

CLO-1	PLOs	ECs	Wks	CL	SDGs
Understand and apply methods to solve systems of linear equations and analyze real-world engineering problems.	PL01 PL02 PL03	EC1 EC3 EC5	WK1 WK2 WK3	C2 C3	SDG 9

- 1 Overview of linear systems of equations and different solution cases (unique, no solution, infinite solutions).
- 2 Gauss elimination method, matrix inversion, and LU factorization.
- 3 Row space, column space, and their application in solving linear systems.
- 4 Engineering case studies: Traffic flows, chemical reactions, and network analysis using linear systems.

CLO-2 Vector Spaces and Transformations

CLO-2	PLOs	ECs	Wks	CL	SDGs
Explore vector spaces, transformations, and their applications in various fields.	PL01 PL02 PL05	EC1 EC2 EC4	WK1 WK3 WK5	C2 C4	SDG 4

- 1 Real vector spaces, subspaces, basis, and dimension.
- 2 Gram-Schmidt process for orthonormal basis and linear transformations.
- 3 Applications of linear transformations: Cryptography and robotic systems.
- 4 Kernel, range of transformation, and matrix representation of transformations.

CLO-3 Eigenvalues and Eigenvectors

CLO-3	PLOs	ECs	Wks	CL	SDGs
Analyze eigenvalues, eigenvectors, and their applications in different fields like computer graphics and genetics.	PL01 PL03 PL05	EC1 EC4 EC5	WK2 WK5 WK6	C3 C5	SDG 9

- 1 Eigenvalues, eigenvectors, and diagonalization of matrices.
- 2 Quadratic forms and positive definite matrices in algebra.
- 3 Singular value decomposition and inner product spaces.
- 4 Applications: Constructing curves, surfaces, and genetic modeling using linear algebra.

CLO-4 Differential Equations Modeling

CLO-4	PLOs	ECs	Wks	CL	SDGs
Apply methods of solving differential equations to model and analyze dynamical systems in engineering.	PL01 PL03 PL04	EC3 EC5 EC6	WK1 WK4 WK7	C3 C4	SDG 7

- 1 Formulation of first order and second-order ODEs, including initial and boundary value problems.
- 2 Analytical methods for first-order ODEs: Variable separable methods, exact equations, and Bernoulli's equations.
- 3 Second-order ODEs: Homogeneous linear equations, Cauchy-Euler equations, and method of undetermined coefficients.
- 4 Laplace transform techniques for solving second-order ODEs and applications in RLC circuits and earthquake modeling.

READ Books / Reading Materials

- 1 Bernard Kolman and David R. Hill, Introductory Linear Algebra, Latest Edition.
- 2 Howard Anton and Chris Rorrers, Elementary Linear Algebra, Latest Edition.
- 3 Erwin Kreyzig, Advanced Engineering Mathematics, John Wiley C Sons Inc., Latest Edition.
- 4 D. G. Zill, M. R. Cullen, Differential Equations with Boundary Value Problems, Latest Edition, Brooks/Cole Publishers.
- 5 D. G. Zill, A First Course on Differential Equations with Modeling Applications, Latest Edition, Brooks/Cole Publishers.
- 6 E. A. Bender, An Introduction to Mathematical Modeling, Latest Edition, Wiley, New York.

MATHP-170 (000762-4/U) · CREDITS: 3

2.2 ELECTRICAL ENGINEERING (LEC)

Course Syllabus & Outline

INFO Course Description

This course covers the fundamental concepts of electrical engineering as listed below in course outline/lecture schedule. Being used and implied by Mechanical Engineering students during their course of study and application of Mechanical Engineering.

CLO-1 Foundational Electrical Definitions and Circuits

CLO-1	PLOs	ECs	Wks	CL	SDGs
Explain and apply foundational electrical definitions, properties, and the analysis of series and parallel circuits.	PL01	EC1	WK1	C2	SDG 4

- 1 Basic electrical definitions (voltage, current, resistance, inductance, capacitance, power).
- 2 Characteristics and calculations in series circuits (Ohm's Law, voltage/current distribution).
- 3 Characteristics and calculations in parallel circuits (current division, equivalent resistance).
- 4 Practical analysis and comparison of mixed series-parallel circuits.

CLO-2 Circuit Analysis and Network Theorems

CLO-2	PLOs	ECs	Wks	CL	SDGs
Evaluate and utilize resistance, capacitance, inductance, and network theorems in electrical circuit analysis.	PL02	EC3	WK2	C3	SDG 9

- 1 Properties of resistance, capacitance, and inductance in AC and DC circuits.
- 2 Application of network theorems (Thevenin's, Norton's, Superposition) in simplifying circuits.
- 3 RLC circuit analysis: Impedance, resonance, and frequency response.
- 4 Practical exercises with AC line current and voltage relations in RLC circuits.

CLO-3 Power Factor Analysis

CLO-3	PLOs	ECs	WKs	CL	SDGs
Measure and analyze power factor and its effects on electrical systems.	PLO4	EC5	WK3	C4	SDG 12

- 1 Power factor definition, significance, and types (leading/lagging).
- 2 Methods for power factor measurement and interpretation of results.
- 3 Power factor correction methods and their economic impact on systems.
- 4 Practical case studies of power factor effects in real-world electrical systems.

CLO-4 Motors and Transformers

CLO-4	PLOs	ECs	WKs	CL	SDGs
Describe and compare the operation, types, and applications of AC and DC motors and transformers.	PLO1	EC2	WK4	C2	SDG 7

- 1 Working principles and characteristics of AC motors and their types (induction, synchronous).
- 2 Transformer working principles, connection types, and efficiency calculations.
- 3 DC motor types, construction, characteristics, and practical applications.
- 4 Analysis of transformer losses, efficiency factors, and transformer applications in power systems.

READ Books / Reading Materials

- 1 William H. Hayt, Jack Kemmerly, and Steven M. Durbin, Engineering Circuit Analysis, Seventh Edition, McGraw-Hill
- 2 J. David Irwin and Robert M. Nelms, Basic Engineering Circuit Analysis, Eighth Edition, John Wiley C Sons
- 3 Robert L. Boylestad, Introductory Circuit Analysis, Eleventh Edition, Prentice Hall

HUM-163 (000003-18/U) · CREDITS: 3

2.3 ENGINEERING MECHANICS-I (STATICS) (LEC)

Course Syllabus & Outline

INFO Course Description

Engineering Mechanics-I (Statics) introduces fundamental concepts of mechanics, including force systems, equilibrium conditions, and structural analysis. Topics cover force vectors, moments, free body diagrams, equilibrium in two and three dimensions, trusses (2D and 3D), frames, machines, friction, and center of gravity. The course provides a solid foundation in statics essential for understanding structural and mechanical systems.

CLO-1 Vector Algebra and Force Systems

CLO-1	PLOs	ECs	Wks	CL	SDGs
Apply vector algebra to solve force system problems in two and three dimensions.	PL01 PL02	EC1 EC3	WK1 WK2	C3	SDG 4 SDG 9

- 1 Introduction to vector representation of forces
- 2 Resultant of a system of forces
- 3 Equilibrium of particles in 2D and 3D
- 4 Applications in real-world force systems

CLO-2 Structural Analysis and Equilibrium

CLO-2	PLOs	ECs	Wks	CL	SDGs
Analyze structures for stability and equilibrium using free-body diagrams.	PL02 PL03	EC1 EC4 EC5	WK2 WK3	C4	SDG 4 SDG 9

- 1 Free-body diagram construction for various structures
- 2 Analysis of forces in trusses using the method of joints
- 3 Analysis of forces in trusses using the method of sections
- 4 Stability and determinacy of structures

CLO-3 Centroids and Moments of Inertia

CLO-3	PLOs	ECs	Wks	CL	SDGs
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Calculate centroids and moments of inertia for areas and composite bodies.	PL01 PL03	EC3 EC4	WK1 WK2	C4	SDG 4 SDG 9
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|---|---|
| 1 Determining centroids of simple geometries | 2 Composite area centroid calculation |
| 3 Parallel-axis theorem for moments of inertia | 4 Applications of moments of inertia in engineering design |

CLO-4 Friction Forces

CLO-4	PLOs	ECs	WKs	CL	SDGs
Solve problems involving friction forces in equilibrium scenarios.	PL02 PL05	EC1 EC3 EC5	WK2 WK3	C5	SDG 4 SDG 9

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|---|---|
| 1 Types of friction (static and kinetic) | 2 Application of friction laws in inclined planes and wedges |
| 3 Friction in belt and pulley systems | 4 Implications of friction in structural and mechanical design |

READ Books / Reading Materials

- | | |
|---|---|
| 1 J L Meriam, L G Kraig, Engineering Mechanics (Statics), John Wiley C Sons Inc. | 2 Beer C Johnston, Vector Mechanics for Engineers: Statics C Dynamics, McGraw Hill. |
| 3 RC Hibbeler, Engineering Mechanics (Statics), Prentice Hall. | 4 Anthony M Bedford, Wallace Fowler, Engineering Mechanics (Statics), Prentice Hall. |
| 5 E. Nelson, Engineering Mechanics: Statics, Schaum's outline series, New York. | |

MECH-121 (667666-1/U) · CREDITS: 3

2.4 THERMODYNAMICS - I (LEC)

Course Syllabus & Outline

INFO Course Description

Thermodynamics is an engineering science linked to most mechanical engineering applications. This course provides an introduction to the thermodynamic concepts, required in courses to follow as well in professional applications. The objective of the course is to develop understanding of energy systems such as engines and refrigeration systems.

CLO-1 Foundational Principles

CLO-1	PLOs	ECs	Wks	CL	SDGs
Explain the foundational principles of thermodynamics, including system definitions, behavior, and basic measurements.	PL01 PL02	EC1 EC3	WK1 WK3	C2	SDG 4

- 1 Defining and describing thermodynamic systems.
- 2 Analyzing system properties and behaviors.
- 3 Measuring mass, length, and force in thermodynamic contexts.
- 4 Understanding specific volume and pressure in systems.

CLO-2 The First Law of Thermodynamics

CLO-2	PLOs	ECs	Wks	CL	SDGs
Apply the First Law of Thermodynamics to analyze energy transfer and cycles in closed systems.	PL02 PL03 PL04	EC2 EC4	WK3 WK4	C3	SDG 9

- 1 Concepts of energy and energy transfer by heat.
- 2 Applying energy balance principles to closed systems.
- 3 Analyzing cycles based on energy principles.
- 4 Energy analysis of various thermodynamic cycles.

CLO-3 Thermodynamic Properties

CLO-3	PLOs	ECs	Wks	CL	SDGs
Evaluate thermodynamic properties for ideal gases and real substances using various models and charts.	PL02 PL04	EC1 EC3 EC5	WK2 WK3	C4	SDG 9

- 1 p-v-T relationships and state determination.
- 2 Generalized compressibility charts for property evaluation.
- 3 Applying the Ideal Gas Model to determine properties.
- 4 Calculating changes in internal energy and enthalpy.

CLO-4 The Second Law of Thermodynamics

CLO-4	PLOs	ECs	Wks	CL	SDGs
Employ the Second Law of Thermodynamics and entropy concepts in the analysis of reversible and irreversible processes.	PL02 PL04 PL05	EC3 EC4	WK3 WK5	C5	SDG 13

- 1 Introducing the Second Law and identifying irreversibility.
- 2 Calculating entropy changes in internally reversible processes.
- 3 Analyzing entropy balance for closed systems and control volumes.
- 4 Assessing isentropic efficiencies of turbines, nozzles, compressors, and pumps.

READ Books / Reading Materials

- 1 Moran, Shapiro. Fundamentals of Engineering Thermodynamics, 6th Edition.
- 2 Cengel, Boles. Thermodynamics: An Engineering Approach, 6th Edition.
- 3 Sontag, Borgnakke, Van Wylen. Fundamentals of Thermodynamics, 6th Edition.

HUM-163 (000003-18/U) · CREDITS: 2

2.5 MATERIALS ENGINEERING (LEC)

Course Syllabus & Outline

INFO Course Description

Materials Engineering delves into the fundamentals of materials science, covering atomic bonding, crystalline structures, imperfections, and mechanical properties. The course also explores phase diagrams, phase transformations, and the development of microstructures. Additionally, it discusses the applications, processing, and testing of metallic, non-metallic, and composite materials, along with corrosion prevention methods and material degradation.

CLO-1 Materials Science Fundamentals

CLO-1	PLOs	ECs	Wks	CL	SDGs
Explain fundamental concepts of materials science, including atomic bonding and crystal structures.	PL01 PL02	EC1 EC2	WK1 WK2	C2	SDG 4 SDG 9

- 1 Atomic bonding types and their impact on materials.
- 2 Crystal structures: BCC, FCC, HCP.
- 3 Types and effects of imperfections in solids.
- 4 Basic mechanical properties of materials.

CLO-2 Phase Diagrams and Microstructure

CLO-2	PLOs	ECs	Wks	CL	SDGs
Apply knowledge of phase diagrams and phase transformations to analyze microstructure development in materials.	PL01 PL04	EC3 EC4	WK2 WK3	C3	SDG 9 SDG 12

- 1 Phase diagrams and their relevance in material science.
- 2 Phase transformations and microstructure development.
- 3 Influence of cooling rates on microstructures.
- 4 Real-world examples of phase changes in metals and alloys.

CLO-3 Materials Processing and Applications

CLO-3	PLOs	ECs	WKs	CL	SDGs
Analyze the properties, applications, and processing methods for different classes of materials.	PL01 PL05	EC4 EC5	WK2 WK4	C4	SDG 9 SDG 12

- 1 Properties and applications of metallic materials.
- 2 Structures and characteristics of polymer materials.
- 3 Types and advantages of composite materials.
- 4 Processing techniques for metallic, polymeric, and composite materials.

CLO-4 Material Degradation and Testing

CLO-4	PLOs	ECs	WKs	CL	SDGs
Assess material performance and degradation under environmental and operational conditions.	PL01 PL07	EC5 EC6	WK4 WK7	C5	SDG 9 SDG 12

- 1 Corrosion types and prevention methods.
- 2 Material degradation in different environments.
- 3 Destructive testing techniques for materials.
- 4 Non-destructive testing (NDT) techniques and applications.

READ Books / Reading Materials

- 1 William D. Callister, David G. Rethwisch. Materials Science and Engineering, Eighth Edition, SI Version, John Wiley C Sons.
- 2 William F. Smith. Introduction to Engineering Materials.
- 3 Roy A. Lindberg. Processes and Materials of Manufacturing.

HUM-163 (000003-18/U) · CREDITS: 2

2.6 CIVICS AND COMMUNITY ENGAGEMENT (LEC)

Course Syllabus & Outline

INFO Course Description

This course is designed to provide students with fundamental knowledge about civics, citizenship, and community engagement. In this course, the students will learn about the essentials of civil society, government, civic responsibilities, inclusivity, and effective ways to participate in shaping the society which will help them apply theoretical knowledge to the real-world situations to make a positive impact on their communities.

CLO-1 Foundations of Civics and Citizenship

CLO-1	PLOs	ECs	Wks	CL	SDGs
Understand the foundational concepts of civics, citizenship, and the role of civic engagement in modern society.	PLO 1 PLO 6	EC1 EC2 EC10	WK1 WK2 WK6	C1 C2	SDG 16

- 1 Definition of civics, citizenship, and civic engagement.
- 2 Historical evolution of civic participation.
- 3 The relationships between democracy and citizenship.
- 4 Types of citizenship: active, participatory, digital, etc.

CLO-2 Government and Civil Society

CLO-2	PLOs	ECs	Wks	CL	SDGs
Analyze the structure and functioning of government, civil society, and their relationship with democracy in Pakistan.	PLO 1 PLO 7	EC1 EC3 EC9	WK1 WK2 WK6 WK7	C3 C4	SDG 10 SDG 16

- 1 Structure and functions of government in Pakistan.
- 2 The relationship between democracy and civil society.
- 3 Right to vote and importance of political participation and representation.
- 4 Foundations of modern society and citizenship.

CLO-3 Rights, Responsibilities, and Ethics

CLO-3	PLOs	ECs	WKs	CL	SDGs
Evaluate citizens' rights and responsibilities, and the ethical considerations in civic engagement.	PLO 6 PLO 9	EC4 EC8 EC12	WK2 WK4 WK6	C4 C5	SDG 5 SDG 16

- 1 Overview of fundamental rights and liberties under the Constitution of Pakistan (1973).
- 2 Civic responsibilities and duties.
- 3 Ethical considerations in civic engagement (accountability, non-violence, peaceful dialogue, civility, etc.).
- 4 Case studies of successful community-driven initiatives.

CLO-4 Digital Citizenship and Inclusivity

CLO-4	PLOs	ECs	WKs	CL	SDGs
Explore the impact of digital citizenship, diversity, inclusion, and social justice in promoting civic participation and addressing societal inequalities.	PLO 6 PLO 8	EC6 EC10 EC13	WK6 WK7 WK8	C5 C6	SDG 10 SDG 11 SDG 16

- 1 The use of digital platforms for civic engagement and responsible use of social media.
- 2 Youth, women, and minorities' engagement in social development.
- 3 Addressing social inequalities and injustices in Pakistan.
- 4 Promoting inclusive citizenship and equal rights for societal harmony.

READ Books / Reading Materials

- 1 "Civics Today: Citizenship, Economics, C You" by McGraw-Hill Education.
- 2 "Citizenship in Diverse Societies" by Will Kymlicka and Wayne Norman.
- 3 "Engaging Youth in Civic Life" by James Youniss and Peter Levine.
- 4 "Digital Citizenship in Action: Empowering Students to Engage in Online Communities" by Kristen Mattson.
- 5 "Globalization and Citizenship: In the Pursuit of a Cosmopolitan Education" by Graham Pike and David Selby.
- 6 "Community Engagement: Principles, Strategies, and Practices" by Becky J. Feldpausch and Susan M. Omilian.
- 7 "Creating Social Change: A Blueprint for a Better World" by Matthew Clarke and Marie-Monique Steckel.

CREDITS: 2

2.7 IDEOLOGY AND CONSTITUTION OF PAKISTAN (LEC)

Course Syllabus & Outline

INFO Course Description

This course is designed to provide undergraduate students with a clear understanding of the ideology and constitutional development of Pakistan as a compulsory general education component. The course introduces the historical background of the Pakistan Movement, the ideological basis of Muslim nationalism, the Two-Nation Theory, and the contributions of key leaders, women, and students in the freedom struggle. It further examines the Constitution of the Islamic Republic of Pakistan, 1973, including the Objectives Resolution, federal structure, organs of the state, fundamental rights, principles of policy, citizens' responsibilities, and important constitutional amendments.

CLO-1 Ideological Foundations and History

CLO-1	POs	ECs	Wks	CL	SDGs
Understand the ideological foundations, historical context, and significance of the creation of Pakistan.	PO1 PO6 PO11	EC1 EC10 EC13	WK1 WK3 WK5	C2 C3	SDG 4 SDG 10 SDG 16

- 1 Definition, characteristics, and significance of ideology in nation-building.
- 2 Historical context of the creation of Pakistan with socio-political, religious, and cultural dimensions of British India.
- 3 Muslim nationalism, communal identity, and the emergence of the Two-Nation Theory.
- 4 Contributions of Sir Syed Ahmad Khan, Allama Muhammad Iqbal, Quaid-e-Azam Muhammad Ali Jinnah, women, and students in the freedom movement.

CLO-2 Evolution of the Pakistan Movement

CLO-2	POs	ECs	Wks	CL	SDGs
Analyze the evolution of the Pakistan Movement and the major events that shaped the demand for a separate homeland.	PO1 PO6 PO8	EC1 EC3 EC10	WK3 WK5 WK8	C3 C4	SDG 4 SDG 10

					SDG 16
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- 1 Urdu-Hindi controversy, Partition of Bengal, Simla Deputation 1906, and the rise of Muslim political consciousness.
- 2 Allama Iqbal's Presidential Address 1930, Lahore Resolution 1940, and the constitutional struggle for Pakistan.
- 3 Role of the All-India Muslim League, Quaid-e-Azam's leadership, and political negotiations before independence.
- 4 Partition of British India, creation of Pakistan, and early administrative and constitutional challenges.

CLO-3 Constitution and State Structure

CLO-3	PLOs	ECs	Wks	CL	SDGs
Explain the Constitution of Pakistan, its development, state structure, and the distribution of powers.	PLO6 PLO7 PLO8	EC5 EC9 EC12	WK4 WK5 WK8	C3 C4 C5	SDG 10 SDG 16 SDG 17

- 1 Meaning and importance of a constitution and the ideological role of the Objectives Resolution 1949.
- 2 Overview of constitutional developments in Pakistan from 1947 to the Constitution of 1973.
- 3 Structure of government: legislature, executive, judiciary, and their constitutional functions.
- 4 Federalism, distribution of powers between federation and provinces, and the significance of the 18th and later constitutional amendments.

CLO-4 Fundamental Rights and Civic Duties

CLO-4	PLOs	ECs	Wks	CL	SDGs
Evaluate fundamental rights, principles of policy, citizens' responsibilities, and constitutional values in contemporary Pakistan.	PLO6 PLO7 PLO11	EC2 EC9 EC13	WK5 WK7 WK8	C4 C5 C6	SDG 4 SDG 10 SDG 16

- 1 Fundamental Rights guaranteed by the Constitution of Pakistan, 1973 (Articles 8-28).
- 2 Principles of Policy (Articles 29-40) and their relevance to welfare, justice, and governance.
- 3 Responsibilities of Pakistani citizens, constitutional obedience, rule of law, and civic participation.
- 4 Notable constitutional amendments, current constitutional debates, and their implications for democracy, rights, and institutions.

HUM-101 (666698-23/U) · CREDITS: 2

2.8 GENDER EQUALITY (LEC)

Course Syllabus & Outline

INFO Course Description

This course is designed to provide undergraduate students with a clear and practical understanding of gender equality, gender sensitivity, inclusion, and women empowerment in society, education, and professional life. The course introduces key concepts such as gender roles, stereotypes, discrimination, equal opportunity, dignity, safety, and respectful communication. It also develops students' ability to recognize gender-based barriers in families, workplaces, classrooms, media, and public institutions. Through discussions, case studies, reflective activities, and local/global examples, students will learn how gender-sensitive attitudes contribute to social justice, national development, peaceful communities, and responsible citizenship. The course supports the integration of gender sensitivity in higher education in line with current HEC guidance and the Women Empowerment Package 2024.

CLO-1 Fundamental Concepts

CLO-1	POs	ECs	Wks	CL	SDGs
Understand fundamental concepts of gender equality, gender sensitivity, inclusion, and women empowerment in social and educational contexts.	PO 6 PO 8	EC1 EC2 EC10	WK1 WK2	C1 C2	SDG 5

- 1 Gender, Sex, and Society:** Basic meanings, differences, and common misconceptions.
- 2 Gender Equality and Equity:** Understanding equal rights, equal opportunity, and fairness.
- 3 Gender Sensitivity:** Respectful language, behavior, classroom culture, and daily interaction.
- 4 Women Empowerment:** Education, participation, leadership, and decision-making.

CLO-2 Analyzing Stereotypes and Discrimination

CLO-2	POs	ECs	Wks	CL	SDGs
Analyze social, cultural, educational, and workplace factors that create gender stereotypes, bias, harassment, and discrimination.	PO 6 PO 7	EC3 EC6 EC8 EC12	WK3 WK5	C3 C4	SDG 10

- 1 Gender Roles and Stereotypes:** Family, culture, textbooks, media, and digital spaces.
- 2 Gender-Based Discrimination:** Access to education, employment, resources, and mobility.
- 3 Harassment and Safe Spaces:** Awareness, prevention, reporting, and institutional responsibility.
- 4 Intersectionality:** How gender connects with class, disability, region, age, and other identities.

CLO-3 Frameworks and Policies

CLO-3	PLOs	ECs	Wks	CL	SDGs
Evaluate national and international frameworks, policies, and institutional practices that promote gender equality and inclusive development.	PLO 7 PLO 9	EC4 EC5 EC9 EC11	WK6 WK7	C4 C5	SDG 16

- 1 Constitutional and Legal Protection:** Equal citizenship, dignity, work rights, and protection from violence.
- 2 HEC and Higher Education Role:** Gender sensitivity in curriculum, campus culture, and student support.
- 3 SDG Framework:** Gender equality as a cross-cutting goal for education, health, economy, and governance.
- 4 Gender Mainstreaming:** Integrating gender analysis in planning, policy, budgeting, and evaluation.

CLO-4 Inclusive Solutions and Practice

CLO-4	PLOs	ECs	Wks	CL	SDGs
Apply gender-sensitive thinking to real-life situations and propose inclusive solutions for education, workplace, community, and professional practice.	PLO 8 PLO 10 PLO 12	EC7 EC10 EC12 EC13	WK7 WK8	C5 C6	SDG 4

- 1 Inclusive Communication:** Respectful discussion, non-biased writing, and conflict-sensitive dialogue.
- 2 Gender-Responsive Workplace:** Equal opportunity, leadership, mentorship, safety, and work-life balance.
- 3 Case Studies and Local Context:** Gender issues in Pakistan, higher education, and professional fields.
- 4 Action Planning:** Designing small gender-sensitive initiatives for classroom, campus, or community improvement.

READ Books / Reading Materials

- 1** UNESCO. (2024). Global Education Monitoring Report 2024: Gender Report. UNESCO Publishing.
- 2** UNESCO. (2024). UNESCO in Action for Gender Equality 2024-2025. UNESCO.
- 3** UN Women. (2024). Manual for Gender Equality Action Plans for Higher Education and Research Institutions. UN Women.
- 4** UN Women. (2022). Handbook on Gender Mainstreaming for Gender Equality Results. UN Women.
- 5** UNDP. (2023). Gender Mainstreaming Training Manual. United Nations Development Programme.
- 6** Condron, C., et al. (2025). Gender Equality Training for Students in Higher Education: A Scoping Review. JMIR Medical Education.
- 7** Shrivastava, R., Ashraf, G. Y., Mishra, G., & Dani, T. S. (Eds.). (2025). Thriving Concepts in Women's and Gender Studies: Ways of Perceiving. Apple Academic Press.
- 8** Kang, M., Lessard, D., Heston, L., & Nordmarken, S. (2017). Introduction to Women, Gender, Sexuality Studies. University of Massachusetts Amherst Libraries / Open Textbook Library.
- 9** Smith, B. G. (2019). Women's Studies: The Basics. Routledge.
- 10** Bhasin, K. (2000). Understanding Gender. Kali for Women.
- 11** Bari, F. (2000). Women in Pakistan: Country Briefing Paper. Asian Development Bank.
- 12** Government of Pakistan and Higher Education Commission. Relevant policies, notifications, and institutional guidelines on gender sensitivity, harassment prevention, and inclusive education.

Abbreviations:

PLOs: Program Learning Outcomes, **CLOs:** Course Learning Outcomes, **ECs:** Engineering Competencies, **WKs:** Knowledge Profiles, **CL:** Cognitive Levels, **SDGs:** Sustainable Development Goals

UNDERGRADUATE PROGRAM

3rd Semester

Course Syllabi & Outlines

SEM 3 Third Semester

3.1 COMPUTER AIDED DRAWING (LAB)

3.3 MECHANICS OF MATERIAL - I (LEC)

3.5 COMPUTER SYSTEM AND PROGRAMMING (LAB)

3.7 THERMODYNAMICS-II (LEC)

3.9 THERMODYNAMICS (LAB)

3.11 MUSLIM HERITAGE (LEC)

3.2 ENGG MECHANICS-II DYNAMICS (LEC)

3.4 COMPUTER SYSTEM AND PROGRAMMING (LEC)

3.6 FLUID MECHANICS - I (LEC)

3.8 ENGINEERING MECHANICS (LAB)

3.10 FEHME QURAN I (LEC)

MECH- 363L (666647-1/U) · CREDITS: 2

3.1 COMPUTER AIDED DRAWING (LAB)

Course Syllabus & Outline

INFO Course Description

These CLOs and topics provide a structured approach to developing core skills in SolidWorks, from basic sketching to 3D modeling, assemblies, and technical drawing documentation.

CLO-1 SolidWorks Interface & 2D Sketching

CLO-1	PLOs	ECs	WKs	CL	SDGs
Understand and utilize the SolidWorks user interface and essential tools for creating 2D sketches.	PLO1	EC1	WK3	P2	SDG 4

- 1 SolidWorks User Interface Overview:** Navigation, toolbars, and customization.
- 2 Basic Sketching Tools:** Lines, rectangles, circles, and arcs.
- 3 Sketch Relations and Constraints:** Defining geometry with relations.
- 4 Dimensioning and Geometric Constraints:** Accurate sketch dimensioning for design intent.

CLO-2 3D Part Modeling

CLO-2	PLOs	ECs	WKs	CL	SDGs
Develop and edit 3D models using fundamental part modeling tools in SolidWorks.	PLO2	EC4	WK5	P3	SDG 9

- 1 Creating Basic 3D Features:** Extrudes, revolves, sweeps, and lofts.
- 2 Editing Part Models:** Feature tree navigation, edit, and rollback functions.
- 3 Applying Material Properties:** Assigning and modifying materials for parts.
- 4 Using Reference Geometry:** Planes, axes, and coordinate systems for complex parts.

CLO-3 Assembly Modeling

CLO-3	PLOs	ECs	WKs	CL	SDGs
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Create assembly models by applying mates and relations to individual components.	PLO3	EC3	WK5	P3	SDG 9
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- 1 Assembly Basics:** Importing and positioning parts in an assembly.
- 2 Applying Standard Mates:** Concentric, parallel, perpendicular, and tangent.
- 3 Advanced Mates:** Width, distance, angle, and symmetry mates.
- 4 Interference Detection and Clearance:** Ensuring part fit and functionality in assemblies.

CLO-4 Technical Drawings & Documentation

CLO-4	PLOs	ECs	WKs	CL	SDGs
Generate and annotate detailed technical drawings from 3D models for documentation.	PLO3	EC10	WK6	P3	SDG 4

- 1 Creating 2D Drawings from 3D Models:** Generating views (front, top, side, isometric).
- 2 Adding Dimensions and Annotations:** Tolerances, notes, and symbols for clarity.
- 3 Detailing with Section and Auxiliary Views:** Creating cross-sectional views for clarity.
- 4 Drawing Templates and Sheet Formats:** Setting up title blocks, revision tables, and BOMs.

READ Books / Reading Materials

- 1** "SolidWorks 2024: A Power Guide for Beginners and Intermediate Users" by CAD Artifex.
- 2** "Engineering Design with SolidWorks 2024 and Video Instruction" by David C. Planchard.
- 3** "Mastering SolidWorks 2024" by Matt Lombard.
- 4** "SolidWorks 2024 Black Book" by Gaurav Verma and Matt Weber.
- 5** "SolidWorks Simulation 2024: A Step-by-Step Project-Based Approach" by John Willis.
- 6** "SolidWorks Sheet Metal & Surface Design 2024" by Lani Tran.
- 7** "SolidWorks for Dummies" (latest edition) by Greg Jankowski and Richard Doyle.

HUM-163 (000003-18/U) · CREDITS: 2

3.2 ENGINEERING MECHANICS-II DYNAMICS (LEC)

Course Syllabus & Outline

INFO Course Description

Engineering Mechanics-II (Dynamics) delves into Newtonian mechanics, covering kinematics and kinetics of particles and rigid bodies. Topics include rectilinear, curvilinear, and constrained motion, along with equations of motion, work-energy principles, linear impulse and momentum, impact analysis, angular momentum, and motion relative to moving reference frames. This course provides a comprehensive understanding of dynamic systems and their behavior in engineering applications.

CLO-1 Kinematics of Particles

CLO-1	PLOs	ECs	Wks	CL	SDGs
Understand and apply kinematics principles to analyze particle motion in one, two, and three dimensions.	PL01 PL02	EC1 EC3	WK1 WK2	C3	SDG 4

- 1 Rectilinear and curvilinear motion of particles.
- 2 Relative velocity and acceleration in particle motion.
- 3 Projectile motion analysis.
- 4 Motion in polar and cylindrical coordinates.

CLO-2 Kinetics of Particles

CLO-2	PLOs	ECs	Wks	CL	SDGs
Analyze the kinetics of particles and apply Newton's second law, work-energy principles, and impulse-momentum methods to solve dynamic problems.	PL01 PL02	EC1 EC3	WK1 WK3	C4	SDG 4

- 1 Newton's laws of motion and applications to particles.
- 2 Work-energy theorem and applications.
- 3 Impulse and momentum principles.
- 4 Conservation of energy and momentum in particle collisions.

CLO-3 Rigid Body Dynamics

CLO-3	PLOs	ECs	Wks	CL	SDGs
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Explore rigid body dynamics, focusing on rotation, translating and rotating bodies, and the application of kinetics to rigid bodies.	PL01 PL03	EC1 EC4	WK1 WK3	C4	SDG 4 SDG 9
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| <p>1 Angular motion and kinematics of rigid bodies.</p> <p>3 Work and energy in rigid body motion.</p> | <p>2 Equations of motion for rigid bodies in translation and rotation.</p> <p>4 Conservation of angular momentum in rigid body dynamics.</p> |
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CLO-4 Principles of Vibrations

CLO-4	PLOs	ECs	WKs	CL	SDGs
Investigate and apply the principles of vibrations, including simple harmonic motion, damping, and resonance in dynamic systems.	PL01 PL02	EC1 EC5	WK1 WK2	C4	SDG 4 SDG 9

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| <p>1 Simple harmonic motion and natural frequencies.</p> <p>3 Resonance and frequency response in engineering systems.</p> | <p>2 Damped and forced vibrations in single-degree-of-freedom systems.</p> <p>4 Applications of vibration analysis in engineering design.</p> |
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READ Books / Reading Materials

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|---|---|
| <p>1 J L Meriam, L G Kraig. Engineering Mechanics (Dynamics), John Wiley C Sons Inc.</p> <p>3 RC Hibbeler. Engineering Mechanics (Dynamics), 13th Ed., Prentice Hall.</p> <p>5 E. Nelson, Engineering Mechanics: Statics, Schaum's Outline Series, New York.</p> | <p>2 Beer C Johnston. Vector Mechanics for Engineers: Statics C Dynamics, McGraw-Hill.</p> <p>4 Anthony M Bedford, Wallace Fowler. Engineering Mechanics (Dynamics), Prentice Hall.</p> |
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MECH- 242 (667671-1/U) · CREDITS: 3

3.3 MECHANICS OF MATERIAL - I (LEC)

Course Syllabus & Outline

INFO Course Description

Solid Mechanics-I delves into equilibrium principles, material behavior, and load types, covering direct stresses and strains, Hooke's law, and mechanical properties. The course also includes thermal stresses, failure modes, and stresses in simple and composite bars, along with torsion, bending stresses, beam deflection, and shear stresses in beams using various methods. Students gain a comprehensive understanding of structural analysis and material behavior under different conditions.

CLO-1 Stress and Strain Analysis

CLO-1	PLOs	ECs	Wks	CL	SDGs
Analyze stress and strain in structural elements under various loading conditions.	PL01 PL02	EC1 EC3 EC5	WK1 WK3	C3	SDG 4 SDG 9

- 1 Concepts of stress and strain.
- 2 Stress-strain diagrams and material properties.
- 3 Types of stresses (normal, shear, bending).
- 4 Axial, shear, and bearing stresses in connections.

CLO-2 Internal Forces and Bending Moments

CLO-2	PLOs	ECs	Wks	CL	SDGs
Determine internal forces and bending moments in beams and frames.	PL01 PL02 PL03	EC1 EC3 EC4	WK1 WK2	C3 C4	SDG 4 SDG 9

- 1 Free body diagrams and equilibrium equations.
- 2 Shear and bending moment diagrams.
- 3 Relationships between load, shear, and bending moment.
- 4 Types of beams and loading (point load, distributed load).

CLO-3 Principles of Torsion

CLO-3	PLOs	ECs	Wks	CL	SDGs
Apply principles of torsion in analyzing circular shafts under twisting moments.	PL02 PL03	EC1 EC3 EC5	WK1 WK3	C4	SDG 4 SDG 9

- 1 Torsion formula and assumptions.
- 2 Shear stress distribution in circular shafts.
- 3 Angle of twist and power transmission.
- 4 Torsional rigidity and design of shafts.

CLO-4 Deflections in Beams

CLO-4	PLOs	ECs	Wks	CL	SDGs
Evaluate deflections in beams using various methods.	PL02 PL04	EC1 EC3 EC4 EC5	WK1 WK3	C4 C5	SDG 4 SDG 9

- 1 Double integration method for beam deflection.
- 2 Moment-area theorem.
- 3 Superposition principles for deflection.
- 4 Application of deflection limits in design.

READ Books / Reading Materials

- 1 Gere. Mechanics of Materials, Sixth Edition.
- 2 Hibbeler, R. C. Mechanics of Materials, Eighth Edition.
- 3 Rajput, R. K. Strength of Materials.
- 4 Nag, Debabrata, Abhijit Chanda. Mechanics of Materials.
- 5 Beer, Ferdinand P., Russel Johnston Jr. Mechanics of Materials, McGraw-Hill.

HUM-163 (000003-18/U) · CREDITS: 2

3.4 COMPUTER SYSTEM AND PROGRAMMING (LEC)

Course Syllabus & Outline

INFO Course Description

Computer Systems and Programming introduces the fundamentals of computer hardware and software, covering the history of computing, data representation, number systems, networks, memory, storage devices, and operating systems. The course also delves into basic programming concepts, including algorithms, flowcharts, pseudocode, control structures, arrays, loops, and the use of library functions and header files. Students will gain a solid foundation in both the theoretical and practical aspects of computing.

CLO-1 Foundations of Computer Systems

CLO-1	PLOs	ECs	Wks	CL	SDGs
Describe foundational concepts of computer systems, including hardware, software, and data representation.	PL01 PL02	EC1 EC2	WK1 WK3	C2	SDG 4

- 1 Overview of computer history and applications in various fields.
- 2 Introduction to computer hardware and peripheral devices.
- 3 Understanding software components and their functions in a computer system.
- 4 Data representation, including binary, ASCII, and Unicode standards.

CLO-2 Number Systems & Data Conversion

CLO-2	PLOs	ECs	Wks	CL	SDGs
Explain number systems and data conversion methods crucial for data processing and computing.	PL01 PL02	EC1 EC3	WK1 WK2	C3	SDG 4

- 1 Types of number systems: binary, decimal, octal, and hexadecimal.
- 2 Conversion methods between number systems.
- 3 Importance and usage of ASCII and Unicode in data encoding.
- 4 Memory and storage devices and their roles in data storage and processing.

CLO-3 Fundamental Programming Constructs

CLO-3	PLOs	ECs	Wks	CL	SDGs
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Demonstrate the use of fundamental programming constructs to solve simple computational problems.	PL02 PL05	EC1 EC3 EC4	WK2 WK4	C3	SDG 9
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- 1 Creating algorithms, flowcharts, and pseudocode for problem-solving.
- 2 Assignment operators and variable manipulation.
- 3 Using conditional statements (if, if-else, switch) for decision-making.
- 4 Implementing loops (for, while) for iterative processing.

CLO-4 Advanced Programming Techniques

CLO-4	PLOs	ECs	WKs	CL	SDGs
Apply programming techniques for array manipulation, function usage, and basic searching algorithms.	PL01 PL05	EC3 EC4	WK3 WK5	C4	SDG 9

- 1 Declaring and passing arrays to functions for data management.
- 2 Utilizing basic searching techniques in arrays.
- 3 Working with library functions and including header files.
- 4 Creating nested control structures for complex problem-solving.

READ Books / Reading Materials

- 1 J. Deitel, H. Deitel, C++ How to Program, 10th Edition, Pearson, 2017.
- 2 Peter Norton, Computer Fundamentals, 7th Edition.
- 3 Robert Lafore, Object-Oriented Programming in C++.
- 4 Nell Dale, John Lewis, Computer Science Illuminated.

HUM-163 (000003-18/U) · CREDITS: 2

3.5 COMPUTER SYSTEM AND PROGRAMMING (LAB)

Course Syllabus & Outline

INFO Course Description

Computer Systems and Programming introduces the fundamentals of computer hardware and software, covering the history of computing, data representation, number systems, networks, memory, storage devices, and operating systems. The course also delves into basic programming concepts, including algorithms, flowcharts, pseudocode, control structures, arrays, loops, and the use of library functions and header files. Students will gain a solid foundation in both the theoretical and practical aspects of computing.

CLO-1 Hardware and Peripheral Devices

CLO-1	PLOs	ECs	Wks	CL	SDGs
Demonstrate fundamental skills in identifying and operating basic computer hardware and peripheral devices.	PL01 PL02	EC1 EC4	WK1	P2	SDG 4

- 1 Setting up and connecting peripheral devices (printers, scanners, etc.) to a computer system.
- 2 Identifying and understanding functions of primary computer components (CPU, RAM, motherboard, storage, etc.).
- 3 Exploring memory types and data storage options (HDD, SSD, USB, and cloud storage).
- 4 Working with different operating system interfaces and their functionalities.

CLO-2 Data Representation Methods

CLO-2	PLOs	ECs	Wks	CL	SDGs
Apply number system conversions and data representation methods to encode and decode data in digital formats.	PL01 PL02	EC1 EC3	WK2	P3	SDG 4

- 1 Converting between binary, decimal, hexadecimal, and octal number systems.
- 2 Encoding and decoding characters using ASCII and Unicode standards.
- 3 Performing arithmetic operations using binary and hexadecimal systems.
- 4 Implementing data representation concepts to store and retrieve digital information.

CLO-3 Foundational Programming Skills

CLO-3	PLOs	ECs	WKs	CL	SDGs
Develop foundational programming skills using basic algorithms and control structures in a programming environment.	PL03 PL05	EC3 EC4	WK3	P3	SDG 4

- 1** Writing simple algorithms and creating flowcharts to outline program logic.
- 2** Implementing basic control structures (if, if-else, switch) in code to handle conditions.
- 3** Using loops (for, while) to perform repeated actions in a program.
- 4** Integrating library functions and header files for efficient program development.

CLO-4 Array Manipulation

CLO-4	PLOs	ECs	WKs	CL	SDGs
Analyze and manipulate arrays to perform data operations within a structured programming environment.	PL02 PL03	EC1 EC3	WK3	P4	SDG 4

- 1** Declaring, initializing, and accessing arrays to store multiple values.
- 2** Implementing functions to pass arrays and manipulate their data.
- 3** Searching and sorting array elements through different algorithms.
- 4** Building nested structures to create complex data handling scenarios.

READ Books / Reading Materials

- 1** C++ Programming: From Problem Analysis to Program Design by D.S. Malik (8th Edition, 2020, Cengage Learning)
- 3** C++ Primer by Stanley B. Lippman, Josée Lajoie, and Barbara E. Moo (6th Edition, 2020, Addison-Wesley)
- 5** Introduction to Computer Science by John Lewis and William Loftus (2nd Edition, 2020, Pearson)
- 7** Object-Oriented Programming in C++ by Robert Lafore (replaced by) C++ Templates: The Complete Guide by David Vandevoorde, Nicolai Josuttis, and Douglas Gregor (2nd Edition, 2017, Addison-Wesley)
- 9** C++ Coding Standards: 101 Rules, Guidelines, and Best Practices by Herb Sutter, Andrei Alexandrescu, and Peter Margitis (2005, Addison-Wesley)
- 11** Computer Science: An Overview by J. Glenn Brookshear (14th Edition, 2020, Pearson)
- 2** Starting Out with C++: From Control Structures through Objects by Tony Gaddis (4th Edition, 2020, Pearson)
- 4** Computer Organization and Design by David A. Patterson and John L. Hennessy (6th Edition, 2020, Morgan Kaufmann)
- 6** Computer Systems: A Programmer's Perspective by Randal E. Bryant and David R. O'Hallaron (3rd Edition, 2016, Pearson)
- 8** Effective C++: 55 Specific Ways to Improve Your Programs and Designs by Scott Meyers (3rd Edition, 2018, Addison-Wesley)
- 10** Introduction to Algorithms by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein (4th Edition, 2022, MIT Press)
- 12** Discrete Mathematics and Its Applications by Kenneth H. Rosen (8th Edition, 2020, McGraw-Hill)

MECH-222 (667675-1/U) · CREDITS: 3

3.6 FLUID MECHANICS - I (LEC)

Course Syllabus & Outline

INFO Course Description

This course develops the basics of fluid mechanics and is a prerequisite for subsequent courses in the thermal-fluid area. The course defines a fluid, describes its properties, and derives governing equations from basic principles. It also supports the students in mathematical development. Both integral and differential approaches are presented and simplifying assumptions and equations are discussed and applied.

CLO-1 Fundamental Properties of Fluids

CLO-1	PLOs	ECs	Wks	CL	SDGs
Describe the fundamental properties of fluids and their implications in engineering applications.	PLO1	EC1	WK1	C1	SDG 4
	PLO2	EC3	WK2	C2	SDG 9

- 1 Dimensions, units, fluid mass, and weight.
- 2 Compressibility, vapor pressure, and viscosity.
- 3 Surface tension and fluid density.
- 4 Fluid types and their properties.

CLO-2 Fluid Statics Principles

CLO-2	PLOs	ECs	Wks	CL	SDGs
Explain and analyze fluid statics principles and their applications in engineering contexts.	PLO1	EC1	WK1	C2	SDG 4
	PLO2	EC4	WK3	C3	SDG 9
	PLO4				

- 1 Pressure and hydrostatic force on surfaces.
- 2 Manometers (plane and inclined) for pressure measurement.
- 3 Buoyancy principles and Archimedes' principles.
- 4 Applications of fluid statics in engineering design.

CLO-3 Fluid Dynamics and Bernoulli's Equation

CLO-3	PLOs	ECs	Wks	CL	SDGs
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Apply elementary fluid dynamics principles, including Bernoulli's equation, to analyze fluid flow.	PL02 PL03 PL04	EC3 EC4	WK2 WK4	C3 C4	SDG 4 SDG 9
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- 1 Streamlines and flow patterns.
- 2 Bernoulli's equation along and across streamlines.
- 3 Static, stagnation, and total pressure measurements.
- 4 Hydraulic and energy grade lines for fluid analysis.

CLO-4 Control Volume and Dimensional Analysis

CLO-4	PLOs	ECs	WKs	CL	SDGs
Employ control volume analysis and dimensional analysis to solve fluid flow problems.	PL02 PL03 PL05	EC3 EC5	WK3 WK5	C4 C5	SDG 4 SDG 9

- 1 Conservation of mass in a control volume.
- 2 Linear and angular momentum equations.
- 3 Energy equation derivation and applications.
- 4 Dimensional analysis and Buckingham Pi theorem for modeling.

READ Books / Reading Materials

- 1 Munson, Bruce R., Donald F. Young, Theodore H. Okiishi, Wade W. Huebsch. Fundamentals of Fluid Mechanics, 6th Edition, John Wiley & Sons, Inc.
- 2 Çengel, Yunus A., John M. Cimbala. Fluid Mechanics: Fundamentals and Applications, 3rd Edition, McGraw-Hill.
- 3 Philip J. Pritchard, John C. Leylegian. Fox and McDonald's Introduction to Fluid Mechanics, J. Wiley & Sons.

MECH-221 (667673-1/U) · CREDITS: 3

3.7 THERMODYNAMICS-II (LEC)

Course Syllabus & Outline

INFO Course Description

This course teaches the application of Thermodynamics and prepares students for subsequent courses in the thermal-fluid area. The course prepares the student to apply the principles of Thermodynamics in power plants and Refrigeration cycles systems. It also supports the students in mathematical development. Both integral and differential approaches are presented and simplifying assumptions and equations are discussed and applied.

CLO-1 Energy Principles & Balance

CLO-1	PLOs	ECs	Wks	CL	SDGs
Analyze energy principles in thermodynamics and apply energy balance to systems.	PL01 PL02 PL03	EC1 EC3 EC5	WK1 WK3	C4	SDG 7

- 1 Defining energy and energy types.
- 2 Closed system energy balance.
- 3 Flow energy in open systems.
- 4 Exegetic (Second Law) efficiency.

CLO-2 Vapor Power Cycles

CLO-2	PLOs	ECs	Wks	CL	SDGs
Evaluate and model vapor power cycles including superheat, reheat, and regenerative cycles.	PL01 PL04 PL011	EC3 EC4 EC9	WK4 WK5	C5	SDG 9

- 1 Modeling and analyzing vapor power systems.
- 2 Superheat and reheat processes in vapor cycles.
- 3 Regenerative vapor power cycle.
- 4 Air-standard cycles (Otto, Diesel, Dual, and Brayton cycles).

CLO-3 Gas Cycles & Psychrometrics

CLO-3	PLOs	ECs	WKs	CL	SDGs
Analyze air-standard and real gas cycles and apply to various engineering systems.	PL02 PL03 PL07	EC3 EC6 EC12	WK2 WK4	C4	SDG 13

- 1 Vapor and gas refrigeration systems.
- 2 Heat pump systems and applications.
- 3 Psychrometric principles and charts.
- 4 Air-conditioning processes and cooling towers.

CLO-4 Refrigeration & Combustion

CLO-4	PLOs	ECs	WKs	CL	SDGs
Evaluate refrigeration cycles, ideal gas mixtures, and combustion processes.	PL02 PL05 PL07	EC3 EC4 EC8	WK3 WK4 WK5	C5	SDG 11

- 1 Combustion process fundamentals.
- 2 Conservation of energy in reacting systems.
- 3 Adiabatic flame temperature.
- 4 Fuel cells and energy efficiency.

READ Books / Reading Materials

- 1 Moran, M. J., & Shapiro, H. N., Fundamentals of Engineering Thermodynamics, 6th Edition, John Wiley & Sons.
- 2 Çengel, Y. A., & Boles, M. A., Thermodynamics: An Engineering Approach, 6th Edition, McGraw-Hill Education.
- 3 Sonntag, R. E., Borgnakke, C., & Van Wylen, G. J., Fundamentals of Thermodynamics, 6th Edition, John Wiley & Sons.

HUM-163 (000003-18/U) · CREDITS: 2

3.8 ENGINEERING MECHANICS (LAB)

Course Syllabus & Outline

INFO Course Description

These CLOs cover essential practical skills in equilibrium, friction, gravity, and rotation, encouraging hands-on understanding through experiments.

CLO-1 Equilibrium Analysis

CLO-1	PLOs	ECs	Wks	CL	SDGs
Apply principles of equilibrium to analyze forces in static systems.	PLO1	EC3	WK3	P2	SDG 9

- Determining forces and angles using Lami's theorem.
- Analyzing forces on a beam using static experiment apparatus.
- Measuring frictional force and coefficient of friction on various surfaces.
- Verifying the axial force in truss members.

CLO-2 Frictional Forces

CLO-2	PLOs	ECs	Wks	CL	SDGs
Investigate frictional forces and understand their role in static and kinetic situations.	PLO2	EC4	WK4	P3	SDG 9

- Determining the frictional force and coefficient of friction for various plates.
- Calculating the coefficient of kinetic and static friction.
- Examining the effect of moment arm on the bell crank lever.
- Determining the ratio and direction of rotation in a gear train.

CLO-3 Forces and Moments in Beams

CLO-3	PLOs	ECs	Wks	CL	SDGs
Evaluate forces and moments in beams to understand principles of equilibrium and rotation.	PLO3	EC5	WK5	P3	SDG 4

- 1 Determining the resultant of forces using beam reaction apparatus.
- 2 Calculating the angle of deflection of a beam in static experiments.
- 3 Analyzing forces using moment of inertia of a flywheel.
- 4 Observing and measuring forces on a beam using static apparatus.

CLO-4 Gravity and Rotational Motion

CLO-4	PLOs	ECs	Wks	CL	SDGs
Explore concepts of gravity, inertia, and rotational motion through experimental applications.	PL04	EC1	WK6	P4	SDG 9

- 1 Finding the Center of Gravity of irregular lamina.
- 2 Determining gravitational acceleration (g) using a simple pendulum.
- 3 Calculating moment of inertia of a flywheel.
- 4 Exploring effect of the moment arm on forces in a system.

READ Books / Reading Materials

- 1 "Engineering Mechanics Laboratory Manual" by Mark C. Minor and John DeWolf.
- 2 "Mechanics Lab Manual" by Michael Beer and William F. Johnston.
- 3 "Physics Laboratory Experiments" by Jerry D. Wilson, Cecilia A. Hernandez, and Chuck W. Cracolice.
- 4 "Applied Mechanics Laboratory Manual" by A.A. Kolchin.

HUM-163 (000003-18/U) · CREDITS: 2

3.9 THERMODYNAMICS (LAB)

Course Syllabus & Outline

INFO Course Description

These CLOs cover essential practical skills in equilibrium, friction, gravity, and rotation, encouraging hands-on understanding through experiments.

CLO-1 Saturation Pressure & Marcet Boiler

CLO-1	PLOs	ECs	WKs	CL	SDGs
Demonstrate an understanding of the saturation pressure apparatus and Marcet boiler.	PL01	EC1	WK1	P2	SDG 4

- 1 Introduction to saturation pressure apparatus: Familiarization with components and operational principles.
- 2 Pressure-temperature relationship: Using saturation pressure apparatus to observe pressure and temperature equilibrium.
- 3 Vapor pressure curve demonstration: Observing and plotting the vapor pressure curve using the apparatus.
- 4 Introduction to the Marcet boiler: Familiarization with components, functionality, and purpose.

CLO-2 Behavior of Steam & Gases

CLO-2	PLOs	ECs	WKs	CL	SDGs
Analyze the behavior of steam and gases under various conditions.	PL02	EC3	WK2	P3	SDG 9

- 1 Pressure-temperature relationship using Marcet boiler: Observing saturated steam equilibrium.
- 2 Vapor pressure curve for steam: Demonstrating and plotting using Marcet boiler readings.
- 3 Pressure-volume relationship of ideal gas: Experimenting with and analyzing results on the perfect gas law apparatus.
- 4 Pressure-temperature relationship of ideal gas: Observing and calculating results using the perfect gas law apparatus.

CLO-3 Steam & Gas Properties

CLO-3	PLOs	ECs	Wks	CL	SDGs
Calculate key properties of steam and gases experimentally.	PL03	EC4	WK3	P4	SDG 4

- 1 Quality of steam calculation: Measuring and calculating steam quality using a throttling calorimeter.
- 2 Comparison of experimental vs. theoretical results: Verifying pressure-volume data with theoretical values.
- 3 Use of perfect gas law apparatus: Calculation of pressure and volume relationships.
- 4 Application of perfect gas law: Confirming ideal gas law relationships and deviations in practical experiments.

CLO-4 Mini Steam Turbine Operations

CLO-4	PLOs	ECs	Wks	CL	SDGs
Operate and evaluate performance parameters of a mini steam turbine power plant.	PL05	EC9	WK4	P5	SDG 7

- 1 Mini steam turbine operation: Demonstrating operational steps and understanding core components.
- 2 Working principles of a steam turbine: Analyzing thermodynamic principles driving turbine function.
- 3 Fuel consumption rate: Measuring and analyzing fuel usage during turbine operation.
- 4 Steam consumption rate: Calculating and interpreting steam consumption for performance assessment.

READ Books / Reading Materials

- 1 "Thermodynamics Laboratory Manual" by R.K. Rajput.
- 2 "Steam Power Plant and Heat Transfer Lab Manual" by Dr. R.P. Sharma.
- 3 "Engineering Thermodynamics Laboratory Manual" by Y. A. Çengel.
- 4 "Mechanical Engineering Laboratory Manual for Thermodynamics and Fluid Mechanics" by U.S. Ingle and S.D. Kale.
- 5 "Thermodynamics Experiments for Engineering Students" by I.H. Bell and M.J. Moldover.
- 6 "Thermal and Fluid Engineering Laboratory Manual" by H. D. Baehr and S. Kabelac.

HUM-163 (000003-18/U) · CREDITS: 3

3.10 FEHME QURAN I (LEC)

Course Syllabus & Outline

INFO Course Description

This course is designed to develop students' foundational ability to understand the Holy Quran through basic Quranic Arabic vocabulary, phrases, sentence patterns, and selected verses. Based on the structured approach of Muallim ul Quran, the course gradually introduces Quranic words, nouns, gender, plurals, demonstrative nouns, prepositions, particles, adjective and possessive compounds, pronouns, nominal sentences, negative and emphatic expressions, and introductory verbal sentences. Students will practice writing meanings of Quranic words, translating short Quranic phrases and sentences, and recognizing repeated linguistic patterns used in the Quran.

CLO-1 Basic Quranic Vocabulary & Grammar

CLO-1	PLOs	ECs	Wks	CL	SDGs
Understand basic Quranic vocabulary, nouns, gender forms, plurals, demonstrative nouns, and frequently occurring particles used in simple Quranic expressions.	PL01 PL06 PL011	EC1 EC10 EC13	WK1 WK3 WK5	C2 C3	SDG 4 SDG 16

- 1 Quranic words and basic meanings: proper nouns, common nouns, masculine and feminine forms.
- 2 Singular, dual, and plural concepts with selected Quranic examples.
- 3 Demonstrative nouns: this/that for masculine and feminine forms.
- 4 Frequently occurring particles and connectors, and common Quranic expressions.

CLO-2 Particles & Sentence Structures

CLO-2	PLOs	ECs	Wks	CL	SDGs
Apply knowledge of Quranic particles, prepositions, negation, emphasis, and nominal sentence structures to translate short Quranic phrases and sentences.	PL01 PL06 PL08	EC1 EC3 EC10	WK1 WK3 WK5	C3 C4	SDG 4 SDG 16

- 1 Emphatic particles and their use in nominal Quranic sentences.
- 2 Prepositions and their meanings with Quranic phrases.

- 3 Negative and exceptive particles and related sentence patterns.

- 4 Nominal, emphatic, negative, interrogative, and oath-based sentence styles in short Quranic examples.

CLO-3 Compounds & Pronouns

CLO-3	PLOs	ECs	WKs	CL	SDGs
Analyze Quranic compounds, possessive constructions, pronouns, and plural patterns in selected Quranic sentences and verses.	PL01 PL06 PL07	EC2 EC6 EC9	WK3 WK5 WK8	C4 C5	SDG 4 SDG 10 SDG 16

- 1 Quranic adjective compounds with selected phrases.
- 2 Quranic possessive construction in phrases and verses.
- 3 Personal pronouns: possessive and attached forms.
- 4 Pronouns with prepositions and plural constructions in selected Quranic sentences and verses.

CLO-4 Interpretation & Verbal Structures

CLO-4	PLOs	ECs	WKs	CL	SDGs
Interpret selected Quranic sentences and verses by recognizing common linguistic styles, sentence patterns, idioms, and introductory verbal structures.	PL06 PL07 PL011	EC5 EC10 EC13	WK5 WK7 WK8	C4 C5 C6	SDG 4 SDG 16 SDG 17

- 1 Revision and translation practice of Quranic sentences.
- 2 Common Quranic styles and related idioms expressions.
- 3 Introduction to verbal sentences and present tense forms.
- 4 Translation of selected Quranic verses using vocabulary, particles, compounds, pronouns, and basic verb forms.

READ Books / Reading Materials

- 1** Muallim ul Quran, Volumes 1-3. Muallim-ul-Quran Foundation / official course material.
- 2** The Holy Quran: Arabic text with word-by-word translation and selected authentic explanations, teacher-recommended edition.
- 3** Abdul Aziz Abdul Raheem. Learn to Recite and Understand the Quran: The Easy Way. Understand Al-Quran Academy.
- 4** Arabic101. How to Understand 85% of the Quran. Arabic101 digital course book/e-book.
- 5** Alan Jones. Arabic Through the Qur'an. Islamic Texts Society.
- 6** Abu Ammaar Yasir Qadhi. An Introduction to the Sciences of the Qur'aan. Al-Hidaayah Publishing.
- 7** Muhammad Abdul Haleem. Understanding the Qur'an: Themes and Style. I.B. Tauris.

HUM-163 (000003-18/U) · CREDITS: 2

3.11 MUSLIM HERITAGE (LEC)

Course Syllabus & Outline

INFO Course Description

This course explores the rich intellectual, scientific, and cultural contributions of Muslim scholars throughout history, particularly during the Islamic Golden Age. It highlights key advancements in fields such as mathematics, medicine, astronomy, and philosophy, and examines their lasting influence on modern civilization. Students will also reflect on the values of inquiry, ethics, and innovation in Islamic thought and their relevance to contemporary global challenges.

CLO-1 Contributions in the Islamic Golden Age

CLO-1	PLOs	ECs	Wks	CL	SDGs
Describe the key contributions of Muslim scholars in science, technology, medicine, mathematics, and philosophy during the Islamic Golden Age.	PL01	EC1	WK1 WK7	C1 C2	SDG 4 SDG 11

- 1 The Rise of Islamic Civilization and the House of Wisdom (Bayt al-Hikma).
- 2 Contributions in Mathematics: Al-Khwarizmi and the Birth of Algebra.
- 3 Advances in Medicine: Ibn Sina (Avicenna) and Al-Zahrawi's Legacy.
- 4 Scientific Discoveries in Optics, Astronomy, and Chemistry.

CLO-2 Influence on Modern Science and Culture

CLO-2	PLOs	ECs	Wks	CL	SDGs
Analyze the influence of Muslim heritage on the development of modern scientific and cultural advancements.	PL01 PL07	EC1 EC6	WK7 WK8	C4	SDG 4 SDG 10

- 1 Transmission of Muslim Knowledge to Europe via Spain and Sicily.
- 2 Influence of Islamic Architecture and Art on European Renaissance.
- 3 Arabic as the Scientific Language of the Medieval World.
- 4 Comparative Study of Muslim Scientific Methods and Modern Practices.

CLO-3 Values of Inquiry and Ethics

CLO-3	PLOs	ECs	Wks	CL	SDGs
Examine the values of inquiry, innovation, and ethics in Islamic civilization and their relevance to contemporary challenges.	PLO8 PLO9	EC8 EC10	WK7 WK8	C3 C5	SDG 4 SDG 16

- 1 The Islamic Ethos of Knowledge: "Iqra" and Its Implications.
- 2 Role of Scholars (Ulama) in Promoting Ethical Scientific Inquiry.
- 3 Environmental Ethics and Sustainability in Islamic Teachings.
- 4 Relevance of Muslim Ethical Traditions in Today's Science and Technology.

CLO-4 Preservation and Dissemination

CLO-4	PLOs	ECs	Wks	CL	SDGs
Demonstrate an appreciation for the preservation and dissemination of Muslim scholarly heritage through written, oral, or digital presentations.	PLO10 PLO11	EC10 EC11	WK8	C3	SDG 4 SDG 17

- 1 Preserving Islamic Manuscripts and Libraries: Global Efforts.
- 2 Digitization of Islamic Knowledge: Case Studies and Platforms.
- 3 Preparing Student Presentations/Reports on Selected Muslim Figures.
- 4 Final Presentations & Reflection on Legacy and Global Relevance.

READ Books / Reading Materials

- 1 Lost Islamic History: Reclaiming Muslim Civilisation from the Past by Firas Alkhatteeb (Updated Edition, 2024).
- 2 Islamesque: The Forgotten Craftsmen Who Built Europe's Medieval Monuments by Diana Darke (2025).
- 3 Muslim Heritage and the Twenty-First Century by Muhammad Ahsan (2023).
- 4 Islam: A New History From Muhammad to the Present by John Tolan (Expected 2025).

UNDERGRADUATE PROGRAM

4th Semester

Course Syllabi & Outlines

SEM 4 Fourth Semester

- | | |
|---|--|
| 4.1 COMPLEX VARIABLES & TRANSFORMS (LEC) | 4.2 MECHANICS OF MATERIALS-II (LEC) |
| 4.3 MECHANICS OF MATERIALS-II (LAB) | 4.4 FLUID MECHANICS-II (LEC) |
| 4.5 FLUID MECHANICS (LAB) | 4.6 MACHINE DESIGN -I (LEC) |
| 4.7 APPLIED AI & MACHINE LEARNING (LEC) | 4.8 APPLIED AI & MACHINE LEARNING (LAB) |
| 4.9 EXPOSITORY WRITING (LEC) | 4.10 FEHME QURAN II (LEC) |

HUM-163 (000003-18/U) · CREDITS: 2+0

4.1 COMPLEX VARIABLES & TRANSFORMS (LEC)

Course Syllabus & Outline

INFO Course Description

Complex Variables & Transforms covers the fundamentals of complex numbers and functions, with applications in engineering. The course explores complex differentiation and integration, including the Cauchy-Riemann equations and Cauchy's integral theorems. Students will delve into power series, conformal mappings, and residue theory, as well as Laplace transformations and their applications. Special functions and Fourier transforms are examined in depth, alongside Z-transforms and their use in solving difference equations.

CLO-1 Complex Numbers and Functions

CLO-1	PLOs	ECs	Wks	CL	SDGs
Explain foundational concepts and functions related to complex numbers and complex-valued functions.	PL01 PL02	EC1 EC2	WK1 WK3	C2 C3	SDG 4

- 1 Review of complex numbers and basic complex-valued functions.
- 2 Elementary functions: exponential, logarithmic, trigonometric, and hyperbolic functions and their inverses.
- 3 Limits and continuity of complex-valued functions.
- 4 Applications of complex numbers and functions in engineering.

CLO-2 Complex Differentiation and Integration

CLO-2	PLOs	ECs	Wks	CL	SDGs
Apply complex differentiation and integration techniques to solve engineering-related problems.	PL02 PL04	EC3 EC5	WK3 WK5	C3 C4	SDG 4

- 1 Derivatives of complex-valued functions, differentiability, and analyticity.
- 2 Cauchy-Riemann equations and harmonic functions.
- 3 Complex integrals, Cauchy-Goursat Theorem, and independence of path.
- 4 Cauchy's Integral Formulas, their consequences, and applications in engineering.

CLO-3 Power Series and Residue Theory

CLO-3	PLOs	ECs	Wks	CL	SDGs
Use power series expansion techniques and residue theory to analyze complex functions.	PL01 PL04	EC1 EC3	WK1 WK4	C3 C4	SDG 4

- 1 Taylor Series, Laurent Series, and the concept of singularities.
- 2 Zeros and poles in complex functions.
- 3 Residue integration method and residue theorem.
- 4 Applications of conformal mapping in engineering contexts.

CLO-4 Transformations in Engineering

CLO-4	PLOs	ECs	Wks	CL	SDGs
Utilize Laplace transformations, Fourier transformations, and Z-transformations for engineering applications.	PL01 PL03	EC2 EC5	WK1 WK4 WK6	C3 C5	SDG 4

- 1 Properties and applications of Laplace transformations: scaling, shifting, and convolution theorem.
- 2 Special functions (Gamma, Beta, and Error functions) and Fourier transformations.
- 3 Fourier Series: sine and cosine series and Fourier transform applications.
- 4 Z-Transformation: properties, inverse Z-transform, convolution theorem, and solution of difference equations.

READ Books / Reading Materials

- 1 Erwin Kreyszig, Advanced Engineering Mathematics, Latest Edition.
- 2 Churchill, Complex Variables and Applications, Latest Edition.
- 3 R. J. Beerends, Fourier and Laplace Transform, Cambridge University Press, Latest Edition.
- 4 Jeffry A., Advanced Engineering Mathematics, Elsevier, Latest Edition.

MECH- 243 (667678-1/U) · CREDITS: 2

4.2 MECHANICS OF MATERIALS-II (LEC)

Course Syllabus & Outline

INFO Course Description

This course continues the development of elastic solid mechanics. Areas covered are shear stresses in bending, stress transformation and principal stresses, deflection of statically determinate beams and an introduction to the analysis of statically indeterminate beams, elastic buckling of columns. Engineering design concepts are integrated throughout the course.

CLO-1 Statically Indeterminate Structures

CLO-1	POs	ECs	Wks	CL	SDGs
Analyze statically indeterminate beams and complex stress-strain relationships in materials.	PO1 PO2	EC1 EC3	WK1 WK4	C4	SDG 9

- 1 Thin and thick curved bars.
- 2 Thin-walled pressure vessels.
- 3 Stress transformation equations.
- 4 Principal planes & principal stresses.

CLO-2 Stress Transformation & Mohr's Circle

CLO-2	POs	ECs	Wks	CL	SDGs
Apply stress transformation techniques and evaluate principal planes and stresses using Mohr's Circle.	PO2 PO4	EC3 EC5	WK2 WK5	C4	SDG 4

- 1 Analysis of stresses and strains.
- 2 Mohr's Circle for stresses and strains.
- 3 Principal strains.
- 4 Theories of failure.

CLO-3 Theories of Failure & Fracture Mechanics

CLO-3	POs	ECs	Wks	CL	SDGs
Assess material behavior under stress using theories of failure and introduce principles of fracture mechanics.	PO2 PO4	EC3 EC5	WK4 WK7	C5	SDG 9

- 1 Stresses and strains in columns.
- 2 Thin-walled pressure vessels (cylindrical and spherical).
- 3 Thick cylinders and compound cylinders.
- 4 Introduction to fracture mechanics.

CLO-4 Advanced Pressure Vessels Mechanics

CLO-4	PLOs	ECs	Wks	CL	SDGs
Investigate advanced pressure vessel mechanics, including thin and thick-walled designs and compound cylinders.	PLO2 PLO3	EC1 EC3	WK4 WK7	C5	SDG 9

- 1 Principal of Virtual Work.
- 2 Theories of failure.
- 3 Stress analysis in statically indeterminate beams.
- 4 Applications in fracture mechanics.

READ Books / Reading Materials

- 1 Beer, F. P., & Johnston, R., Mechanics of Materials, McGraw-Hill.
- 2 Gere, J. M., Mechanics of Materials, 6th Edition.
- 3 Hibbeler, R. C., Mechanics of Materials, 8th Edition.
- 4 Rajput, R. K., Strength of Materials.
- 5 Nag, D., & Chanda, A., Mechanics of Materials.
- 6 Benham, P. P., & Crawford, R. J., Mechanics of Engineering Materials, Longman.

MECH- 262 (666648-1/U) · CREDITS: 1

4.3 MECHANICS OF MATERIALS-II (LAB)

Course Syllabus & Outline

INFO Course Description

This lab is designed to equip students with practical skills in material testing and mechanical property evaluation. Through hands-on experiments, students will measure properties such as tensile and compressive strength, hardness, elasticity, and rigidity across various materials. They will verify theoretical principles, including Hook's Law, Euler's theory of column buckling, and creep behavior under sustained loads. Additionally, students will learn to determine hardness using different scales and techniques.

CLO-1 Tensile and Compression Testing

CLO-1	PLOs	ECs	Wks	CL	SDGs
Evaluate Material Properties through Tensile and Compression Testing.	PL01 PL03	EC1 EC4	WK1 WK2	C3 C4	SDG 4 SDG 9

- 1 Tensile testing of metallic material.
- 2 Tensile testing of flat plate specimen.
- 3 Tensile testing of deformed bar.
- 4 Compression test of concrete.

CLO-2 Elastic and Rigidity Moduli

CLO-2	PLOs	ECs	Wks	CL	SDGs
Analyze and Determine Elastic and Rigidity Moduli in Beam Testing.	PL02 PL04	EC3 EC5	WK3 WK4	C4 C5	SDG 4 SDG 9

- 1 To verify the modulus of elasticity using 3-point bend test.
- 2 To verify the modulus of rigidity using 3-point bend test.
- 3 To determine the modulus of elasticity of circular beam.
- 4 To observe the action of shear force and bending moment at a cut section of a beam.

CLO-3 Variable Load Conditions

CLO-3	PLOs	ECs	Wks	CL	SDGs
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Examine Mechanical Behavior of Materials Under Variable Load Conditions.	PL01 PL05	EC4 EC6	WK5 WK6	C4 C5	SDG 4 SDG 12
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- 1 To determine the rpm at different loads for fatigue testing of a specimen using rotating fatigue testing machine.
- 2 To investigate creep behavior using Creep Test Setup.
- 3 To verify Euler's theory using critical loads for column buckling.
- 4 To determine Spring Constant (K) and verify Hook's Law.

CLO-4 Hardness Testing Techniques

CLO-4	PLOs	ECs	Wks	CL	SDGs
Determine Hardness of Materials Using Various Testing Techniques.	PL03 PL06	EC3 EC9	WK7 WK8	C3 C5	SDG 4

- 1 Scratch Hardness testing (MOH scale).
- 2 Vickers Hardness testing of steel.
- 3 Vickers Hardness testing of aluminum.
- 4 Compression test of concrete.

READ Books / Reading Materials

- 1 "Materials Science and Engineering Lab Manual" by William D. Callister.
- 2 "Mechanical Testing of Materials" by Adrian P. Mouritz.
- 3 "Engineering Materials Lab Manual" by T.A. Fowler.
- 4 "Experimental Methods for Engineers" by Jack P. Holman.
- 5 "Strength of Materials Laboratory Manual" by R.K. Rajput.

MECH- 223 (667680-1/U) · CREDITS: 3

4.4 FLUID MECHANICS-II (LEC)

Course Syllabus & Outline

INFO Course Description

This course teaches two- and three-dimensional ideal fluid flow Potential flow, circulation, stream function and velocity potential, uniform flow, two-dimensional source and sink, vortex, the doublet, lift and drag forces. Two- and three- dimensional viscous fluid flow Navier stokes equations of motion, two-dimensional flow between parallel plates, flow in a circular pipe, creep flow, Reynold's equation, and hydrodynamic lubrication in journal bearing. Boundary layer theory, boundary layer control, airfoil cascades. Fluid machinery Similarity relations for turbo machines, specific speed, impulse turbines, reaction turbines, hydraulic jacks, pumps and their performance curves.

CLO-1 Viscous Flow Analysis

CLO-1	PLOs	ECs	WKs	CL	SDGs
Analyze viscous flow in pipes and apply principles to evaluate flow rate, pressure losses, and fluid behavior under laminar and turbulent conditions.	PL01 PL02 PL03	EC1 EC3	WK1 WK2	C4	SDG 9

- 1 Characteristics of flow in pipes.
- 2 Laminar and turbulent pipe flow.
- 3 Losses in straight pipe sections and components.
- 4 Flow rate measurement using flowmeters.

CLO-2 Immersed Bodies & Boundary Layers

CLO-2	PLOs	ECs	WKs	CL	SDGs
Evaluate flow over immersed bodies and boundary layer characteristics to determine forces like lift and drag for various objects.	PL01 PL02 PL04	EC1 EC3	WK1 WK4	C5	SDG 9 SDG 13

- 1 External flow features.
- 2 Boundary layer characteristics (laminar, transitional, turbulent).
- 3 Boundary layer separation.
- 4 Lift and drag forces on objects.

CLO-3 Compressible Flow Principles

CLO-3	PLOs	ECs	WKs	CL	SDGs
Apply principles of compressible flow, analyze Mach number, and solve flow problems across shock waves.	PL01 PL02 PL03	EC1 EC3	WK1 WK3	C5	SDG 9 SDG 11

- 1 Compressible vs. incompressible flows.
- 2 Categories of compressible flows.
- 3 Speed of sound and Mach number.
- 4 Isentropic and non-isentropic flow across shock waves.

CLO-4 Turbomachinery & CFD

CLO-4	PLOs	ECs	WKs	CL	SDGs
Assess turbomachinery function, efficiency, and scaling through fluid mechanics principles, including introductory CFD techniques.	PL01 PL02 PL04	EC1 EC4	WK1 WK6	C5	SDG 9

- 1 Turbomachine function and loss minimization.
- 2 Turbine vs. pump characteristics.
- 3 Turbomachine scaling.
- 4 Introduction to CFD and Finite Volume Method.

READ Books / Reading Materials

- 1 Fluid Mechanics by Munson, 7th Edition, John Wiley & Sons.
- 2 Fluid Mechanics: Fundamentals and Applications by Yunus A. Çengel, 3rd Edition, McGraw-Hill Education.

MECH- 262 (666648-1/U) · CREDITS: 1

4.5 FLUID MECHANICS (LAB)

Course Syllabus & Outline

INFO Course Description

This course enables students to apply fluid mechanics principles through hands-on experiments that involve measuring discharge coefficients of devices such as orifice meters, notches, and Venturi meters. They will analyze fluid flow behavior in pipe systems, calculating factors like friction and minor losses while exploring the effects of flow dynamics, such as Reynolds number and vane impact. Additionally, students will verify fundamental theorems, such as Bernoulli's Theorem, and study devices for measuring velocity, viscosity, and pressure. By evaluating flow characteristics and using experimental methods, students gain a comprehensive understanding of fluid behavior in engineering contexts, essential for advancing their analytical and practical skills in fluid mechanics.

CLO-1 Discharge Coefficients

CLO-1	POs	ECs	Wks	CL	SDGs
Apply Principles of Fluid Mechanics to Determine Discharge Coefficients.	PO1 PO3	EC1 EC3	WK1 WK2	C3 C4	SDG 4 SDG 9

- 1 To determine the coefficient of discharge of an Orifice Meter.
- 2 To determine the coefficient of discharge of Notch (V, Rectangular & Trapezoidal types).
- 3 To determine the coefficient of discharge of a Venturi meter.
- 4 To determine the coefficient of discharge, contraction & velocity of an orifice.

CLO-2 Pipe Systems and Flow Dynamics

CLO-2	POs	ECs	Wks	CL	SDGs
Analyze Fluid Flow Characteristics and Effects in Pipe Systems.	PO2 PO5	EC4 EC9	WK3 WK4	C4 C5	SDG 4 SDG 11

- 1 To determine the friction factor for pipes.
- 2 To find critical Reynolds number for pipe flow.
- 3 To determine the minor losses due to sudden enlargement, sudden contraction, and bends.
- 4 To determine the coefficient impact of vanes.

CLO-3 Fundamental Fluid Mechanics Theorems

CLO-3	PLOs	ECs	WKs	CL	SDGs
Verify and Apply Fundamental Fluid Mechanics Theorems.	PL01 PL04	EC1 EC5	WK5 WK6	C3 C4	SDG 4

- 1 To verify Bernoulli's Theorem.
- 2 To verify Bernoulli's Equation experimentally and calculate the total energy at different points.
- 3 To study Velocity, Viscosity & Pressure Measuring devices.
- 4 To determine the Metacentric height of a floating body.

CLO-4 Experimental Methods in Fluid Flow

CLO-4	PLOs	ECs	WKs	CL	SDGs
Evaluate Fluid Flow Behavior Using Experimental Methods.	PL03 PL06	EC3 EC12	WK7 WK8	C5 C6	SDG 4 SDG 6

- 1 To determine the coefficient of discharge of an Orifice Meter.
- 2 To determine the coefficient of discharge of Venturi meter.
- 3 To determine the friction factor for the pipes.
- 4 To study Velocity, Viscosity & Pressure Measuring devices.

READ Books / Reading Materials

- 1 Fluid Mechanics Laboratory Manual by K. Subramanya.
- 2 Fluid Mechanics Lab Manual by S. K. Som and Gautam Biswas.
- 3 Fluid Mechanics and Hydraulic Machines Lab Manual by Dr. R.K. Bansal.
- 4 Fluid Mechanics: Fundamentals and Applications Laboratory Manual by Yunus A. Çengel and John M. Cimbala.

MECH- 262 (666648-1/U) · CREDITS: 3

4.6 MACHINE DESIGN -I (LEC)

Course Syllabus & Outline

INFO Course Description

Machine Design and CAD-I is the first course offered to ME students that introduces them with the design standards and designs of basic machine components. The course first introduces the philosophy of design procedure and design standards and then gradually covers the design of common machine elements. The students are expected to prepare professional quality solutions and communicate the results of analysis and design, effectively.

CLO-1 Stress and Strain in Machine Elements

CLO-1	PLOs	ECs	Wks	CL	SDGs
Analyze different types of stress and strain in machine elements.	PL01 PL02 PL03	EC1 EC3 EC5	WK1 WK2 WK4	C3	SDG 9

- 1 Design philosophy and types of design.
- 2 Concepts of stress and strain.
- 3 Different types of stress and strain in machine elements.
- 4 Stress-strain diagram and its significance.

CLO-2 Design of Mechanical Joints

CLO-2	PLOs	ECs	Wks	CL	SDGs
Design mechanical joints considering functional requirements.	PL02 PL03 PL04	EC3 EC4 EC5	WK4 WK5 WK6	C5	SDG 9 SDG 12

- 1 Basic concepts and methodology of joint design.
- 2 Design of riveted joints.
- 3 Design of welded joints.
- 4 Design of bolted joints in mechanical systems.

CLO-3 Tolerances and Fit Standards

CLO-3	PLOs	ECs	WKs	CL	SDGs
Develop understanding of metal fits, tolerances, and standards.	PL02 PL03	EC1 EC2 EC4	WK5 WK6	C3	SDG 12

- 1 Basic concepts of tolerance in machine design.
- 2 Types of fits in engineering design.
- 3 ISO standard fits charts.
- 4 Applications of tolerance and fit standards in mechanical design.

CLO-4 Factor of Safety and Design Limits

CLO-4	PLOs	ECs	WKs	CL	SDGs
Evaluate factor of safety in mechanical design to ensure durability.	PL02 PL03 PL05	EC3 EC4 EC5	WK2 WK4 WK5	C5	SDG 9 SDG 12

- 1 Actual and permissible stresses.
- 2 Factor of safety in design.
- 3 Stress analysis of various machine elements.
- 4 Determining design safety limits and application in engineering design.

READ Books / Reading Materials

- 1 Robert L. Mott, Machine Elements in Mechanical Design.
- 2 Robert L. Norton, Design of Machinery.
- 3 R. S. Khurmi, J. K. Gupta, A Textbook of Machine Design.
- 4 Joseph E. Shigley, Theory of Machines & Mechanisms.

MECH- 321 (668022-1/U) · CREDITS: 3

4.7 APPLIED ARTIFICIAL INTELLIGENCE & MACHINE LEARNING (LEC)**Course Syllabus & Outline****INFO Course Description**

Applied AI & Machine Learning course aims to equip the students' exposure to emerging trends in the field of AI and machine learning.

CLO-1 Foundations of AI and Agents

CLO-1	POs	ECs	Wks	CL	SDGs
Explain fundamental AI concepts, including AI foundations, agents, and environments.	PO1 PO2	EC1 EC3	WK1 WK2	C2	SDG 4

- 1 Foundations of AI (Logic, Computation, Probability).
- 2 Different types of agents: Simple reflex, Model-based, Goal-based, Utility-based.
- 3 Properties and types of environments.
- 4 Agent structure: Architecture, Sensors, Actuators, and Agent Functions.

CLO-2 Logical Models and Reasoning

CLO-2	POs	ECs	Wks	CL	SDGs
Develop mathematical and logical models for reasoning and knowledge representation, including propositional and first-order logic.	PO1 PO2 PO4	EC2 EC3 EC4	WK3 WK4	C3	SDG 9

- 1 Types of knowledge: Declarative, Procedural, Meta, Heuristic, and Structural.
- 2 Syntax and semantics of propositional logic with truth tables and logical connectives.
- 3 Basics of first-order logic with atomic sentences and quantifiers.
- 4 Non-monotonic reasoning and its applications in knowledge representation.

CLO-3 Probabilistic Reasoning and Filters

CLO-3	POs	ECs	Wks	CL	SDGs
Analyze uncertain states and apply probabilistic reasoning to solve AI-based problems using Bayes, Gaussian, and Particle Filters.	PO2 PO3 PO5	EC3 EC5 EC6	WK3 WK5	C4	SDG 4 SDG 9

- 1 Basics of probability: Conditional probability and Bayes theorem.
- 2 Applications of Bayes filters in uncertain state estimation.
- 3 Implementation and mathematical modeling of Gaussian filters.
- 4 Application and limitations of Particle filters in real-world AI systems.

CLO-4 Machine Learning Algorithms

CLO-4	PLOs	ECs	Wks	CL	SDGs
Apply machine learning principles and algorithms, including supervised, unsupervised, and reinforcement learning, to real-world problems.	PLO3 PLO4 PLO7	EC4 EC5 EC12	WK3 WK6	C5	SDG 9 SDG 11

- 1 Introduction to linear and logistic regression with gradient descent.
- 2 Clustering techniques in unsupervised learning, including K-means and hierarchical clustering.
- 3 Basics of neural networks: Learning process and types.
- 4 Q-learning and its applications in reinforcement learning for dynamic system.

READ Books / Reading Materials

- 1 Russell S., Norvig P., Artificial Intelligence – A Modern Approach, Latest Edition, Prentice Hall.
- 2 Luger G.F., Artificial Intelligence – Structures and Strategies for Complex Problem Solving, Latest Edition, Pearson.
- 3 Hal Daume III, A Course in Machine Learning.
- 4 Tom M. Mitchell, Machine Learning.
- 5 Aurelien Geron, Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems.

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4.8 APPLIED ARTIFICIAL INTELLIGENCE & MACHINE LEARNING (LAB)**Course Syllabus & Outline****INFO Course Description**

This lab course focuses on the practical implementation of AI and ML algorithms using popular tools and libraries such as Python, TensorFlow, and scikit-learn. Through hands-on projects, students will gain experience in data preprocessing, model training, evaluation, and deployment. Emphasis is placed on real-world applications across different domains.

CLO-1 Data Preprocessing & EDA

CLO-1	PLOs	ECs	Wks	CL	SDGs
Demonstrate foundational proficiency in Python and MATLAB tools for AI and ML, including data preprocessing and exploratory data analysis to extract and visualize insights.	PLO-01	EC1	WK1 WK3	C2	SDG 4

- 1 Week 1:** Introduction to the Lab Environment and Tools (Python, Jupyter, Colab, NumPy, Pandas).
- 2 Week 2:** Data Preprocessing and Exploratory Data Analysis (EDA) including cleaning, scaling, and visualization.
- 3 Week 3:** Supervised Learning - Regression (Linear, Polynomial, and performance evaluation).
- 4 Week 4:** Supervised Learning - Classification (Logistic Regression, kNN, Decision Trees, ROC-AUC).

CLO-2 Supervised Learning Models

CLO-2	PLOs	ECs	Wks	CL	SDGs
Apply supervised learning techniques to classify, predict, and interpret results across various regression and classification models using machine learning libraries.	PLO-02	EC3	WK4 WK8	C3	SDG 9

- 1 Week 5:** Ensemble Learning Techniques (Random Forest, Gradient Boosting, hyperparameter tuning).
- 2 Week 6:** Unsupervised Learning - Clustering (K-Means, hierarchical clustering, DBSCAN, silhouette score).
- 3 Week 7:** Dimensionality Reduction Techniques (PCA, t-SNE, and feature reduction).
- 4 Week 8:** Neural Networks with Keras and TensorFlow (Architecture basics, simple networks).

CLO-3 Unsupervised Learning and Dimensionality Reduction

CLO-3	PLOs	ECs	Wks	CL	SDGs
Analyze and implement unsupervised learning algorithms to identify patterns and reduce data complexity using clustering and dimensionality reduction methods.	PLO-03	EC4	WK6 WK7	C4	SDG 9 SDG 11

- 1 Week 9:** Deep Learning - Convolutional Neural Networks (CNNs) for image recognition.
- 2 Week 10:** Natural Language Processing (NLP) Basics (Tokenization, stemming, TF-IDF).
- 3 Week 11:** Sequence Models and Recurrent Neural Networks (RNNs) including LSTM and text generation.
- 4 Week 12:** Transfer Learning and Pretrained Models (VGG16, ResNet, BERT).

CLO-4 Deep Learning Deployment

CLO-4	PLOs	ECs	Wks	CL	SDGs
Develop and deploy deep learning models for complex tasks, utilizing neural networks, CNNs for image classification, and sequence models for text and time series data.	PLO-05	EC10	WK5 WK9	C5	SDG 4 SDG 9

- 1 Week 13:** Model Optimization and Hyperparameter Tuning (Grid Search, Random Search).
- 2 Week 14:** Model Deployment and Serving (Flask, FastAPI, TensorFlow Serving).
- 3 Week 15:** Final Project Preparation and Consultation (Defining objectives, proposals).
- 4 Week 16:** Final Project Presentation and Evaluation.

READ Books / Reading Materials

- 1** "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron.
- 2** "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville.
- 3** "Python Machine Learning" by Sebastian Raschka and Vahid Mirjalili.
- 4** "Introduction to Machine Learning with Python: A Guide for Data Scientists" by Andreas C. Müller.
- 5** "Pattern Recognition and Machine Learning" by Christopher Bishop.
- 6** "Artificial Intelligence: A Modern Approach" by Stuart Russell and Peter Norvig.

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4.9 EXPOSITORY WRITING (LEC)

Course Syllabus & Outline

INFO Course Description

Expository Writing is a sequential undergraduate course aimed at refining writing skills in various contexts. Building upon the foundation of the pre-requisite course, Functional English, this course will enhance students' abilities of producing clear, concise and coherent written texts in English. The course will also enable students to dissect intricate ideas, to amalgamate information and to express their views and opinions through well-organized essays. The students will further be able to refine their analytical skills to substantiate their viewpoints using credible sources while adhering to established ethical writing norms.

CLO-1 Basics of Expository Writing

CLO-1	PLOs	ECs	Wks	CL	SDGs
Understand and Apply the Basics of Expository Writing.	PL01 PL05	EC1 EC10	Wk1 Wk2	C2 C3	SDG 4

- 1 Definition, types, purpose, and applications of expository writing.
- 2 Characteristics of effective expository writing (clarity, coherence, and organization).
- 3 Introduction to paragraph writing.
- 4 Crafting an engaging introduction and hook.

CLO-2 Effective Drafting and Editing

CLO-2	PLOs	ECs	Wks	CL	SDGs
Implement the Writing Process for Effective Drafting and Editing.	PL02 PL05	EC3 EC9	Wk3 Wk4	C3 C4	SDG 4

- 1 Pre-writing techniques (brainstorming, free-writing, mind-mapping, listing, questioning, and outlining).
- 2 Three-stage process of drafting techniques.
- 3 Revising and editing for correct grammar, clarity, coherence, and conciseness.
- 4 Peer review, feedback, and fine-tuning through proofreading.

CLO-3 Organize and Structure Essays

CLO-3	PLOs	ECs	Wks	CL	SDGs
Organize and Structure Essays for Cohesion and Coherence.	PL01 PL03	EC4 EC12	Wk5 Wk6	C4 C5	SDG 4

- 1 Thesis statement (crafting a clear and focused central idea).
- 2 Body paragraphs (topic sentences, supporting evidence, and transitional devices).
- 3 Types of concluding paragraphs and leaving an impact.
- 4 Ensuring cohesion and coherence through effective transitions.

CLO-4 Adaptation and Ethical Considerations

CLO-4	PLOs	ECs	Wks	CL	SDGs
Adapt Expository Writing to Different Types and Audiences with Ethical Considerations.	PL04 PL06	EC8 EC11	Wk7 Wk8	C5 C6	SDG 4

- 1 Description, illustration, classification, and cause-and-effect writing techniques.
- 2 Writing for specific purposes and audiences (to inform, analyze, persuade, entertain, etc.).
- 3 Proper citation and referencing using APA, MLA, or other citation styles.
- 4 Avoiding plagiarism through original writing and integrating quotes and evidence ethically.

READ Books / Reading Materials

- 1 "The St. Martin's Guide to Writing" by Rise B. Axelrod and Charles R. Cooper.
- 2 "They Say / I Say: The Moves That Matter in Academic Writing" by Gerald Graff and Cathy Birkenstein.
- 3 "Writing Analytically" by David Rosenwasser and Jill Stephen.
- 4 "Style: Lessons in Clarity and Grace" by Joseph M. Williams and Joseph Bizup.
- 5 "The Elements of Style" by William Strunk Jr. and E.B. White.
- 6 "Good Reasons with Contemporary Arguments" by Lester Faigley and Jack Selzer.
- 7 "Writing to Learn: How to Write - and Think - Clearly About Any Subject at All" by William Zinsser.
- 8 "The Norton Field Guide to Writing" by Richard Bullock, Maureen Daly Goggin, and Francine Weinberg.

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4.10 FEHME QURAN II (LEC)

Course Syllabus & Outline

INFO Course Description

This course is designed to strengthen students' direct understanding of the Holy Quran through an applied study of Quranic Arabic based on Muallim ul Quran (Volumes 3-5). It builds upon Fehme Quran I by focusing on advanced sentence patterns, present, past and imperative verb forms, object pronouns, negation, conditional structures, passive voice, and selected linguistic expressions frequently used in Quranic verses. Through guided translation, vocabulary practice, grammar recognition, and reflection on meanings, students will develop the ability to comprehend hundreds of Quranic sentences and longer verses independently. The course aims to enable students to understand a major portion of each page of the Holy Quran with clarity, accuracy, respect, and meaningful connection with Quranic guidance.

CLO-1 Present-Tense Verbs and Pronouns

CLO-1	PLOs	ECs	Wks	CL	SDGs
Understand and translate Quranic verses containing advanced present-tense verb forms, object pronouns, and related sentence structures.	PL01	EC1	WK1	C2	SDG4
	PL06	EC10	WK3	C3	SDG10
	PL011	EC13	WK5		SDG16

- 1 Present-tense forms for third-person plural, second-person singular/plural, and first-person usage in Quranic verses.
- 2 Recognition and translation of present-tense verbs with object pronouns.
- 3 Use of present-tense forms in longer Quranic sentences and selected verses.
- 4 Guided vocabulary practice for direct comprehension and translation of Quranic meanings.

CLO-2 Past-Tense Forms and Passive Voice

CLO-2	PLOs	ECs	Wks	CL	SDGs
Analyze Quranic past-tense forms and apply them in the understanding and translation of selected Quranic verses.	PL01	EC1	WK3	C3	SDG4
	PL06	EC3	WK5	C4	SDG10
	PL08	EC10	WK8		SDG16

- 1 Past-tense singular forms for third person and their use in Quranic expression.
- 2 Past-tense plural forms for third person and first person in Quranic verses.
- 3 Past-tense second-person and feminine forms with translation practice.
- 4 Passive voice in past tense and its role in understanding Quranic meaning.

CLO-3 Advanced Grammatical Patterns

CLO-3	PLOs	ECs	Wks	CL	SDGs
Apply important Quranic Arabic grammatical patterns, including negation, conditionals, purpose clauses, and imperative structures.	PLO1	EC2	WK1	C3	SDG4
	PLO7	EC9	WK4	C4	SDG10
	PLO11	EC13	WK7	C5	SDG16

- 1 Negative imperative forms for singular and plural expressions in Quranic sentences.
- 2 Conditional sentences and masdar muawwal (مصدر مؤول) in Quranic usage.
- 3 Laam al-Ta'leel (لام التعليل) and Laam al-Juhud (لام الجهد) in verse translation.
- 4 Imperative verbs for singular and plural forms and their contextual meanings.

CLO-4 Independent Comprehension and Reflection

CLO-4	PLOs	ECs	Wks	CL	SDGs
Demonstrate independent comprehension of longer Quranic verses by integrating vocabulary, grammar, translation, and reflective understanding.	PLO6	EC5	WK5	C4	SDG4
	PLO7	EC10	WK7	C5	SDG16
	PLO11	EC12	WK8	C6	SDG17

- 1 Direct comprehension of hundreds of Quranic sentences and frequently occurring Quranic expressions.
- 2 Translation of longer Quranic verses by combining vocabulary, particles, verbs, and sentence patterns.
- 3 Understanding common Quranic themes through selected verses and contextual discussion.
- 4 Independent practice, quizzes, revision activities, and interpretation-based reflection on Quranic guidance.

READ Books / Reading Materials

- 1** Higher Education Commission (HEC). Fehm-e-Quran / Understanding of Quran - II: Proposed Course Outline, Curriculum Division, Islamabad.
- 3** Muallim-ul-Quran Official Website: printed books, flipbooks, tutorial videos, confirmation videos, quizzes, question papers and teacher support material.
- 5** Dukes, Kais. The Quranic Arabic Corpus: Word-by-Word Grammar, Syntax and Morphology of the Holy Quran. University of Leeds / corpus.quran.com.
- 7** Abdul Karim Parekh. The Easy Dictionary of the Qur'an. Islamic Book Service / available editions.
- 9** Jones, Alan. Arabic Through the Qur'an. Islamic Texts Society.
- 11** Abu Ameenah Bilal Philips. Arabic Grammar Made Easy / Quranic Arabic learning resources. International Islamic Publishing editions.
- 2** Dr. Ubaid ur Rahman Bashir. Muallim ul Quran, Volumes 3, 4 and 5. Muallim-ul-Quran Publications / official course material.
- 4** Understand Al-Quran Academy. Understand Al-Quran and Quranic Arabic learning resources, courses, worksheets and video lessons.
- 6** Khattab, Mustafa. The Clear Quran Dictionary: A Dictionary of Quranic Vocabulary. The Clear Quran Series / Furqaan Institute resources.
- 8** Badawi, Elsaid M., and Muhammad Abdel Haleem. Arabic-English Dictionary of Quranic Usage. Brill.
- 10** Abdul Wahid Hamid. Access to Quranic Arabic. MELS / Muslim Education and Literary Services.
- 12** The Noble Quran / The Clear Quran / Saheeh International translations for comparative meaning support under teacher supervision.

UNDERGRADUATE PROGRAM

5th Semester

Course Syllabi & Outlines

SEM 5 Fifth Semester

5.1 PROJECT MANAGEMENT (LEC)

5.3 INSTRUMENTATION AND CONTROL ENGG (LEC)

5.5 HEAT & MASS TRANSFER (LEC)

5.7 ELECTRICAL AND ELECTRONICS ENGG (LAB)

5.9 NUMERICAL ANALYSIS (LAB)

5.2 MECHANICS OF MACHINES (LEC)

5.4 INSTRUMENTATION AND CONTROL ENGG (LAB)

5.6 ELECTRONICS ENGINEERING (LEC)

5.8 NUMERICAL ANALYSIS (LEC)

5.10 ENGINEERING ECONOMICS (LEC)

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5.1 PROJECT MANAGEMENT (LEC)

Course Syllabus & Outline

INFO Course Description

The primary objective of this course is to get the fair understanding of core issues pertaining to Engineering Project Management. This course is aimed at providing both basic and some advanced exposure to emerging trends in the field of Project Management, so as to enable the engineering professionals of tomorrow to successfully complete sophisticated projects within the constraints of capital, time, and other resources with due regards to stakeholders set of expectations. Engineering students will learn key Project Management skills and strategies and will be able to face emerging challenges.

CLO-1 Project Management Fundamentals

CLO-1	PLOs	ECs	Wks	CL	SDGs
Understand the fundamental concepts of project management, including project life cycle, stakeholder analysis, and proposal development.	PLO 1	EC 1	WK 1 WK 5	C 2	SDG 9

- History of project management.
- Project, program, and portfolio management.
- Project phases/stages, project life cycle, and project charter.
- Stakeholder analysis.
- Characteristics of good proposals, types of proposals, and proposal templates.

CLO-2 Project Feasibility and Selection

CLO-2	PLOs	ECs	Wks	CL	SDGs
Analyze project feasibility and selection criteria using techniques such as break-even analysis, cost-benefit ratio, and internal rate of return.	PLO 2	EC 3	WK 2 WK 4	C 4	SDG 8

- Technical, social, managerial, and financial aspects of project feasibility.
- Economic analysis of engineering projects.

- 3** Project selection criteria using cost-benefit analysis, net present value (NPV), and internal rate of return (IRR).

CLO-3 Project Planning and Scheduling

CLO-3	PLOs	ECs	WKs	CL	SDGs
Apply project planning, scheduling, and cost estimation techniques, including critical path method (CPM), work breakdown structure (WBS), and earned value management.	PLO 4	EC 4	WK 5	C 5	SDG 11

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|---|---|
| <p>1 Project planning (resource & HR planning), work breakdown structure (WBS).</p> <p>3 Cost estimation and earned value management (EVM).</p> | <p>2 Project scheduling, critical path method (CPM), and activity charts.</p> <p>4 Cost variance analysis and control mechanisms.</p> |
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CLO-4 Risk, Quality, and HR Management

CLO-4	PLOs	ECs	WKs	CL	SDGs
Implement project risk, quality, and HR management strategies to ensure successful project completion and closure.	PLO 9	EC 5 EC 9	WK 6	C 6	SDG 12

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|---|---|
| <p>1 Project risk management tools, risk identification, and mitigation strategies.</p> <p>3 Project HR plan, building effective project teams, and communication management.</p> | <p>2 Quality assurance and project quality management processes.</p> <p>4 Project closure, evaluation, and termination processes.</p> |
|---|---|

READ Books / Reading Materials

- 1** Project Management: A system Approach to Planning, Scheduling and Controlling 11th Edition, Harold Kerzner.
- 3** Cleland, David. Field guide to project management. New York: Wiley.
- 5** Frame, J. D. Managing projects in organizations. San Francisco: Jossey- Bass.
- 7** Haynes, M.E. Project management: From idea to implementation. Los Altos, CA: Crisp Publications.
- 9** Lewis, James, P. 1998. Mastering project management. New York: McGraw-Hill.
- 11** Miller, Roger & Lessard, Donald. 2000. The strategic management of large engineering projects. Cambridge, MA: MIT Press.
- 13** Shtub, Avraham, Bard, Jonathan, & Globerson, Shlomo. 1994. Project management: Engineering, technology, and implementation. Englewood Cliffs, Prentice-Hall.
- 15** J.R. Meredith and S.J. Mantel. Project Management: A Managerial Approach. John Wiley and Sons. New York. 2019. (Reference).
- 2** Bennett, F. Lawrence. 1996. The management of engineering. New York: Wiley.
- 4** Eisner, H. Essentials of project management and systems engineering management. New York: Wiley.
- 6** Goldratt, Eliyahu. Critical chain. North River Press.
- 8** Lewis, James, Project planning, scheduling & control. New York: McGraw-Hill.
- 10** Lientz, Bennet & Rea, Kathryn. 1995. Project management for the 21st century. San Diego: Academic Press.
- 12** Nicholas, J.M. Managing business & engineering projects. Englewood Cliffs, NJ: Prentice Hall.
- 14** Project Management by Adrienne Watt.

MECH- 362 (668028-1/U) · CREDITS: 2

5.2 MECHANICS OF MACHINES (LEC)

Course Syllabus & Outline

INFO Course Description

This course is about the design and synthesis of mechanisms, machines and the underlying concepts of kinematics. It starts with the discussion about fundamental concepts, for example links, joints, kinematics chains and degrees of freedom of the planar mechanisms. Special emphasis is given to enhance the student capability in building analytical models of mechanisms. This will enable students to characterize the mechanisms before making or bringing the mechanisms into realization.

CLO-1 Fundamentals of Mechanisms

CLO-1	PLOs	ECs	WKs	CL	SDGs
Explain the fundamentals of mechanisms and their classifications.	PLO 1 PLO 2	EC 1 EC 2	WK 1 WK 2	C 2	SDG 4

- Machine & Mechanisms.
- Mechanism Terminology.
- Kinematic Diagram and Kinematic Inversion.
- Four-Bar Mechanism and Slider Crank Mechanism.

CLO-2 Mechanism Analysis Techniques

CLO-2	PLOs	ECs	WKs	CL	SDGs
Apply techniques for mechanism analysis through graphical and analytical methods.	PLO 1 PLO 3	EC 3 EC 4	WK 1 WK 3	C 3 C 4	SDG 4 SDG 9

- Techniques of Mechanism Analysis.
- Vector Analysis and Motion.
- Analytical Vector Methods for Displacement Analysis.
- Graphical and Complex-Number Methods for Linkage Analysis.

CLO-3 Position and Displacement Analysis

CLO-3	PLOs	ECs	WKs	CL	SDGs
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Analyze position and displacement in mechanisms using various approaches.	PLO 1 PLO 4	EC 3 EC 5	WK 1 WK 2	C 4 C 5	SDG 4 SDG 9
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- 1 Position and Displacement Analysis of Planar Linkages.
- 2 Spatial Linkages and Three-Dimensional Mechanisms.
- 3 Computer-Implemented Numerical Position Analysis.
- 4 Displacement Analysis using Complex-Number Methods.

CLO-4 Velocity Parameters

CLO-4	PLOs	ECs	WKs	CL	SDGs
Evaluate velocity parameters in mechanisms through analytical techniques.	PLO 1 PLO 2 PLO 4	EC 3 EC 5	WK 1 WK 2 WK 3	C 5 C 6	SDG 4 SDG 9

- 1 Average Speed and Angular Velocity in Mechanisms.
- 2 Velocity of a Point and Motion of a Rigid Body.
- 3 Application of Vector and Matrix Methods to Linkages.
- 4 Velocity Analysis using Complex-Number Methods.

READ Books / Reading Materials

- 1 David H. Myszka. Machines and Mechanisms.
- 2 Thomas Bevan. The Theory of Machines.
- 3 John J. Uicker, Gordon R. Pennock, Joseph E. Shigley. Theory of Machines and Mechanisms.
- 4 Robert Ferrier McKay. The Theory of Machines.
- 5 J. A. Collins. Mechanical Design of Machine Elements and Machines. J. Wiley.
- 6 W. B. Green. Theory of Machine.
- 7 R. L. Norton. Design of Machinery.

MECH- 421 (668034-1/U) · CREDITS: 2

5.3 INSTRUMENTATION AND CONTROL ENGINEERING (LEC)

Course Syllabus & Outline

INFO Course Description

This course introduces the principles and applications of instrumentation and control in mechanical systems. It covers measurement techniques for physical variables, sensor and transducer technologies, signal conditioning, and dynamic system response. Students learn to model, analyze, and design control systems using classical methods, with emphasis on feedback, stability, and performance. Practical applications and simulation tools are integrated to bridge theory and real-world control challenges.

CLO-1 Measurement Systems and Transducers

CLO-1	PLOs	ECs	Wks	CL	SDGs
Explain the principles and characteristics of measurement systems and transducers used in mechanical instrumentation.	PLO 1 PLO 7	EC 1 EC 6	WK 1 WK 2	C 2	SDG 4 SDG 9

- 1 Introduction to Measurement Systems: General Configuration and Terminology.
- 2 Static Characteristics of Instruments (Accuracy, Precision, Linearity).
- 3 Transducers and Sensors: Types and Operating Principles.

CLO-2 Performance Analysis of Instruments

CLO-2	PLOs	ECs	Wks	CL	SDGs
Analyze static and dynamic performance of instruments and sensors used for measuring mechanical variables such as displacement, velocity, acceleration, force, pressure, and temperature.	PLO 2 PLO 5	EC 3 EC 5	WK 2 WK 3	C 4	SDG 9 SDG 12

- 1 Dynamic Characteristics and Response of Measurement Systems.
- 2 Measurement of Mechanical Quantities: Displacement, Velocity, Acceleration.

3 Measurement of Pressure, Force, and Temperature.

4 Signal Conditioning and Data Acquisition Systems.

CLO-3 Feedback Control System Modeling

CLO-3	PLOs	ECs	Wks	CL	SDGs
Apply feedback control concepts to model and analyze mechanical systems using block diagrams and transfer functions.	PLO 2 PLO 3	EC 3 EC 4	WK 4 WK 5	C 3	SDG 4 SDG 9

1 Introduction to Control Systems: Open and Closed Loop.

2 System Modeling Using Differential Equations and Transfer Functions.

3 Block Diagrams, Signal Flow Graphs, and System Simplification.

CLO-4 Control Systems Design and Simulation

CLO-4	PLOs	ECs	Wks	CL	SDGs
Design and simulate control systems for mechanical processes using time and frequency domain methods.	PLO 3 PLO 4	EC 4 EC 5	WK 4 WK 5 WK 6	C 5	SDG 9 SDG 13

1 Time Domain Analysis: Step Response, Transient and Steady-State Analysis.

2 Root Locus Techniques and System Stability.

3 Frequency Domain Analysis: Bode Plot and Nyquist Criteria.

4 Design of Controllers: PID, Lead-Lag Compensation.

5 Simulation of Control Systems Using MATLAB/Simulink.

6 Course Summary, Applications, and Final Exam Preparation.

READ Books / Reading Materials

1 Sensors and Actuators: Engineering System Instrumentation (2nd Ed., 2023) Author: Clarence W. de Silva.

2 Fundamentals of Industrial Instrumentation and Process Control (2nd Ed., 2023) Author: William C. Dunn.

3 Adaptive Control: Algorithms, Analysis and Applications (2024) Authors: Ioan Doré Landau, Rogelio Lozano, Mohammed M. Saad, Alireza Karimi.

4 Instrumentation Fundamentals for Process Control (2022) Author: Douglas O. J. deSa.

MECH- 421 (668034-1/U) · CREDITS: 1

5.3 INSTRUMENTATION AND CONTROL ENGINEERING (LAB)

Course Syllabus & Outline

INFO Course Description

This lab complements the theoretical course by providing hands-on experience in the measurement and control of mechanical systems. Students work with sensors and transducers to measure key physical variables, calibrate instruments, and analyze sensor data. Using both hardware and simulation tools, they implement and evaluate feedback control systems. The lab reinforces core concepts in system dynamics, control theory, and instrumentation through practical experimentation and software modeling.

CLO-1 Sensors and Transducers Usage

CLO-1	PLOs	ECs	Wks	CL	SDGs
Use appropriate sensors and transducers to measure mechanical variables such as displacement, temperature, pressure, and force.	PLO 1 PLO 5	EC 1 EC 3	WK 2 WK 3	C 3	SDG 9

- 1 Measurement of Displacement Using LVDT.
- 2 Pressure Measurement Using Strain Gauge Sensors.
- 3 Temperature Sensing with Thermocouples and RTDs.
- 4 Force Measurement Using Load Cells.

CLO-2 Calibration and Data Interpretation

CLO-2	PLOs	ECs	Wks	CL	SDGs
Calibrate and interpret data from instrumentation systems with attention to accuracy, linearity, and sensitivity.	PLO 1 PLO 2	EC 5	WK 2 WK 3	C 4	SDG 4 SDG 12

- 1 Calibration of Thermocouples and RTDs.
- 2 Calibration and Linearity Check of a Pressure Transducer.
- 3 Accuracy and Sensitivity Analysis of Displacement Sensors.
- 4 Data Acquisition and Signal Conditioning using DAQ.

CLO-3 Feedback Control Implementation

CLO-3	PLOs	ECs	Wks	CL	SDGs
Implement basic feedback control systems using hardware or simulation platforms and analyze their time response.	PLO 2 PLO 3	EC 4 EC 5	WK 4 WK 5	C 3	SDG 9

- 1 Speed Control of a DC Motor using PID Controller (Hardware).
- 2 Implementation of a Closed-loop Temperature Control System.
- 3 Time Response Analysis of First-Order and Second-Order Systems.
- 4 Stability and Error Analysis in Feedback Systems.

CLO-4 Simulation and Performance Evaluation

CLO-4	PLOs	ECs	Wks	CL	SDGs
Simulate and evaluate the performance of mechanical control systems using software tools like MATLAB/Simulink.	PLO 4 PLO 11	EC 5 EC 11	WK 5 WK 6	C 5	SDG 9 SDG 13

- 1 Simulation of Step and Impulse Response in MATLAB/Simulink.
- 2 Root Locus and Bode Plot Analysis of a Control System.
- 3 Design and Tuning of PID Controllers in Simulink.
- 4 Comparison of Time and Frequency Domain Responses.

READ Books / Reading Materials

- 1 Sensors and Actuators: Engineering System Instrumentation (2nd Ed., 2023) Author: Clarence W. de Silva.
- 2 Modern Control Systems Laboratory Manual (Companion to Richard Dorf's book, 13th+ editions).
- 3 Measurement and Instrumentation: Theory and Application (2nd Edition, 2021) Author: Alan S. Morris & Reza Langari.
- 4 Control Systems Engineering (7th or 8th Edition, 2020–2023) Author: Norman S. Nise.
- 5 Lessons In Industrial Instrumentation (Free PDF Manual) Author: Tony R. Kuphaldt.
- 6 MATLAB/Simulink Lab Exercises for Control Engineering (MathWorks).

MECH- 421 (668034-1/U) · CREDITS: 1

5.4 INSTRUMENTATION AND CONTROL ENGINEERING (LAB)

Course Syllabus & Outline

INFO Course Description

This lab complements the theoretical course by providing hands-on experience in the measurement and control of mechanical systems. Students work with sensors and transducers to measure key physical variables, calibrate instruments, and analyze sensor data. Using both hardware and simulation tools, they implement and evaluate feedback control systems. The lab reinforces core concepts in system dynamics, control theory, and instrumentation through practical experimentation and software modeling.

CLO-1 Sensors and Transducers Usage

CLO-1	PLOs	ECs	Wks	CL	SDGs
Use appropriate sensors and transducers to measure mechanical variables such as displacement, temperature, pressure, and force.	PLO 1 PLO 5	EC 1 EC 3	WK 2 WK 3	C 3	SDG 9

- 1 Measurement of Displacement Using LVDT.
- 2 Pressure Measurement Using Strain Gauge Sensors.
- 3 Temperature Sensing with Thermocouples and RTDs.
- 4 Force Measurement Using Load Cells.

CLO-2 Calibration and Data Interpretation

CLO-2	PLOs	ECs	Wks	CL	SDGs
Calibrate and interpret data from instrumentation systems with attention to accuracy, linearity, and sensitivity.	PLO 1 PLO 2	EC 5	WK 2 WK 3	C 4	SDG 4 SDG 12

- 1 Calibration of Thermocouples and RTDs.
- 2 Calibration and Linearity Check of a Pressure Transducer.
- 3 Accuracy and Sensitivity Analysis of Displacement Sensors.
- 4 Data Acquisition and Signal Conditioning using DAQ.

CLO-3 Feedback Control Implementation

CLO-3	PLOs	ECs	Wks	CL	SDGs
Implement basic feedback control systems using hardware or simulation platforms and analyze their time response.	PLO 2 PLO 3	EC 4 EC 5	WK 4 WK 5	C 3	SDG 9

- 1 Speed Control of a DC Motor using PID Controller (Hardware).
- 2 Implementation of a Closed-loop Temperature Control System.
- 3 Time Response Analysis of First-Order and Second-Order Systems.
- 4 Stability and Error Analysis in Feedback Systems.

CLO-4 Simulation and Performance Evaluation

CLO-4	PLOs	ECs	Wks	CL	SDGs
Simulate and evaluate the performance of mechanical control systems using software tools like MATLAB/Simulink.	PLO 4 PLO 11	EC 5 EC 11	WK 5 WK 6	C 5	SDG 9 SDG 13

- 1 Simulation of Step and Impulse Response in MATLAB/Simulink.
- 2 Root Locus and Bode Plot Analysis of a Control System.
- 3 Design and Tuning of PID Controllers in Simulink.
- 4 Comparison of Time and Frequency Domain Responses.

READ Books / Reading Materials

- 1 Sensors and Actuators: Engineering System Instrumentation (2nd Ed., 2023) Author: Clarence W. de Silva.
- 2 Modern Control Systems Laboratory Manual (Companion to Richard Dorf's book, 13th+ editions).
- 3 Measurement and Instrumentation: Theory and Application (2nd Edition, 2021) Author: Alan S. Morris & Reza Langari.
- 4 Control Systems Engineering (7th or 8th Edition, 2020–2023) Author: Norman S. Nise.
- 5 Lessons In Industrial Instrumentation (Free PDF Manual) Author: Tony R. Kuphaldt.
- 6 MATLAB/Simulink Lab Exercises for Control Engineering (MathWorks).

MECH- 321 (668022-1/U) · CREDITS: 3

5.5 HEAT & MASS TRANSFER (LEC)

Course Syllabus & Outline

INFO Course Description

This course teaches the basics of Heat and Mass Transfer and prepares students for subsequent courses in the thermal-fluid area. The course provides detailed understanding of modes of heat transfer i.e. Conduction, Convection and Radiations. This course also covers boiling and condensation, Mass Transfer and Heat exchangers.

CLO-1 Heat Transfer Fundamentals

CLO-1	PLOs	ECs	Wks	CL	SDGs
Understand the fundamental principles of heat transfer, including the physical origins of heat transfer, modes of heat transfer, and thermodynamic relationships.	PLO 1	EC 1 EC 2	WK 1 WK 3	C 2 C 3	SDG 9 SDG 12

- 1 Physical Origins of Heat Transfer: Explore the basic principles of energy transfer.
- 2 Modes of Heat Transfer: Discuss conduction, convection, and radiation.
- 3 Thermodynamic Relationships: Analyze relationships between heat, work, and energy.
- 4 Heat Transfer Applications: Review practical applications in engineering systems.

CLO-2 One-Dimensional Steady-State Conduction

CLO-2	PLOs	ECs	Wks	CL	SDGs
Analyze one-dimensional steady-state conduction, including conduction rate equations, thermal properties of matter, heat diffusion equations, and boundary conditions.	PLO 2	EC 3 EC 5	WK 4 WK 5	C 4 C 5	SDG 9 SDG 11

- 1 Conduction Rate Equation: Derive and apply the conduction rate equation.
- 2 Thermal Properties of Matter: Examine thermal conductivity and its impact on conduction.
- 3 Heat Diffusion Equation: Introduce and solve the heat diffusion equation.
- 4 Boundary and Initial Conditions: Explore setting up boundary and initial conditions for conduction problems.

CLO-3 Two-Dimensional Conduction and Numerical Methods

CLO-3	PLOs	ECs	Wks	CL	SDGs
Analyze two-dimensional steady-state conduction and apply numerical methods for heat transfer applications, including shape factors and heat transfer from extended surfaces.	PLO 3	EC 4 EC 6	WK 5 WK 6	C 5 C 6	SDG 9 SDG 12

- 1 Shape Factors in Heat Transfer: Discuss the concept of shape factors and their applications.
- 2 Numerical Methods for Heat Transfer: Introduce numerical techniques for solving heat transfer problems.
- 3 Heat Transfer from Extended Surfaces: Analyze the principles of extended surface heat transfer.
- 4 Radial Systems: Investigate heat conduction in radial systems.

CLO-4 Convective Heat Transfer Mechanisms

CLO-4	PLOs	ECs	Wks	CL	SDGs
Evaluate convective heat transfer mechanisms, including boundary layer concepts, local and average convection coefficients, and the governing equations for laminar and turbulent flow.	PLO 4	EC 4	WK 7	C 5	SDG 12

- 1 Convection Boundary Layers: Explore the formation and characteristics of convection boundary layers.
- 2 Local and Average Convection Coefficients: Discuss how to determine convection coefficients in various scenarios.
- 3 Laminar and Turbulent Flow: Analyze the differences and equations governing laminar and turbulent flow.
- 4 Governing Equations for Laminar Flow: Review the equations and concepts relevant to laminar flow in various geometries.

READ Books / Reading Materials

- 1 Bergman, T. L., Levine, M. S., Fundamentals of Heat and Mass Transfer, 8th Edition, John Wiley & Sons.
- 2 Holman, J. P., Heat Transfer, 10th Edition, McGraw-Hill.
- 3 Çengel, Y. A., Heat and Mass Transfer: Fundamentals and Applications, 5th Edition, McGraw-Hill.

MECH- 262 (669648-1/U) · CREDITS: 2

5.6 ELECTRONICS ENGINEERING (LEC)

Course Syllabus & Outline

INFO Course Description

This course covers the fundamental concepts of electronics engineering as listed below in course outline/lecture schedule. Being used and implied by Mechanical Engineering students during their course of study and application of Mechanical Engineering.

CLO-1 Semiconductor Devices and Diodes

CLO-1	PLOs	ECs	Wks	CL	SDGs
Understand the fundamental principles of semiconductor devices and diodes.	PLO 1 PLO 2	EC 1 EC 3	WK 1 WK 3	C 2	SDG 4

- 1 Semiconductor properties and junctions.
- 2 Diode types and applications.
- 3 Diode circuit analysis.
- 4 Rectifiers and voltage regulators.

CLO-2 Bipolar Junction Transistors (BJT)

CLO-2	PLOs	ECs	Wks	CL	SDGs
Analyze Bipolar Junction Transistor (BJT) operation and biasing methods.	PLO 1 PLO 2 PLO 3	EC 1 EC 3 EC 4	WK 1 WK 3	C 3	SDG 4

- 1 BJT bias circuits and stability.
- 2 Small-signal BJT amplifiers.
- 3 Load lines and operating points.
- 4 Frequency response of BJT amplifiers.

CLO-3 BJT Amplifiers Design

CLO-3	PLOs	ECs	Wks	CL	SDGs
Design and evaluate BJT amplifiers for various applications.	PLO 1 PLO 3	EC 2 EC 4 EC 5	WK 2 WK 4	C 4	SDG 4 SDG 9

- 1 BJT structure and working principles.
- 2 BJT biasing techniques.
- 3 DC operating point and stability.
- 4 Thermal stabilization and compensation.

CLO-4 Digital Logic Principles

CLO-4	PLOs	ECs	Wks	CL	SDGs
Apply digital logic principles to design and simplify logic circuits.	PLO 2 PLO 3	EC 1 EC 3 EC 6	WK 1 WK 4	C 3	SDG 4

- 1 Number systems and conversions.
- 2 Boolean algebra and simplification techniques.
- 3 Combinational logic design and analysis.
- 4 Sequential logic circuits, flip-flops, and counters.

READ Books / Reading Materials

- 1 Thomas L. Floyd, Electronic Devices (Conventional Current Version).
- 2 Thomas L. Floyd, Digital Fundamentals.

MECH- 262 (666648-1/U) · CREDITS: 1

5.7 ELECTRICAL AND ELECTRONICS ENGINEERING (LAB)

Course Syllabus & Outline

INFO Course Description

In this Lab, students will develop essential skills in electrical lab fundamentals and instrumentation. They will learn to use core lab equipment, including multimeters, oscilloscopes, and function generators, along with understanding resistor color coding and verifying Ohm's law. Through hands-on activities, they will analyze circuit behavior, applying Kirchhoff's Laws (KVL/KCL), current/voltage divider rules, and exploring diode characteristics and rectification principles.

CLO-1 Electrical Lab Fundamentals

CLO-1	PLOs	ECs	Wks	CL	SDGs
Apply Electrical Lab Fundamentals and Basic Resistor Concepts.	PL01 PL03	EC1 EC3	Wk1 Wk2	C2 C3	SDG 4

- 1 Electrical Lab Fundamentals and safety protocols.
- 2 Color coding of Resistors.
- 3 Verification of Ohm's Law and power dissipation.
- 4 To find the voltage across a resistor in practical circuits.

CLO-2 Circuit Laws Verification

CLO-2	PLOs	ECs	Wks	CL	SDGs
Analyze and Verify Circuit Laws in Various Configurations.	PL01 PL05	EC4 EC5	Wk3 Wk4	C4 C5	SDG 4 SDG 9

- 1 Calibration and operation of digital oscilloscope.
- 2 To study and verify Kirchhoff's Voltage Law (KVL).
- 3 To verify Kirchhoff's Current Law (KCL) for parallel circuits.
- 4 To verify Current Divider Rule (CDR) in parallel resistance circuits.

CLO-3 Electrical Instruments

CLO-3	PLOs	ECs	Wks	CL	SDGs
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Demonstrate the Use of Basic Electrical Instruments and Components.	PL02 PL03	EC1 EC9	Wk5 Wk6	C3 C4	SDG 4
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- 1 Usage and applications of Digital Multi Meter.
- 2 Circuit prototyping on Bread Board.
- 3 Signal generation using Function Generator.
- 4 Waveform analysis using Oscilloscope.

CLO-4 Diode Characteristics

CLO-4	PLOs	ECs	Wks	CL	SDGs
Analyze Diode Characteristics and Rectification Circuits.	PL01 PL04	EC4 EC12	Wk7 Wk8	C4 C5	SDG 4 SDG 7

- 1 V-I Characteristics of generic Diodes.
- 2 Implementation and analysis of Half Wave Rectification.
- 3 Implementation and analysis of Full Wave Rectification.
- 4 Verifying Series Circuit Readings (I, V, and R).

READ Books / Reading Materials

- 1 "Basic Electronics: Theory and Practice, Laboratory Manual" by Sean Westcott and Jean Riescher Westcott.
- 2 "Practical Electronics for Inventors" by Paul Scherz and Simon Monk (Lab Companion).
- 3 "Introductory Circuit Analysis, Laboratory Manual" by Robert Boylestad.
- 4 "Electronics Laboratory Primer: A Design Approach" by E. J. Mastascusa, W. J. Fleming, and S. K. Schultz.
- 5 "Fundamentals of Electric Circuits, Laboratory Manual" by Charles Alexander and Matthew Sadiku.

HUM-163 (000003-18/U) · CREDITS: 2

5.8 NUMERICAL ANALYSIS (LEC)

Course Syllabus & Outline

INFO Course Description

This course introduces numerical methods and their applications in engineering, covering topics like Newton and Lagrange's interpolation methods, numerical differentiation, and numerical integration (Trapezoidal and Simpson's rules). Students will learn solution techniques for linear and nonlinear equations, including Gauss elimination, LU factorization, and iterative methods. The course also addresses numerical methods for initial/boundary value problems, eigenvalue computations, and optimization methods.

CLO-1 Errors and Interpolation Methods

CLO-1	PLOs	ECs	Wks	CL	SDGs
Understand and analyze errors in numerical computation and apply interpolation methods to solve engineering problems.	PLO1 PLO2	EC1 EC3	WK1 WK2	C2 C3	SDG 9

- 1 Types, sources, and analysis of errors in numerical computation.
- 2 Floating-point arithmetic: Binary, decimal representation, precision considerations.
- 3 Interpolation methods: Newton's forward, backward, central difference, and Lagrange's interpolation.
- 4 Applications of interpolation and least-square approximation in engineering.

CLO-2 Numerical Differentiation and Integration

CLO-2	PLOs	ECs	Wks	CL	SDGs
Apply numerical differentiation and integration techniques to evaluate derivatives and integrals with engineering applications.	PLO2 PLO4	EC3 EC5	WK1 WK3	C3 C4	SDG 9 SDG 11

- 1 Derivation and application of first- and second-order numerical differentiation.
- 2 Trapezoidal rule, Simpson's rules, and Romberg integration for numerical integration.
- 3 Composite Trapezoidal and Simpson's rules for enhanced accuracy.
- 4 Case studies on the use of numerical differentiation and integration in engineering.

CLO-3 Linear and Nonlinear Equations

CLO-3	PLOs	ECs	WKs	CL	SDGs
Solve systems of linear and nonlinear equations using direct and iterative numerical methods and apply these to engineering cases.	PLO2 PLO4	EC3 EC4	WK2 WK4	C3 C5	SDG 9

- 1 Solution of linear algebraic equations using Gauss elimination and LU factorization.
- 2 Numerical solutions of nonlinear equations: Bisection, Newton's, and Secant methods.
- 3 Iterative methods for linear systems: Jacobi, Gauss-Seidel, and SOR methods.
- 4 Case studies on the application of these methods in engineering disciplines.

CLO-4 Advanced Numerical Applications

CLO-4	PLOs	ECs	WKs	CL	SDGs
Develop and apply numerical methods for initial and boundary value problems, eigenvalue computations, and optimization to engineering scenarios.	PLO1 PLO2 PLO3	EC3 EC5	WK2 WK4	C4 C5	SDG 9 SDG 11

- 1 Numerical solutions of IVPs using Euler's method, Runge-Kutta methods, and error analysis.
- 2 Numerical solutions of BVPs using the Finite Difference Method.
- 3 Power, inverse power, and shifted inverse power methods for computing eigenvalues.
- 4 Optimization techniques: Unconstrained optimization, Golden search ratio, and applications in engineering.

READ Books / Reading Materials

- 1 Richard L. Burden, J. Douglas Faires, Numerical Analysis, Latest Edition.
- 2 R.W. Hamming, Numerical Methods for Scientists and Engineers, Latest Edition.
- 3 Steven C. Chapra, R. P. Canale, Numerical Methods for Engineers, Latest Edition.

HUM-163 (000003-18/U) · CREDITS: 1

5.9 NUMERICAL ANALYSIS (LAB)

Course Syllabus & Outline

INFO Course Description

This course introduces numerical methods and their implementation using MATLAB, focusing on techniques for solving mathematical problems in engineering and science. Topics include error analysis, numerical solutions of linear and nonlinear equations, interpolation, differentiation, integration, and numerical solutions of ordinary differential equations. Emphasis is placed on developing MATLAB scripts and functions to apply these techniques to real-world problems.

CLO-1 MATLAB Basics and Root Finding

CLO-1	PLOs	ECs	Wks	CL	SDGs
Understand the fundamentals of MATLAB programming and basic numerical analysis techniques, including error analysis and the application of root-finding methods.	PLO-01	EC1	WK1 WK3	C2	SDG 4

- 1 MATLAB basics: Environment, syntax, and essential commands. Error types: Round-off, truncation, propagation.
- 2 Root Finding Methods: Bisection, Fixed-point, Secant, and Newton-Raphson methods implemented in MATLAB.
- 3 Error analysis and convergence criteria programming in MATLAB.
- 4 Solving linear systems of equations: Gaussian Elimination, Gauss-Jordan, and LU decomposition.

CLO-2 Iterative Methods and Curve Fitting

CLO-2	PLOs	ECs	Wks	CL	SDGs
Develop and implement numerical techniques for solving systems of linear equations and curve-fitting, including linear and nonlinear interpolation methods.	PLO-02	EC3	WK4 WK8	C3	SDG 9

- 1 Iterative Methods for Linear Systems: Jacobi and Gauss-Seidel iterations.
- 2 Interpolation and Curve Fitting: Polynomial interpolation (Lagrange, Newton) and least-squares approximation.

- 3** Numerical Differentiation: Finite difference approximations (Forward, backward, central).

- 4** Numerical Integration: Trapezoidal rule, Simpson's rule, and adaptive quadrature.

CLO-3 Differential Equations and Matrix Methods

CLO-3	PLOs	ECs	Wks	CL	SDGs
Apply numerical methods for differentiation, integration, and solving ordinary differential equations, with emphasis on accuracy and stability.	PLO-03	EC4	WK6 WK7	C4	SDG 4 SDG 9

- 1** Ordinary Differential Equations (ODEs): Euler's method, Heun's method, and Runge-Kutta methods.

- 2** Boundary Value Problems: Finite difference method and Shooting method.

- 3** Eigenvalue Problems: Power method and QR decomposition.

- 4** Numerical Solutions of Partial Differential Equations (PDEs): Heat equation and wave equation applications.

CLO-4 Optimization and Final Project

CLO-4	PLOs	ECs	Wks	CL	SDGs
Utilize MATLAB to solve advanced numerical analysis problems, including optimization, eigenvalue computation, and partial differential equations, and develop a comprehensive final project.	PLO-05	EC10	WK5 WK9	C5	SDG 9 SDG 11

- 1** Optimization Techniques: Gradient descent, Newton's method, constrained and unconstrained optimization.

- 2** Final Project Preparation: Problem selection, analysis, and implementation utilizing custom MATLAB applications.

- 3** Final Project Presentations and Review: Demonstration of MATLAB-based solutions.

- 4** Course review and QCA session.

READ Books / Reading Materials

- 1** "Numerical Methods for Engineers" by Steven Chapra and Raymond Canale.

- 2** Software: MATLAB (with a focus on scripting and function creation).

HUM-163 (000003-18/U) · CREDITS: 2

5.10 ENGINEERING ECONOMICS (LEC)

Course Syllabus & Outline

INFO Course Description

This course explores the critical intersection of engineering and economics, emphasizing the pivotal role engineers play in business and strategic decision-making for large-scale projects. Participants delve into fundamental economic principles and learn to navigate complex economic landscapes inherent in engineering endeavors.

CLO-1 Role of Engineers in Economics

CLO-1	PLOs	ECs	Wks	CL	SDGs
Understand the role of engineers in economic decision-making and fundamental principles of engineering economics.	PLO 1 PLO 11	EC1 EC3 EC9	WK1 WK2 WK4	C1 C2	SDG 9 SDG 12

- 1 Role of engineers in business and economic decisions.
- 2 Economic decisions vs design decisions.
- 3 Strategic economic decisions in large-scale projects.
- 4 Fundamental principles of engineering economics.

CLO-2 Interest Rates and Money Management

CLO-2	PLOs	ECs	Wks	CL	SDGs
Analyze interest rates, economic equivalence, and money management for engineering projects.	PLO 2 PLO 3	EC3 EC5 EC12	WK2 WK5 WK6	C3 C4	SDG 8 SDG 12

- 1 Interest: The cost of money and economic equivalence.
- 2 Development of formulas for equivalence calculations.
- 3 Nominal and effective interest rates.
- 4 Debt management and investing in financial assets.

CLO-3 Evaluating Engineering Projects

CLO-3	PLOs	ECs	Wks	CL	SDGs
Apply present-worth, annual equivalent-worth, and rate-of-return analysis for evaluating engineering projects.	PLO 4	EC3	WK4	C4	SDG 8
	PLO 7	EC4	WK6	C5	SDG 9
		EC5	WK7		

- 1 Project cash flows and present-worth analysis.
- 2 Annual equivalent-worth criterion and life-cycle cost analysis.
- 3 Rate of return and internal rate-of-return criterion.
- 4 Comparing mutually exclusive alternatives.

CLO-4 Project Risks and Special Topics

CLO-4	PLOs	ECs	Wks	CL	SDGs
Evaluate costs, project risks, and special economic topics such as depreciation, capital budgeting, and replacement decisions.	PLO 9	EC6	WK4	C5	SDG
	PLO	EC10	WK6	C6	12
	11	EC12	WK8		SDG 13

- 1 Cost concepts relevant to decision-making and profit estimation.
- 2 Asset depreciation, tax methods, and developing cash flows.
- 3 Risk analysis: Sensitivity, break-even, and scenario analysis.
- 4 Replacement decisions and capital budgeting decisions.

READ Books / Reading Materials

- 1 Contemporary Engineering Economics by Chan S. Park, latest edition, Pearson ISBN: 9780134105598.
- 2 Engineering Economic Analysis by Donal G. Newnan, Jerome P. Lavelle, Ted G. Eschenbach, latest edition, Oxford University Press, ISBN: 978- 0199339273.
- 3 Engineering Economy by Leland T. Blank and Anthony Tarquin.

UNDERGRADUATE PROGRAM

6th Semester

Course Syllabi & Outlines

SEM 6 Sixth Semester

6.1 HEATING, VENTILATION & AIR COND. (LEC)

6.3 MANUFACTURING PROCESSES (LAB)

6.5 FINITE ELEMENT METHODS (LEC)

6.7 MECHANICAL VIBRATIONS (LEC)

6.2 MANUFACTURING PROCESSES (LEC)

6.4 MACHINE DESIGN-II (LEC)

6.6 FINITE ELEMENT METHODS (LAB)

6.8 MECHANISMS AND MECHANICAL VIBRATION (LAB)

HUM-163 (000003-18/U) · CREDITS: 3

6.1 HEATING, VENTILATION & AIR CONDITIONING (LEC)

Course Syllabus & Outline

INFO Course Description

This course is an introduction to the design of thermal systems for indoor climate control. The concepts, design, application and control of air conditioning and refrigeration are introduced through the use of fundamentals of thermo-fluids. The course is designed to provide a balance among theory and practical design principles and to introduce the students with real world problems of air conditioning and refrigeration design and applications.

CLO-1 Fundamental Thermal Principles

CLO-1	PLOs	ECs	Wks	CL	SDGs
Understand the fundamental thermal principles governing heating, ventilation, and air conditioning systems, including thermodynamic properties, processes, and psychrometric concepts.	PLO 1	EC1 EC4 EC6	WK1 WK3 WK4	C2 C3 C4	SDG 3 SDG 11 SDG 12

- 1 Concepts, Models, and Laws of Thermodynamics.
- 2 Thermodynamic Properties of Matter in HVAC Applications.
- 3 Understanding and Using the Psychrometric Chart.
- 4 Calculating Relative Humidity and Humidity Ratio.

CLO-2 Heating and Cooling Load Calculations

CLO-2	PLOs	ECs	Wks	CL	SDGs
Analyze heating and cooling load calculations for HVAC systems, applying health and comfort criteria to estimate heat loss and gain.	PLO 2	EC3 EC5 EC10	WK5 WK6 WK8	C5 C6	SDG 3 SDG 4 SDG 11

- 1 Health and Comfort Criteria in HVAC Design.
- 2 Factors Influencing Thermal Comfort in Indoor Environments.
- 3 Methods for Estimating Heat Loss in Buildings.
- 4 Procedures for Estimating Cooling Loads in HVAC Systems.

CLO-3 Air-Conditioning Systems Evaluation

CLO-3	PLOs	ECs	Wks	CL	SDGs
Evaluate and design various air-conditioning systems, including thermal distribution systems, single-zone systems, and variable-air-volume systems.	PLO 3	EC2 EC4 EC6	WK7 WK9	C3 C5 C6	SDG 6 SDG 11 SDG 12

- 1 Overview of Thermal Distribution Systems in HVAC.
- 2 Design Considerations for Classic Single-Zone Air Conditioning Systems.
- 3 Principles of Variable-Air-Volume Systems.
- 4 Water Systems in HVAC Applications.

CLO-4 Refrigeration Systems

CLO-4	PLOs	ECs	Wks	CL	SDGs
Understand the components and operation of refrigeration systems, including the vapor-compression cycle, refrigerants, and heat pump systems.	PLO 4	EC1 EC6 EC7	WK4 WK5 WK6	C2 C3 C4	SDG 6 SDG 12 SDG 13

- 1 Analysis of the Carnot Refrigeration Cycle.
- 2 Understanding the Coefficient of Performance (COP) in Refrigeration.
- 3 Types and Functions of Compressors in Refrigeration Systems.
- 4 Overview of the Absorption Refrigeration Cycle and its Applications.

READ Books / Reading Materials

- 1 Stoecker, W. F., Jones, J. W., Refrigeration and Air Conditioning, 2nd Edition, McGraw-Hill Book Co.
- 2 McQuiston, F. C., Parker, J. D., Spitler, J. D., Heating, Ventilating, and Air-Conditioning: Analysis and Design, 6th Edition, John Wiley & Sons.
- 3 Kreider, J. F., Curtiss, P. S., Rabl, A., Heating and Cooling of Buildings: Design for Efficiency, 2nd Edition, CRC Press.
- 4 ASHRAE Handbook Fundamentals, 2017, ASHRAE, USA.

MECH- 302 (668024-3/U) · CREDITS: 2

6.2 MANUFACTURING PROCESSES (LEC)

Course Syllabus & Outline

INFO Course Description

This course teaches about manufacturing processes like Metal Casting Process & Equipment. Molding and molding sands, foundry practices, casting and its types, pattern and pattern making, molding tools and foundry equipment, permanent mold casting. Forming & Shaping Plastics & Composite Materials. Extrusion, injection molding, blow molding, thermo-forming, processing elastomers, polymer foam processing and forming, processing metal matrix and ceramic matrix composites. Powder Metallurgy. Production of metal powders, compaction, sintering, design considerations. Forming & Shaping Processes and Equipment. Rolling, various rolling processes and milling, Extrusion and Drawing, Extrusion and drawing equipment, Forging. Sheet Metal Forming. Sheet metal characteristics and formability, bending sheet and plate, tube bending, deep drawing, super plastic forming, equipment for sheet metal forming.

CLO-1 Casting and Surface Treatment

CLO-1	POs	ECs	Wks	CL	SDGs
Describe Casting and Recommend Techniques for Surface Treatment of Ferrous and Non-Ferrous Metals.	PO1 PO3	EC1 EC5	WK1 WK2	C2 C3	SDG 9

- 1 Overview of casting methods (sand casting, die casting, investment casting, etc.).
- 2 Types of ferrous and non-ferrous metals and their casting properties.
- 3 Surface treatment techniques (heat treatment, plating, coating, etc.).
- 4 Selection criteria for casting and surface treatment methods.

CLO-2 Machining Process Design

CLO-2	POs	ECs	Wks	CL	SDGs
Design a Machining Process by Analyzing Tool Types, Material Properties, and Machine Characteristics.	PO2 PO3	EC3 EC4	WK3 WK4	C4 C5	SDG 9 SDG 12

- 1 Understanding cutting tools and their materials (HSS, carbide, ceramics, etc.).
- 2 Material properties affecting machining (hardness, ductility, thermal conductivity, etc.).

- 3** Characteristics and selection of machines (lathes, milling machines, CNC, etc.).

- 4** Process planning for machining operations and tool selection.

CLO-3 Bulk Deformation and Sheet Metal Shaping

CLO-3	PLOs	ECs	WKs	CL	SDGs
Design a Method for Processing Bulk Metallic Deformation and Sheet Metal Shaping.	PL01 PL03	EC4 EC12	WK5 WK6	C4 C5	SDG 9

- 1** Bulk deformation processes (forging, extrusion, rolling, etc.).
- 3** Equipment and tooling for deformation and shaping processes.

- 2** Sheet metal shaping processes (bending, deep drawing, stamping, etc.).
- 4** Analysis of mechanical properties and forming techniques.

CLO-4 Rapid Prototyping and Modern Manufacturing

CLO-4	PLOs	ECs	WKs	CL	SDGs
Apply Rapid Prototyping and Modern Manufacturing Techniques to Develop Functional Prototypes.	PL05 PL06	EC4 EC11	WK7 WK8	C5 C6	SDG 9 SDG 12

- 1** Introduction to rapid prototyping methods (3D printing, SLS, SLA, etc.).
- 3** Modern manufacturing techniques (laser machining, water jet cutting, etc.).

- 2** Selection of materials and techniques for prototyping.
- 4** Development of functional prototypes and assessment of their performance.

READ Books / Reading Materials

- 1** Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes and Systems, John Wiley.
- 2** S. Kalpakjian, S. R. Schmid, Manufacturing Processes for Engineering Materials, Pearson.
- 3** Stanley A. Komacek, Ann E. Lawson, Andrew C. Horton, Manufacturing Technology, Glencoe/McGraw-Hill.
- 4** B. Beddoes, Principles of Metal Manufacturing.
- 5** Geoffrey Boothroyd, Peter Dewhurst, Winston A. Knight, Product Design for Manufacture and Assembly.

MECH- 302 (668024-3/U) · CREDITS: 1

6.3 MANUFACTURING PROCESSES (LAB)

Course Syllabus & Outline

INFO Course Description

This lab is designed to provide students with practical experience in essential manufacturing and fabrication techniques, spanning both traditional and modern processes. Through hands-on work, students will learn to operate machinery like lathes, milling machines, and CNC systems to create components with precise dimensions and surface finishes. They will also explore casting, welding, and 3D printing to understand various methods of part fabrication. Quality control practices are introduced to ensure accuracy and adherence to specifications, equipping students with skills in inspection and quality assurance.

CLO-1 Traditional Machining Processes

CLO-1	PLOs	ECs	Wks	CL	SDGs
Demonstrate Proficiency in Traditional Machining Processes.	PL01 PL03	EC1 EC4	WK1 WK2	C3 C4	SDG 4 SDG 9

- 1 Producing horizontal and vertical plane surfaces on a shaper.
- 2 Producing slots on milling machines.
- 3 Working on a work piece using a lathe machine.

CLO-2 Casting and Welding Techniques

CLO-2	PLOs	ECs	Wks	CL	SDGs
Apply Casting and Welding Techniques in Fabrication.	PL02 PL05	EC4 EC8	WK3 WK4	C3 C5	SDG 4 SDG 12

- 1 Making a model by casting.
- 2 Preparing different welding joints using arc welding.
- 3 Making joints using gas welding.

CLO-3 Additive Manufacturing

CLO-3	PLOs	ECs	Wks	CL	SDGs
Utilize Additive Manufacturing Technologies for Part Production.	PL04 PL06	EC6 EC9	WK5 WK6	C3 C4	SDG 4 SDG 9

- 1 Programming for 3D printing and tool path generation.
- 2 Manufacturing/fabrication of work piece using 3D printing.
- 3 Procurement procedure and introduction to job manufacturing processes.

CLO-4 CNC Machining and Quality Control

CLO-4	PLOs	ECs	Wks	CL	SDGs
Implement CNC Machining and Quality Control Processes.	PL01 PL07	EC5 EC12	WK7 WK8	C4 C5	SDG 4 SDG 9

- 1 CNC lathe programming.
- 2 Quality control and assurance.
- 3 Working on a work piece using a CNC lathe machine.

READ Books / Reading Materials

- 1 "Workshop Technology: Part I and II" by W.A.J. Chapman.
- 2 "Manufacturing Processes Laboratory Manual" by R.K. Rajput.
- 3 "Fundamentals of Modern Manufacturing Lab Manual" by Mikell P. Groover.
- 4 "Introduction to Manufacturing Processes and Workshop Technology" by Rajender Singh.
- 5 "Practical CNC Machining and Programming" by Michael J. Peterson.

MECH- 304 (666802-1/U) · CREDITS: 2

6.4 MACHINE DESIGN-II (LEC)

Course Syllabus & Outline

INFO Course Description

Machine design is a core course that equips students with the basics of mechanical engineering design. It prepares students for the engineering problems encountered and everyday life. Knowledge of Statics, Dynamics and Mechanics of Materials is a pre-requisite for a better understanding of fundamental design concepts.

CLO-1 Gear Design and Stress Analysis

CLO-1	PLOs	ECs	Wks	CL	SDGs
Analyze and Apply Concepts of Gear Design and Stress Analysis.	PL01 PL03	EC1 EC5	WK1 WK2	C4 C5	SDG 9

- 1 Types of gears (spur, helical, bevel, and worm) and their applications.
- 2 Stress analysis on gear teeth.
- 3 Power transmission by gears.
- 4 Gear material selection and design considerations.

CLO-2 Flywheels and Bearings

CLO-2	PLOs	ECs	Wks	CL	SDGs
Design Flywheels for Specific Applications and Analyze Bearing Selection.	PL02 PL03	EC4 EC12	WK3 WK4	C4 C5	SDG 9

- 1 Flywheel design concepts for different requirements.
- 2 Stress analysis and energy storage in flywheels.
- 3 Selection of bearings for machinery.
- 4 Procedures for selecting sliding contact and rolling contact bearings.

CLO-3 Brakes and Clutches

CLO-3	PLOs	ECs	Wks	CL	SDGs
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Develop and Assess the Design of Brakes and Clutches.	PL01 PL05	EC4 EC9	WK5 WK6	C3 C5	SDG 9
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|---|---|
| 1 Different types of clutches and their design concepts.

3 Material selection for brakes and clutches. | 2 Brake types and their design principles.

4 Performance analysis of braking and clutch systems. |
|---|---|

CLO-4 Power Screws and Flexible Drives

CLO-4	PLOs	ECs	Wks	CL	SDGs
Design Power and Translation Screws and Select Standard Machine Elements.	PL03 PL06	EC4 EC11	WK7 WK8	C5 C6	SDG 9 SDG 12

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|---|---|
| 1 Introduction to power screws and translation screws.

3 Applications of power screws in mechanical systems. | 2 Stress and efficiency analysis of power/translation screws.

4 Selection criteria for flat belts, V belts, chain drives, and rope drives. |
|---|---|

READ Books / Reading Materials

- | | |
|---|---|
| 1 Mott, R. L., Machine Elements in Mechanical Design.

3 Shigley, J. E., Theory of Machines & Mechanisms. | 2 Norton, R. L., Design of Machinery.

4 Khurmi, R. S., Machine Design. |
|---|---|

MECH- 304 (666802-1/U) · CREDITS: 2

6.5 FINITE ELEMENT METHODS (LEC)

Course Syllabus & Outline

INFO Course Description

This course introduces the fundamental concepts and applications of the Finite Element Method in mechanical engineering analysis. Students will learn discretization, element formulation, stiffness matrix development, boundary conditions, and solution procedures for structural and thermal problems. The course emphasizes practical modeling, interpretation of results, and use of FEM tools for engineering design and analysis.

CLO-1 Fundamentals of FEA

CLO-1	PLOs	ECs	Wks	CL	SDGs
Understand and Apply Fundamentals of Finite Element Analysis (FEA) and Element Performance.	PL01 PL03	EC1 EC5	WK1 WK2	C2 C3	SDG 9

- 1 Introduction to finite element modeling and preliminary decisions.
- 2 Types of finite elements and their properties.
- 3 Equilibrium and compatibility concepts in FEA.
- 4 Factors affecting element performance, including error sources and convergence.

CLO-2 Shape Functions and Stiffness Matrix

CLO-2	PLOs	ECs	Wks	CL	SDGs
Utilize Finite Element Methods, Shape Functions, and Stiffness Matrix Assembly.	PL02 PL03	EC3 EC4	WK3 WK4	C3 C4	SDG 9

- 1 Direct Stiffness and Energy Methods.
- 2 Shape functions for linear and quadratic elements.
- 3 Types of elements (beam, truss, linear, planar) and their applications.
- 4 Stiffness matrix formation and transformation from local to global coordinates.

CLO-3 Static Structural Analysis

CLO-3	PLOs	ECs	Wks	CL	SDGs
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Conduct Static Structural Analysis for 1D, 2D, and 3D Structures.	PL03 PL05	EC4 EC9	WK5 WK6	C4 C5	SDG 9
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|---|--|
| <ol style="list-style-type: none"> 1 Modeling techniques for 1D, 2D, and 3D structures. 3 Material selection and boundary conditions for static analysis. | <ol style="list-style-type: none"> 2 Static loading conditions in structural analysis. 4 Interpreting results and validating structural analysis findings. |
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CLO-4 Thermal Stress Analysis

CLO-4	PLOs	ECs	Wks	CL	SDGs
Perform Heat Transfer and Thermal Stress Analysis in Finite Element Models.	PL04 PL06	EC8 EC12	WK7 WK8	C5 C6	SDG 9 SDG 13

- | | |
|---|---|
| <ol style="list-style-type: none"> 1 Basics of heat transfer and thermal stress analysis in FEA. 3 Thermal analysis (steady-state). | <ol style="list-style-type: none"> 2 Selecting appropriate boundary conditions based on problem requirements. 4 Analysis of thermal stresses in materials under varying conditions. |
|---|---|

READ Books / Reading Materials

- | | |
|---|--|
| <ol style="list-style-type: none"> 1 Moaveni, Saeed, Finite Element Analysis: Theory and Application with ANSYS. 3 Budynas, Richard G., Advanced Strength and Applied Stress Analysis, McGraw-Hill. | <ol style="list-style-type: none"> 2 Logan, Daryl, A First Course in the Finite Element Method, Fifth Edition. |
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MECH- 363L (666647-1/U) · CREDITS: 1

6.6 FINITE ELEMENT METHODS (LAB)

Course Syllabus & Outline

INFO Course Description

These CLOs and topics will equip students with practical simulation skills in key mechanical engineering domains using ANSYS software.

CLO-1 Solid Mechanics Simulations

CLO-1	PLOs	ECs	Wks	CL	SDGs
Apply ANSYS software to solve problems in Solid Mechanics by performing simulations related to stress, strain, and deformation analysis.	PL01 PL02 PL05	EC1 EC3 EC4 EC5	WK1 WK2 WK3 WK4	C3	SDG 9 SDG 12

- 1 Simulating stress-strain analysis for various materials under load.
- 2 Performing deformation analysis of structures under different boundary conditions.
- 3 Evaluating factors of safety in mechanical components.
- 4 Conducting fatigue analysis and predicting failure modes.

CLO-2 Fluid Mechanics Simulations

CLO-2	PLOs	ECs	Wks	CL	SDGs
Perform Fluid Mechanics simulations using ANSYS Fluent to analyze flow behavior, pressure distributions, and related phenomena.	PL01 PL02 PL04	EC1 EC3 EC4 EC5	WK1 WK2 WK4	C3	SDG 6 SDG 9 SDG 13

- 1 Simulating incompressible and compressible fluid flows.
- 2 Analyzing fluid flow through pipes and channels, including pressure drop calculations.
- 3 Visualizing and interpreting turbulent flow behavior and its effects.
- 4 Solving flow problems involving fluid-structure interaction (FSI).

CLO-3 Heat Transfer Simulations

CLO-3	PLOs	ECs	WKs	CL	SDGs
Conduct Heat Transfer simulations in ANSYS to determine heat flow, temperature gradients, and thermal stresses in engineering components.	PL01 PL02 PL04	EC1 EC3 EC4 EC5	WK1 WK2 WK4	C4	SDG 7 SDG 9 SDG 13

- 1 Simulating steady-state and transient heat conduction in solids.
- 2 Modeling convection heat transfer in fluid systems.
- 3 Analyzing heat exchanger performance using ANSYS.
- 4 Performing radiation heat transfer simulations and calculating thermal loads.

CLO-4 Thermodynamic Processes Simulations

CLO-4	PLOs	ECs	WKs	CL	SDGs
Simulate Thermodynamic processes using ANSYS, such as energy balance, heat work interactions, and system efficiencies.	PL01 PL02 PL05	EC1 EC3 EC4 EC5	WK1 WK2 WK3	C4	SDG 7 SDG 9 SDG 13

- 1 Modeling thermal cycles and efficiency using thermodynamic principles.
- 2 Simulating real-gas behavior and phase changes in engineering systems.
- 3 Conducting simulations of refrigeration and air-conditioning systems.
- 4 Evaluating thermal stresses in components under varying temperature conditions.

READ Books / Reading Materials

- 1 Finite Element Analysis: Theory and Application with ANSYS by Saeed Moaveni.
- 2 Introduction to Computational Fluid Dynamics: The Finite Volume Method by H. Versteeg and W. Malalasekera.
- 3 Heat Transfer: A Practical Approach by Yunus A. Cengel.
- 4 Engineering Thermodynamics: Work and Heat Transfer by G.F.C. Rogers and Y.R. Mayhew.
- 5 ANSYS Tutorial Release 2023.
- 6 Structural & Thermal Analysis Using the ANSYS Mechanical APDL Release 2023 Environment By Kent L. Lawrence.
- 7 Computational Fluid Dynamics, Getting Started Quickly With ANSYS CFX 18 Through Simple Examples By Stefan Lecheler.
- 8 Finite Element Simulations with ANSYS Workbench 2021, By Huei-Huang Lee.
- 9 ANSYS Workbench 2023 R2: A Tutorial Approach, 6th Edition, By Prof. Sham Tickoo.

MECH- 461 (668032-1/U) · CREDITS: 3

6.7 MECHANICAL VIBRATIONS (LEC)

Course Syllabus & Outline

INFO Course Description

This course deals with observation, analysis, and modification of vibration in mechanical systems. In addition to analysis and experimentation, practical applications and design considerations related to modifying the vibrational behavior of mechanical devices and structures will also be studied. This understanding is important for humans, particularly engineers, as there are desirable types of vibration and undesirable vibrations. The course gives knowledge of vibrations in rotating and oscillating bodies. Fundamental analysis in frequency and in time domain. Response analysis, of free and forced vibrations.

CLO-1 Single-Degree-of-Freedom Systems

CLO-1	POs	ECs	Wks	CL	SDGs
Understand the fundamentals of vibrations and analyze single-degree-of-freedom systems in both free and forced vibration scenarios, including damping effects and harmonic excitation.	PO1	EC1	WK1	C2	SDG 9
	PO2	EC3	WK3	C3	
	PO3	EC5		C4	

- 1 Introduction to Vibrations: Understanding the basics of vibrations, degrees of freedom, and the types of vibratory systems.
- 2 Free Vibrations in Single-Degree-of-Freedom Systems: Analyzing undamped and damped free vibrations using Newton's method and energy methods.
- 3 Forced Vibrations in Single-Degree-of-Freedom Systems: Investigating harmonic excitation and resonance in forced vibration systems.
- 4 Logarithmic Decrement and Damping: Understanding viscous damping, spring-damper combinations, and their effects on vibration.

CLO-2 Analytical Methods for Vibration Analysis

CLO-2	POs	ECs	Wks	CL	SDGs
Apply analytical methods, such as Newton's method and energy method, to solve problems in damped and	PO2	EC4	WK1	C3	SDG 9
	PO4	EC6	WK3	C4	SDG
	PO5	EC13	WK4	C5	12

undamped vibratory systems, including transient and steady-state responses.					
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|---|---|
| <p>1 Newton's Method for Vibration Analysis: Applying Newton's laws to model free and forced vibratory systems.</p> <p>3 Transient Vibrations in Single-Degree-of-Freedom Systems: Analyzing the system's response to impulse and arbitrary inputs.</p> | <p>2 Energy Methods for Vibration Analysis: Using the principle of conservation of energy to solve vibration problems.</p> <p>4 Steady-State Vibrations in Forced Systems: Evaluating the steady-state response under harmonic and rotating unbalance forces.</p> |
|---|---|

CLO-3 Two-Degree-of-Freedom Systems

CLO-3	PLOs	ECs	Wks	CL	SDGs
Analyze and solve two-degree-of-freedom systems, including both free and forced vibration cases, by applying normal mode analysis and considering damping and coupling effects.	PL01 PL02 PL05	EC3 EC5 EC9	WK2 WK5	C3 C4 C5	SDG 9

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| <p>1 Normal Mode Analysis in Two-Degree-of-Freedom Systems: Analyzing free vibrations in undamped two-degree-of-freedom systems.</p> <p>3 Forced Vibration in Two-Degree-of-Freedom Systems: Investigating forced harmonic vibration in undamped and damped systems.</p> | <p>2 Coordinate Coupling and Damping: Understanding the concept of coordinate coupling and its effect on vibration analysis.</p> <p>4 System Stability in Two-Degree-of-Freedom Systems: Assessing the stability of systems through root-locus and other methods.</p> |
|--|---|

CLO-4 Multi-Degree-of-Freedom Systems

CLO-4	PLOs	ECs	Wks	CL	SDGs
Evaluate multi-degree-of-freedom systems using eigenvalue analysis, influence coefficients, and numerical methods like Holzer's method to solve vibration problems in mechanical systems.	PL02 PL04 PL07	EC7 EC11	WK1 WK3 WK6	C4 C5 C6	SDG 9 SDG 13

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| <p>1 Eigenvalue and Eigenvector Analysis: Applying eigenvalue analysis to multi-degree-of-freedom vibratory systems.</p> <p>3 Holzer's Method: Applying Holzer's method for analyzing torsional vibrations in multi-degree-of-freedom systems.</p> | <p>2 Matrix Iteration Method: Using numerical methods to solve multi-degree-of-freedom systems.</p> <p>4 Influence Coefficients in Multi-Degree-of-Freedom Systems: Using influence coefficients to solve complex vibratory systems.</p> |
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READ Books / Reading Materials

- | | |
|--|--|
| 1 Thompson, W.T., Mechanical Vibrations: Theory and Applications, 5th Edition, Prentice Hall. | 2 Rao, S.S., Mechanical Vibrations, 3rd Edition, McGraw-Hill. |
| 3 Meirovitch, Leonard, Elements of Vibration Analysis, McGraw Hill, 2001. | 4 Thomson, W.T., Dahleh, M.D., Theory of Vibration with Applications. |

MECH- 461 (668032-1/U) · CREDITS: 1

6.8 MECHANISMS AND MECHANICAL VIBRATION (LAB)

Course Syllabus & Outline

INFO Course Description

This lab focuses on the principles of oscillations and vibrations through practical experiments. Students will determine the theoretical natural frequency of systems, comparing it with actual values while examining the effects of damping on oscillatory decay. They will explore forced oscillations and measure amplitude using a drum recorder. The lab will also cover simple and compound pendulums, investigating how the period is independent of mass but proportional to length. Additionally, students will analyze bifilar pendulums and torsional vibrations, assessing factors like rod length and diameter. Finally, they will measure the critical speed of shafts, reinforcing concepts of mechanical dynamics through hands-on experience.

CLO-1 Natural Frequency and Damping

CLO-1	PLOs	ECs	Wks	CL	SDGs
Understand and Apply Concepts of Natural Frequency and Damping in Oscillating Systems.	PL01 PL02	EC1 EC3	WK1 WK4	P2 P3	SDG 4

- 1 Determine the theoretical natural frequency for varying constants and lever arms and compare these with experimental values.
- 2 Illustrate the effects of damping on decay behavior in oscillating systems.
- 3 Determine the amplitude of forced oscillations and record data using a drum recorder.
- 4 Observe the absorption of oscillations by using an absorber.

CLO-2 Simple and Compound Pendulums

CLO-2	PLOs	ECs	Wks	CL	SDGs
Investigate Properties of Simple and Compound Pendulums.	PL01 PL02	EC1 EC3	WK1 WK4	P2 P3	SDG 4

- 1 Verify that the time period of a simple pendulum is independent of displacement.
- 2 Verify that the time period of a simple pendulum is independent of mass.
- 3 Demonstrate that the time period of a simple pendulum is directly proportional to its length.
- 4 Calculate and compare the time period of a compound pendulum to a real pendulum.

CLO-3 Bifilar and Torsional Pendulums

CLO-3	PLOs	ECs	Wks	CL	SDGs
Analyze the Motion Characteristics of Bifilar and Torsional Pendulums.	PL01 PL02	EC1 EC3	WK1 WK4	P3 P4	SDG 4

- 1 Compare the time period of a bifilar pendulum with a simple pendulum.
- 2 Investigate the effect of additional mass on the time period of a bifilar pendulum.
- 3 Determine the time period of torsional vibration as a function of the rod's length and diameter.
- 4 Examine the effect of rotating mass on the time period of torsional vibration using different disk and plate configurations.

CLO-4 Critical Speed and Damping

CLO-4	PLOs	ECs	Wks	CL	SDGs
Examine Critical Speed and Damping in Rotational Systems.	PL01 PL02	EC1 EC3	WK1 WK4	P3 P4	SDG 4

- 1 Investigate and measure the damping ratio of oscillating systems.
- 2 Determine the critical speed or whirling speed of shafts.
- 3 Study the impact of additional masses on critical speed and system stability.
- 4 Evaluate experimental data to identify factors influencing system resonance and damping behavior.

READ Books / Reading Materials

- 1 "Mechanical Vibrations Laboratory Manual" by Daniel J. Inman (Wiley).
- 2 "Vibration Testing and Measurement Laboratory Manual" by Randall J. Allemang (Cengage Learning).
- 3 "Mechanical Vibrations Laboratory Experiments" by Singiresu S. Rao (Prentice Hall).
- 4 "Laboratory Experiments in Mechanical Vibrations" by William J. Palm III (McGraw-Hill).
- 5 "Mechanical Vibrations Simulation Laboratory Manual" (MATLAB-based) by N. Dukkipati (CRC Press).
- 6 "Vibration Analysis and Simulation Laboratory Manual" (ANSYS-based) by Xiaoping Wu (Wiley).
- 7 "Mechanical Vibrations Simulation Laboratory" (Simulink-based) by J. L. Marine (Pearson).
- 8 "Experimental and Computational Methods in Mechanical Vibrations" by Michael D. Todd (Springer).

UNDERGRADUATE PROGRAM

7th Semester

Course Syllabi & Outlines

SEM 7 Seventh Semester**7.1** INTERNAL COMBUSTION ENGINES (LEC)**7.3** PRODUCT DESIGN AND DEVELOPMENT (LEC)**7.5** FINAL YEAR DESIGN PROJECT – I (LAB)**7.7** APPLIED STATISTICS (LEC)**7.2** HVAC AND HEAT & MASS TRANSFER (LAB)**7.4** PRODUCT DESIGN AND DEVELOPMENT (LAB)**7.6** CLIMATE CHANGE AND RISK MANAGEMENT (LEC)

MECH- 421 (668034-1/U) · CREDITS: 2

7.1 INTERNAL COMBUSTION ENGINES (LEC)

Course Syllabus & Outline

INFO Course Description

The course provides introductory overview of spark ignition and compression ignition engines. Describes combustion chemistry and identifies the parameters and engine operations to develop understanding of the thermodynamics and combustion process for a quantitative analysis of internal combustion engines. Detail of gas exchange and inflow and outflow of gases explained. Engine classification, engine cycle, combustion processes, reaction of engine fuels, release of energy and ultimate conversion into useful work is illustrated. A concise discussion on topics like performance of engines, Knocking, Octane number, Cetane number, engine valve timing, ignition advance/ retard, and working principle of turbo-charged engine is also included. Highlighting that Internal Combustion Engines are a source of pollution and controlling the emissions is emphasized.

CLO-1 Basic Concepts and Components

CLO-1	POs	ECs	Wks	CL	SDGs
Understand the basic concepts and components of Internal Combustion Engines (IC Engines), including engine cycles, classifications, and historical developments.	PO1 PO2	EC1 EC3	WK1 WK2	C2 C4	SDG 4

- 1 Definition and classification of IC Engines.
- 2 Engine components for 2-stroke and 4-stroke engines.
- 3 Comparison between 2-stroke and 4-stroke engines.
- 4 Historical evolution and terminologies used in engine technology.

CLO-2 Operating Cycles and Characteristics

CLO-2	POs	ECs	Wks	CL	SDGs
Analyze the operating cycles and characteristics of IC Engines, focusing on performance parameters such as power, torque, efficiency, and emissions.	PO1 PO4 PO5	EC3 EC4 EC6	WK1 WK2 WK5	C4 C5	SDG 7 SDG 13

- 1 4-stroke and 2-stroke engine cycles.
- 2 SI and CI engine cycles and air-standard cycle analysis.

- 3** Power, torque, and efficiency in engine performance.

- 4** Emission requirements and combustion efficiency.

CLO-3 Thermo-chemistry and Fuel Induction

CLO-3	PLOs	ECs	WKs	CL	SDGs
Evaluate the influence of thermo-chemistry, fuel types, and air-fuel induction systems on the performance and efficiency of IC Engines.	PL01 PL02 PL04	EC1 EC4 EC6	WK1 WK2 WK3	C4 C5	SDG 7 SDG 13

- 1** Thermo-chemistry principles and their role in IC engines.

- 2** Octane and Cetane ratings of SI and CI fuels.

- 3** Gasoline and alternative fuel comparison for IC Engines.

- 4** Air and fuel induction systems for SI and CI engines.

CLO-4 Combustion, Cooling, and Pollution Control

CLO-4	PLOs	ECs	WKs	CL	SDGs
Examine the combustion process, engine cooling, lubrication, and pollution control methods for enhancing engine performance and reducing emissions.	PL04 PL05 PL06	EC4 EC6 EC9	WK5 WK6 WK7	C5 C6	SDG 7 SDG 11 SDG 13

- 1** Combustion process and operating parameters (pressure, temperature, etc.).

- 2** Comparison between CI and SI engine combustion.

- 3** Engine cooling and lubrication systems.

- 4** Engine emissions, pollution control devices, and standards.

READ Books / Reading Materials

- 1** Pulkrabek, William W., Engineering Fundamentals of the Internal Combustion Engines.
- 3** Taylor, C.F., Combustion Engines in Theory and Practice.

- 2** Heywood, J.B., Internal Combustion Engines Fundamentals, 2nd Edition, McGraw Internal.
- 4** Schäfer, R. V., Schäfer, F., Internal Combustion Engine Handbook - Basics, Components, Systems, and Perspectives, SAE International.

MECH- 363L (666647-1/U) · CREDITS: 2

7.2 HVAC AND HEAT & MASS TRANSFER (LAB)

Course Syllabus & Outline

INFO Course Description

The lab objectives in Heat Transfer and Refrigeration/Air Conditioning aim to provide students with practical insights into thermal and fluid systems through hands-on experiments. Students engage with concepts of linear and radial heat conduction, exploring both conduction and convection in various heat exchanger setups, including free and forced convection units. Through experiments on film wise and dropwise condensation, students observe condensation heat transfer coefficients under different conditions. In the Refrigeration and Air Conditioning portion, they analyze systems like the mechanical heat pump, determining power input, heat output, and coefficient of performance (COP), as well as investigate fan power and cooling load in air conditioning units.

CLO-1 Heat Conduction and Temperature Profiles

CLO-1	PLOs	ECs	Wks	CL	SDGs
Demonstrate understanding of different heat conduction methods and analyze temperature profiles for effective heat transfer.	PL01 PL02	EC1 EC3	WK3	P2	SDG 9

- 1 To measure the rate of heat transfer through a solid material under steady-state conditions and determine the thermal conductivity of the material.
- 2 To observe the radial distribution of heat in a cylindrical material and calculate the thermal conductivity for radial conduction.
- 3 To analyze the heat transfer rate and temperature profiles within a shell-and-tube heat exchanger and assess the impact of flow rate on heat transfer efficiency.
- 4 To observe the temperature variations and evaluate the heat transfer efficiency in a double-pipe heat exchanger under counter-current flow conditions.

CLO-2 Convection and Condensation

CLO-2	PLOs	ECs	Wks	CL	SDGs
Evaluate heat transfer coefficients and investigate various heat exchange modes, including convection and condensation.	PL01 PL02 PL04	EC1 EC3 EC5	WK3	P3	SDG 9 SDG 13

- 1 To study the heat transfer characteristics of free convection in a heat exchanger and measure the temperature distribution and heat transfer coefficient under natural convection conditions.
- 2 To examine the effects of forced convection on heat transfer rate in a heat exchanger and calculate the heat transfer coefficient at different flow rates and inlet temperatures.
- 3 To observe the condensation phenomena on different surfaces, measure the heat transfer coefficients for filmwise and dropwise condensation, and compare their effectiveness under similar conditions.
- 4 To determine the heat flux and heat transfer coefficient during condensation at varying surface temperatures and pressures, analyzing the impact of different condensation regimes on heat transfer efficiency.

CLO-3 Mechanical Heat Pumps

CLO-3	PLOs	ECs	Wks	CL	SDGs
Examine the operation and efficiency parameters of mechanical heat pumps and air conditioning units.	PL01 PL02 PL04	EC1 EC3 EC5	WK4	P3	SDG 7 SDG 9

- 1 To understand the operation and basic components of a mechanical heat pump, including compressor, evaporator, and condenser, through hands-on demonstration and analysis of the system's heat transfer process.
- 2 To measure the power input and heat output of a mechanical heat pump and calculate its coefficient of performance (COP) under various operating conditions to evaluate system efficiency.
- 3 To observe and record the temperature profile of a mechanical heat pump system under steady-state conditions, analyzing how temperature varies across different system components.
- 4 To study the impact of varying the compressor pressure ratio on the volumetric efficiency of a mechanical heat pump, examining how changes in pressure affect system performance and efficiency.

CLO-4 Refrigeration Cycles and Cooling Load

CLO-4	PLOs	ECs	Wks	CL	SDGs
Analyze key performance indicators of refrigeration cycles and assess cooling load calculations for energy optimization.	PL01 PL02 PL07	EC1 EC3 EC5	WK4	P4	SDG 7 SDG 13

- 1 To determine the COP of a refrigeration machine by measuring the heat absorbed from the cooling space and the work input, allowing an assessment of the machine's efficiency.
- 2 To understand the operation of a vapor compression refrigeration cycle and calculate the rate of heat extraction from the evaporator, evaluating the unit's cooling capacity.
- 3 To measure the power consumed by the fan in an air conditioning unit and analyze its impact on overall system performance,
- 4 To calculate the cooling load required to maintain a specified temperature in a room by accounting for heat gains from various

including air circulation and cooling efficiency.

sources, enabling proper selection and sizing of an air conditioning system.

READ Books / Reading Materials

- 1 Heat Transfer Laboratory Manual by Holman and Greeley.
- 2 Experimental Methods for Engineers by Holman.
- 3 Refrigeration and Air Conditioning Laboratory Manual by LabVIEW.
- 4 Thermal Engineering Laboratory Manual by Kothandaraman and Subramanyan.
- 5 Fundamentals of Heat and Mass Transfer: Laboratory Guide by Incropera and DeWitt.
- 6 Laboratory Manual for Heat and Mass Transfer by Cengel.
- 7 Practical Refrigeration and Air Conditioning by William E. Campbell.

HUM-163 (000003-18/U) · CREDITS: 3

7.3 PRODUCT DESIGN AND DEVELOPMENT (LEC)

Course Syllabus & Outline

INFO Course Description

Product Development Process, Opportunity Identification, Product Planning, Identifying Customer Needs, Product Design Specifications, Product Concept Creation, Selection, and Testing, Industrial Design, Design for Manufacture and Environment, Prototyping, Service Design, Economic Sustainability in Product Design and Development, Project Management (Optional).

CLO-1 Product Development Process

CLO-1	POs	ECs	Wks	CL	SDGs
Describe the stages of the product development process, including opportunity identification, product planning, and customer need analysis.	PL01 PL010	EC1 EC3 EC10	WK1 WK2 WK7	C2	SDG 4 SDG 9

- 1 Introduction to Product Development Process and Stakeholders.
- 2 Opportunity Identification and Selection Techniques.
- 3 Product Planning and Technology Road mapping.
- 4 Identifying and Analyzing Customer Needs using Voice of Customer (VoC).

CLO-2 Product Design Specifications and Concepts

CLO-2	POs	ECs	Wks	CL	SDGs
Develop product design specifications and generate, evaluate, and test product concepts to meet customer and market requirements.	PL02 PL03 PL04	EC1 EC3 EC4 EC5	WK2 WK3 WK4	C5	SDG 9 SDG 12

- 1 Developing Product Design Specifications (PDS).
- 2 Concept Generation Techniques: Brainstorming, SCAMPER, TRIZ.
- 3 Concept Screening and Selection using Pugh Matrix.
- 4 Concept Testing through Customer Feedback and Prototyping.

CLO-3 Industrial Design and Manufacturing

CLO-3	PLOs	ECs	WKs	CL	SDGs
Apply principles of industrial design, design for manufacturing and the environment, and prototyping in the product realization process.	PLO2 PLO4 PLO5	EC4 EC5 EC6	WK3 WK4 WK5	C3	SDG 9 SDG 12 SDG 13

- 1 Fundamentals of Industrial Design and User-Centered Design (UCD).
- 2 Design for Manufacturability and Assembly (DFMA).
- 3 Design for Environment (DfE) and Sustainability Considerations.
- 4 Rapid Prototyping Techniques and Tools.

CLO-4 Sustainability and Project Management

CLO-4	PLOs	ECs	WKs	CL	SDGs
Analyze the role of service design, economic sustainability, and project management in successful product design and development.	PLO6 PLO11	EC5 EC9 EC11	WK7 WK8	C4	SDG 8 SDG 12

- 1 Principles and Importance of Service Design.
- 2 Cost Estimation and Economic Analysis in Product Development.
- 3 Sustainability and Life Cycle Assessment (LCA).
- 4 Basics of Project Management: Gantt Charts, Milestones, Risk Management.

READ Books / Reading Materials

- 1 Product Design and Development (8th Edition, 2026) Authors: Karl T. Ulrich, Steven D. Eppinger & Maria C. Yang.
- 2 The Principles of Product Development Flow (2nd Edition) Author: Donald G. Reinertsen.
- 3 Prototyping and Modelmaking for Product Design (2nd Edition) Author: Bjarki Hallgrímsson.

HUM-163 (000003-18/U) · CREDITS: 3

7.4 PRODUCT DESIGN AND DEVELOPMENT (LAB)

Course Syllabus & Outline

INFO Course Description

This lab course provides practical, hands-on experience in the product design and development process, emphasizing user-centered design and innovation. Students will apply tools to identify customer needs and translate them into well-defined product design specifications. Through structured methods, they will generate, evaluate, and refine product concepts based on user feedback and decision matrices. The course also covers rapid prototyping techniques, economic evaluations, and basic project planning.

CLO-1 Customer Needs and Specifications

CLO-1	PLOs	ECs	Wks	CL	SDGs
Apply tools and techniques to identify customer needs and translate them into product design specifications.	PL01 PL02	EC1 EC3	WK2 WK7	C3	SDG 4 SDG 9

- 1 Conducting User Interviews and Observations to Identify Needs.
- 2 Organizing Customer Needs using Affinity Diagrams.
- 3 Constructing a House of Quality (QFD) for Product Planning.
- 4 Writing Product Design Specifications (PDS) Based on VoC.

CLO-2 Concept Generation and Evaluation

CLO-2	PLOs	ECs	Wks	CL	SDGs
Generate, select, and evaluate product concepts through structured decision-making and user feedback methods.	PL02 PL04 PL05	EC3 EC4 EC5	WK2 WK3 WK4	C4	SDG 9 SDG 12

- 1 Brainstorming and Mind Mapping for Concept Generation.
- 2 Applying the SCAMPER Technique to Modify Existing Products.
- 3 Performing Concept Screening using a Pugh Matrix.
- 4 Conducting Concept Testing via User Surveys or Focus Groups.

CLO-3 Prototyping and DFM

CLO-3	PLOs	ECs	Wks	CL	SDGs
Develop prototypes using rapid prototyping tools and apply design for manufacturing and environmental principles.	PLO4 PLO5	EC4 EC6	WK3 WK4 WK5	C3	SDG 9 SDG 12 SDG 13

- 1 3D Modeling and Printing of Product Concepts.
- 2 Evaluating Design for Assembly using DFA Index.
- 3 Applying Life Cycle Thinking to Evaluate Material Choices.
- 4 Building Low-Fidelity Prototypes using Recyclable Material.

CLO-4 Economic Evaluation and Project Planning

CLO-4	PLOs	ECs	Wks	CL	SDGs
Demonstrate economic evaluation and project planning techniques in the context of product development and sustainability.	PLO6 PLO11	EC5 EC9 EC11	WK7 WK8	C5	SDG 8 SDG 12

- 1 Estimating Product Costs Using a Bill of Materials (BOM).
- 2 Preparing a Simple Business Model Canvas for a Product Idea.
- 3 Planning a Product Development Timeline using Gantt Charts.
- 4 Conducting a Basic Life Cycle Cost Analysis for Sustainability.

READ Books / Reading Materials

- 1 Product Design and Development Authors: Karl T. Ulrich, Steven D. Eppinger, Maria Yang (8th Edition, 2026).
- 2 Prototyping and Modelmaking for Product Design Author: Bjarki Hallgrímsson.
- 3 Design Thinking for Strategic Innovation Author: Idris Mootee.
- 4 Engineering Design: A Project-Based Introduction Author: Clive L. Dym, Patrick Little.
- 5 Sustainable Product Design and Development by Anoop Desai (Springer).

HUM-163 (000003-18/U) · CREDITS: 3

7.5 FINAL YEAR DESIGN PROJECT – I (LAB)

Course Syllabus & Outline

INFO Course Description

This course introduces the student to identifying, selecting, and proposing complex engineering problems relevant to societal needs. Students will formulate structured project proposals, develop problem-solving methodologies, and present their preliminary findings effectively.

CLO-1 Problem Identification

CLO-1	PLOs	ECs	Wks	CL	SDGs
Identify and select a complex engineering problem relevant to societal needs and professional objectives.	PL01	EC1	WK1 WK3	C2	SDG 3 SDG 8

- 1 Conduct a brainstorming session to generate a list of real-world problems.
- 2 Research existing engineering challenges aligning with societal needs.
- 3 Evaluate each potential problem for relevance, complexity, and feasibility.
- 4 Finalize a specific problem statement and outline its significance.

CLO-2 Project Proposal Formulation

CLO-2	PLOs	ECs	Wks	CL	SDGs
Formulate a structured project proposal including objectives, scope, and expected outcomes.	PL02	EC3	WK6 WK8	C3	SDG 8 SDG 11

- 1 Define the main objectives, scope, and boundaries of the project.
- 2 Identify potential constraints, risks, and assumptions affecting the project.
- 3 Develop a timeline with milestones to achieve each phase of the project.
- 4 Draft a detailed project proposal that includes background, objectives, and expected outcomes.

CLO-3 Methodology Development

CLO-3	PLOs	ECs	Wks	CL	SDGs
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Develop an appropriate methodology to solve the selected problem, considering available resources, tools, and techniques.	PL04	EC5	WK2 WK5	C4	SDG 8 SDG 9
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- 1 Identify and select appropriate engineering tools, software, and techniques.
- 2 Develop a step-by-step methodology, outlining procedures and testing.
- 3 Conduct feasibility analysis based on resources and limitations.
- 4 Prepare a draft of the chosen methodology, justifying tool selection.

CLO-4 Initial Reporting and Presentation

CLO-4	PLOs	ECs	WKs	CL	SDGs
Prepare a comprehensive report and presentation of the project's initial findings, demonstrating communication skills and preliminary results.	PL06	EC7	WK7 WK9	C5	SDG 8 SDG 11

- 1 Compile a structured report detailing the background, methodology, and initial results.
- 2 Create visual aids (graphs, charts, diagrams) to support data presentation.
- 3 Develop a professional presentation summarizing objectives, methods, and findings.
- 4 Conduct a mock presentation to gather peer feedback.

READ Books / Reading Materials

- 1 "A Student's Guide to Academic and Professional Writing in Education" by Katie O. Arostegui
- 2 "Project Management for Engineering, Business, and Technology" by John M. Nicholas and Herman Steyn
- 3 "The Craft of Research" by Wayne C. Booth, Gregory G. Colomb, and Joseph M. Williams
- 4 "Research Design: Qualitative, Quantitative, and Mixed Methods Approaches" by Creswell

MECH- 421 (668034-1/U) · CREDITS: 2

7.6 CLIMATE CHANGE AND RISK MANAGEMENT (LEC)

Course Syllabus & Outline

INFO Course Description

This course introduces students to scientific foundations, impacts, and strategic responses to climate change, with a strong emphasis on risk management. It explores the causes and consequences of climate change at both global and local levels, enabling students to assess vulnerabilities and risks affecting ecosystems and infrastructure. Students will study various mitigation and adaptation strategies, tools for managing climate risks, and policy responses.

CLO-1 Scientific Basis of Climate Change

CLO-1	PLOs	ECs	Wks	CL	SDGs
Explain the scientific basis, causes, and consequences of climate change at local and global scales.	PL01 PL07	EC1 EC6	WK1 WK7	C2	SDG 4 SDG 13

- 1 Introduction to Climate Science and the Earth's Energy Balance.
- 2 Greenhouse Effect, GHGs, and Anthropogenic Contributions.
- 3 Climate Change Evidence: IPCC Reports and Global Trends.
- 4 Regional and Local Climate Change Impacts (Case Studies).

CLO-2 Vulnerability and Risk Assessment

CLO-2	PLOs	ECs	Wks	CL	SDGs
Analyze climate-related vulnerabilities, risks, and their impacts on natural and human systems.	PL01 PL02 PL06	EC3 EC6 EC10	WK1 WK7 WK8	C4	SDG 11 SDG 13

- 1 Vulnerability and Exposure: Concepts and Frameworks.
- 2 Climate Risk Assessment: Natural Systems (Water, Agriculture, Biodiversity).
- 3 Climate Risk Assessment: Human Systems (Health, Urban Infrastructure).
- 4 Tools for Vulnerability Mapping and Risk Indicators.

CLO-3 Mitigation and Adaptation Strategies

CLO-3	PLOs	ECs	Wks	CL	SDGs
Evaluate climate change mitigation and adaptation strategies, including sustainable development approaches.	PL01 PL05 PL07	EC5 EC6	WK5 WK7	C5	SDG 7 SDG 12 SDG 13

- 1 Mitigation Strategies: Emission Reduction, Renewable Energy.
- 2 Adaptation Strategies: Resilient Infrastructure and Community Planning.
- 3 Climate Policy: Paris Agreement, Carbon Pricing, Climate Finance.
- 4 Role of Sustainable Development in Climate Action.

CLO-4 Risk Management Frameworks

CLO-4	PLOs	ECs	Wks	CL	SDGs
Apply risk management frameworks and tools to assess and respond to climate-related hazards.	PL02 PL06 PL011	EC5 EC9 EC11	WK4 WK7 WK8	C3	SDG 3 SDG 9 SDG 13

- 1 Introduction to Risk Management: Concepts and Life Cycle.
- 2 Frameworks for Climate Risk Management (ISO 31000, UNDRR).
- 3 Tools for Risk Mitigation: Early Warning, Contingency Planning.
- 4 Case Studies in Climate Risk Management and Course Review.

READ Books / Reading Materials

- 1 Risk and Resilience in the Era of Climate Change (2nd Ed., 2024) Author: Vinod Thomas.
- 2 Climate Change and Risk Management: Strategies, Analysis, and Adaptation (2024) Editors: Antonio Di Pietro, José Martí & Vinay Kumar.
- 3 Disaster Risk and Management Under Climate Change (2024) Authors: Anil K. Gupta, Akhilesh Gupta & Pritha Acharya.
- 4 Handbook of Climate Change Impacts on River Basin Management (2024) Editors: Saeid Eslamian et al.

MECH- 304 (666802-1/U) · CREDITS: 2

7.7 APPLIED STATISTICS (LEC)

Course Syllabus & Outline

INFO Course Description

This course covers fundamental concepts and techniques in statistics and data analysis, enabling students to collect, analyze, interpret, and present data effectively.

CLO-1 Data Presentation and Summarization

CLO-1	POs	ECs	Wks	CL	SDGs
Present and Summarize Data Using Measures of Central Tendency and Dispersion.	PO1 PO5	EC1 EC10	WK1 WK2	C2 C3	SDG 4

- 1 Techniques for effective data presentation.
- 2 Calculating and interpreting measures of central tendency (mean, median, mode).
- 3 Calculating and interpreting measures of dispersion (range, variance, standard deviation).
- 4 Applications of data summarization in real-world contexts.

CLO-2 Regression and Correlation Analysis

CLO-2	POs	ECs	Wks	CL	SDGs
Analyze Relationships Between Variables Using Regression, Correlation, and Curve Fitting.	PO2 PO3	EC3 EC4	WK3 WK4	C3 C4	SDG 9

- 1 Basics of linear regression and interpretation of regression models.
- 2 Correlation analysis and correlation coefficients.
- 3 Curve fitting techniques and their applications.
- 4 Goodness of fit tests and error analysis.

CLO-3 Probability Distributions

CLO-3	POs	ECs	Wks	CL	SDGs
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Apply Probability Distributions to Analyze Data Patterns.	PL01 PL03	EC1 EC5	WK5 WK6	C4 C5	SDG 9
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| <ol style="list-style-type: none"> 1 Fundamentals of probability and probability laws. 3 Applications of probability distributions in data analysis. | <ol style="list-style-type: none"> 2 Characteristics of binomial, Poisson, and normal distributions. 4 Sampling distributions and estimation techniques. |
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CLO-4 Hypothesis Testing and SPC

CLO-4	PLOs	ECs	Wks	CL	SDGs
Conduct Hypothesis Testing and Use Statistical Process Control (SPC) for Quality Monitoring.	PL04 PL06	EC8 EC9	WK7 WK8	C5 C6	SDG 9 SDG 12

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| <ol style="list-style-type: none"> 1 Hypothesis testing concepts and applications. 3 Control charts for attributes (P-chart, NP-chart, etc.). | <ol style="list-style-type: none"> 2 Setting up and interpreting control charts for mean and range. 4 Implementing SPC for quality control and process improvement. |
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READ Books / Reading Materials

- | | |
|--|---|
| <ol style="list-style-type: none"> 1 Douglas C. Montgomery (2010), Applied Statistics and Probability for Engineers. 3 McCuen, Statistical methods for engineers, Richard Prentice Hall. 5 Anthony Hayter (2012), Probability Statistics for Engineers and Scientists. | <ol style="list-style-type: none"> 2 Applied Statistics in Business and Economics 5th Edition (2016). 4 Jax Devore (2011), Probability and Statistics for Engineering and the Sciences. |
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UNDERGRADUATE PROGRAM

8th Semester

Course Syllabi & Outlines

SEM 8 Eighth Semester

8.1 OCCUPATIONAL HEALTH & SAFETY (LEC)

8.2 REVERSE ENGINEERING & INSPECTION (LEC)

8.3 REVERSE ENGINEERING & INSPECTION (LAB)

8.4 MECHATRONICS & ROBOTICS ENGINEERING (LEC)

8.5 MECHATRONICS & ROBOTICS ENGINEERING (LAB)

8.6 AERODYNAMICS (LEC)

8.7 ENTREPRENEURSHIP (LEC)

8.8 FINAL YEAR DESIGN PROJECT-II (LAB)

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8.1 OCCUPATIONAL HEALTH & SAFETY (LEC)

Course Syllabus & Outline

INFO Course Description

This course introduces the student to the study of workplace occupational health and safety. The student will learn safe work practices in offices, industry and construction as well as how to identify and prevent or correct problems associated with occupational safety and health in these locations as well as in the home.

CLO-1 Foundations of Health and Safety

CLO-1	PLOs	ECs	Wks	CL	SDGs
Understand the Foundations and Scope of Health and Safety in the Workplace.	PL01	EC1	WK1 WK3	C2	SDG 3 SDG 8

- 1 Define the nature and scope of health and safety, including its importance and benefits.
- 2 Identify reasons, benefits, and barriers to good health and safety practices.
- 3 Discuss the legal framework and Occupational Health and Safety (OHS) Management Systems.
- 4 Explain the impact of fostering a positive safety culture in academic and professional environments.

CLO-2 Workplace Hazards Assessment

CLO-2	PLOs	ECs	Wks	CL	SDGs
Develop Skills in Recognizing, Assessing, and Communicating Workplace Hazards.	PL02	EC3	WK6 WK8	C3	SDG 8 SDG 11

- 1 Describe the RAMP principles (Recognize, Assess, Minimize, Prepare) for safety.
- 2 Identify types of workplace hazards, including physical, chemical, and environmental hazards.
- 3 Explain the significance of safety signs, symbols, and labels for hazard communication.
- 4 Utilize Material Safety Data Sheets (MSDS) and Global Harmonized Systems (GHS) to find and interpret hazard information.

CLO-3 Risk Control Measures

CLO-3	PLOs	ECs	Wks	CL	SDGs
Assess Risks and Implement Effective Risk Control Measures.	PL04	EC5	WK2 WK5	C4	SDG 8 SDG 9

- 1 Define risk and describe concepts and terminology associated with risk assessment.
- 2 Conduct risk assessment procedures and utilize risk metrics for hazard evaluation.
- 3 Apply the principles of risk prevention and the hierarchy of controls to minimize hazards.
- 4 Develop strategies for selecting and implementing appropriate risk control measures.

CLO-4 Emergency Responses and Investigation

CLO-4	PLOs	ECs	Wks	CL	SDGs
Prepare for Emergency Responses and Investigate Workplace Incidents.	PL06	EC7	WK7 WK9	C5	SDG 8 SDG 11

- 1 Outline emergency response procedures for fires, chemical spills, and first aid.
- 2 Describe the importance of safety drills, firefighting, and emergency evacuations.
- 3 Identify stress factors in the workplace and strategies for managing stress to improve safety.
- 4 Explain incident investigation techniques, including recording, reporting, and auditing health and safety measures.

READ Books / Reading Materials

- 1 Jeremy Stranks, The A-Z of Health and Safety.
- 2 Jeremy Stranks, The Manager's Guide to Health & Safety at Work.
- 3 Ogletree, Deakins, Nash, Smoak and Stewarts, Occupational Safety and Health Law Handbook.

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8.2 REVERSE ENGINEERING AND INSPECTION TECHNIQUES (LEC)**Course Syllabus & Outline****INFO Course Description**

This course covers the fundamentals of reverse engineering, including its significance, industrial applications, and legal/ethical considerations. Students learn to apply data acquisition methods using 3D scanning, coordinate measuring machines (CMM), and CAD modeling. Additionally, they analyze inspection techniques such as geometric dimensioning and tolerancing (GD&T), CMM, and optical/non-contact methods.

CLO-1 Fundamentals of Reverse Engineering

CLO-1	PLOs	ECs	Wks	CL	SDGs
Understand the fundamentals of reverse engineering, including its significance, applications in industrial engineering, and legal and ethical considerations.	PL01 PL07	EC1 EC6 EC8	WK1 WK7 WK8	C2 C3	SDG 9 SDG 12

- 1 Definition and significance of reverse engineering.
- 2 Applications of reverse engineering in industrial engineering.
- 3 Legal and ethical considerations in reverse engineering.
- 4 Case studies on reverse engineering in industries like automotive and aerospace.

CLO-2 Data Acquisition Methods

CLO-2	PLOs	ECs	Wks	CL	SDGs
Apply data acquisition methods and techniques for reverse engineering using tools such as 3D scanning, CMM, and CAD modeling.	PL02 PL05 PL09	EC3 EC4 EC10	WK3 WK5 WK6	C3 C4	SDG 9

- 1 Data acquisition methods (3D scanning, coordinate measuring).
- 2 Point cloud data processing techniques.
- 3 CAD modeling from scan data.
- 4 Reverse engineering software tools and hands-on experience.

CLO-3 Inspection Techniques and GD&T

CLO-3	PLOs	ECs	WKs	CL	SDGs
Analyze inspection techniques such as geometric dimensioning and tolerancing (GD&T), coordinate measuring machines, and optical methods.	PL02 PL04 PL07	EC3 EC5 EC6	WK3 WK5 WK6	C4 C5	SDG 9 SDG 12

- 1 Geometric dimensioning and tolerancing (GD&T) fundamentals.
- 2 Inspection using coordinate measuring machines (CMM).
- 3 Optical and non-contact inspection techniques.
- 4 Surface roughness and material composition analysis.

CLO-4 Material Analysis and NDT

CLO-4	PLOs	ECs	WKs	CL	SDGs
Evaluate surface and material analysis methods, including non-destructive testing (NDT) and metrology standards, to ensure quality.	PL03 PL04 PL06	EC4 EC5 EC12	WK4 WK6 WK7	C5 C6	SDG 9 SDG 12

- 1 Surface roughness measurement methods.
- 2 Non-destructive testing (NDT) techniques.
- 3 Metrology and measurement standards (calibration, traceability).
- 4 Applications of reverse engineering under Industry 4.0 perspectives.

READ Books / Reading Materials

- 1 Messler, Robert W. Reverse Engineering: Mechanisms, Structures, Systems & Materials. McGraw Hill Education.
- 2 Wang, Wego. Reverse Engineering: Technology of Reinvention. CRC Press.
- 3 Raheja, Amar. Reverse Engineering: An Industrial Perspective. Springer Nature.

HUM-163 (000003-18/U) · CREDITS: 1

8.3 REVERSE ENGINEERING AND INSPECTION TECHNIQUES (LAB)**Course Syllabus & Outline****INFO Course Description**

This outline ensures that students gain comprehensive hands-on experience with a range of reverse engineering and inspection techniques essential for mechanical engineering applications.

CLO-1 Measurement and Inspection Tools

CLO-1	PLOs	ECs	Wks	CL	SDGs
Identify and apply fundamental measurement and inspection techniques using basic and advanced tools to accurately capture dimensions.	PL01 PL02	EC1 EC5	WK1 WK2 WK3 WK4	C2 C3	SDG 4

- 1 Introduction to Reverse Engineering and Laboratory Safety.
- 2 Measurement Techniques Using Basic Tools (calipers, micrometers, depth gauges).
- 3 Introduction to Coordinate Measuring Machines (CMM).
- 4 3D Scanning Techniques (handheld and stationary 3D scanners).

CLO-2 3D Scan Data and CAD Modeling

CLO-2	PLOs	ECs	Wks	CL	SDGs
Demonstrate the ability to process 3D scan data and utilize CAD modeling to create accurate 3D representations applying GD&T.	PL01 PL03 PL05	EC2 EC4 EC9	WK5 WK6 WK7 WK8	C3 C4	SDG 4 SDG 9

- 1 Processing 3D Scan Data (importing, cleaning, mesh generation).
- 2 CAD Modeling from 3D Scanned Data (SolidWorks, Inventor).
- 3 Dimensional and Geometric Tolerancing (GD&T) principles.
- 4 Surface Inspection Techniques (profilometers, visual tools).

CLO-3 NDT and Component Assessment

CLO-3	PLOs	ECs	Wks	CL	SDGs
Analyze and assess component properties through surface inspection, material identification, and NDT methods.	PL03 PL05 PL09	EC5 EC6 EC11	WK4 WK6 WK8 WK9	C4 C5	SDG 9 SDG 12

- 1 Material Identification Techniques (spectrometers, hardness).
- 2 Case Study: Reverse Engineering a Simple Component.
- 3 Non-Destructive Testing (NDT) Techniques (ultrasonic, radiographic).
- 4 Quality Control and Inspection Documentation.

CLO-4 Comprehensive Reverse Engineering Project

CLO-4	PLOs	ECs	Wks	CL	SDGs
Conduct a comprehensive reverse engineering project by integrating measurement, modeling, inspection, and reporting techniques.	PL04 PL06 PL09	EC9 EC10 EC13	WK4 WK6 WK8 WK9	C5 C6	SDG 4 SDG 9

- 1 Final Project: Selection and Reverse Engineering of a Complex Part.
- 2 Presentation and Review of Final Project.
- 3 Lab Wrap-Up, review of key laboratory concepts, and Final Assessment.

READ Books / Reading Materials

- 1 "Reverse Engineering: An Industrial Perspective" by Vinesh Raja and Kiran J. Fernandes.
- 2 "Introduction to Reverse Engineering" by Kathryn A. Ingle.
- 3 "Handbook of Dimensional Measurement" by Mark Curtis and John A. Bosch.
- 4 "Fundamentals of Dimensional Metrology" by Connie L. Dotson.
- 5 "Coordinate Metrology: Accuracy of Systems and Measurements" by Jerzy A. Sładek.
- 6 "3D Scanning for Reverse Engineering" by Bernhard Kainz and Xiao-Yong Zhang.
- 7 "Engineering Metrology and Measurements" by R.K. Jain and R.K. Verma.
- 8 "Geometric Dimensioning and Tolerancing for Mechanical Design" by Gene Corgono.
- 9 "Rapid Prototyping and Engineering Applications" by Frank W. Liou.

MECH- 461 (668032-1/U) · CREDITS: 2

8.4 MECHATRONICS & ROBOTICS ENGINEERING (LEC)

Course Syllabus & Outline

INFO Course Description

Introduction to Mechatronics, components of Mechatronics systems, data acquisitions systems and software interfaces, sensors, actuators, and current trends in robotics. Types of robots, joints, degrees of freedom, Denavit-Hartenberg coordinate transformations, Forward and Inverse kinematics, Jacobian, Velocity and Force Analysis, Dynamics, Path planning, and Linear control of manipulators.

CLO-1 Mechatronic Systems and Components

CLO-1	POs	ECs	Wks	CL	SDGs
Describe the fundamental components of mechatronic systems, including sensors, actuators, data acquisition systems, and software interfaces.	PO1 PO2	EC1 EC3	WK1 WK2	C2	SDG 4 SDG 9

- 1 Introduction to Mechatronics: Definitions and Applications.
- 2 Components of Mechatronic Systems: Overview of Sensors and Actuators.
- 3 Data Acquisition Systems and Signal Conditioning.
- 4 Software Interfaces for Mechatronic Systems (e.g., LabVIEW, MATLAB).

CLO-2 Robot Classification and Transformations

CLO-2	POs	ECs	Wks	CL	SDGs
Classify different types of robots, their joints, degrees of freedom, and apply coordinate transformations using the Denavit-Hartenberg method.	PO1 PO2	EC1 EC3	WK1 WK2 WK4	C3	SDG 4 SDG 9

- 1 Types of Robots and Classification Based on Structure and Use.
- 2 Types of Joints, Degrees of Freedom, and Kinematic Constraints.
- 3 Denavit-Hartenberg (D-H) Parameters and Coordinate Transformations.
- 4 Coordinate Frame Transformation: From Local to Global Systems.

CLO-3 Kinematics and Jacobian Analysis

CLO-3	POs	ECs	Wks	CL	SDGs
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Analyze forward and inverse kinematics, Jacobian matrices, velocity, and force relationships in robotic manipulators.	PL01	EC1	WK1	C4	SDG 4
	PL02	EC3	WK2		SDG 9
	PL03	EC5	WK4		

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| 1 Forward Kinematics of Robotic Manipulators. | 2 Inverse Kinematics and Solvability Conditions. |
| 3 Jacobian Matrix: Velocity Mapping and Singularities. | 4 Force and Moment Analysis Using Jacobian Transpose. |

CLO-4 Dynamics, Trajectory, and Control

CLO-4	PLOs	ECs	WKs	CL	SDGs
Evaluate dynamic behavior, trajectory planning, and implement linear control strategies for robotic systems.	PL01	EC1	WK1	C5	SDG 4
	PL02	EC3	WK2		SDG 9
	PL03	EC4	WK4		
	PL04	EC5	WK5		

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| 1 Dynamics of Robotic Manipulators (Lagrangian and Newton-Euler Methods). | 2 Path Planning: Cartesian and Joint Space Techniques. |
| 3 Trajectory Generation and Time Scaling. | 4 Linear Control of Manipulators: PD, PID Controllers. |

READ Books / Reading Materials

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|--|---|
| 1 Mechatronics: Concepts, Tools, Applications, and New Trends (2025). | 2 Robotics and Mechatronics: Integrating Electronics and Artificial Intelligence (Dec 2024). |
| 3 Mechatronics: Fundamentals and Applications (2025). | 4 Modern Robotics: Mechanics, Planning, and Control (Park & Lynch). |
| 5 Introduction to Mechatronics and Measurement Systems (Bolton). | |

MECH- 461 (668032-1/U) · CREDITS: 1

8.5 MECHATRONICS & ROBOTICS ENGINEERING (LAB)

Course Syllabus & Outline

INFO Course Description

This laboratory course provides practical experience in the fundamental principles of mechatronics and robotics through hands-on experiments and simulations. Students explore the operation and integration of sensors, actuators, and DAQ systems. The lab emphasizes coordinate transformations, forward/inverse kinematics, trajectory planning, and basic control strategies.

CLO-1 Sensors, Actuators, and DAQ

CLO-1	PLOs	ECs	Wks	CL	SDGs
Identify and operate sensors, actuators, and data acquisition hardware used in mechatronic systems.	PL01 PL05	EC1 EC3	WK2 WK4	C3	SDG 4 SDG 9

- 1 Calibration and Testing of Temperature and Proximity Sensors.
- 2 Interfacing Analog and Digital Sensors with DAQ Systems.
- 3 Controlling a DC Motor and a Servo Motor using Microcontroller.
- 4 Data Acquisition and Logging using NI LabVIEW or Arduino.

CLO-2 Robot Configurations and Transformations

CLO-2	PLOs	ECs	Wks	CL	SDGs
Implement basic robot configurations and simulate joint types, degrees of freedom, and coordinate transformations.	PL01 PL02 PL05	EC1 EC3 EC4	WK2 WK3 WK4	C3	SDG 4 SDG 9

- 1 Building a 2-DOF Robotic Arm with Servo Joints.
- 2 Identifying and Simulating Robot Joint Types in MATLAB/Simulink.
- 3 Demonstration of Degree of Freedom (DoF) using a Physical Robot Model.
- 4 Coordinate Transformation Between Base and Tool Frames.

CLO-3 Forward and Inverse Kinematics

CLO-3	PLOs	ECs	Wks	CL	SDGs
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Perform forward and inverse kinematics analysis using simulation tools and physical robot arms.	PL01	EC1	WK2	C4	SDG 4
	PL02	EC3	WK4		SDG 9
	PL03	EC5			

- 1 Forward Kinematics of a 2-Link Planar Robot using Denavit–Hartenberg Parameters.
- 2 Inverse Kinematics using Numerical Methods in MATLAB.
- 3 Validation of Kinematic Results on a Robotic Arm (e.g., Dobot, Lynxmotion).
- 4 Workspace Analysis and Reachability of a Manipulator.

CLO-4 Trajectory Planning and Control

CLO-4	PLOs	ECs	WKs	CL	SDGs
Design and test simple trajectory planning and control algorithms for robotic manipulators.	PL02	EC1	WK2	C5	SDG 4
	PL03	EC3	WK4		SDG 9
	PL04	EC4	WK5		
	PL05	EC5			

- 1 Trajectory Planning in Joint Space using Cubic Polynomial Functions.
- 2 Implementation of PD Controller for a Robotic Arm.
- 3 End-Effector Path Tracking using MATLAB/Simulink.
- 4 Real-Time Control of a 2-Link Manipulator for Predefined Path.

READ Books / Reading Materials

- 1 Mechatronics: Principles and Applications (Lab Companion) by Godfrey C. Onwubolu.
- 2 Mechatronics Laboratory Manual by Dr. P. K. Sinha (NIT).
- 3 NI LabVIEW for Engineers by Ron Travis.
- 4 Arduino Cookbook (3rd Ed.) by Michael Margolis & Brian Jepson.

MECH- 461 (668032-1/U) · CREDITS: 3

8.6 AERODYNAMICS (LEC)

Course Syllabus & Outline

INFO Course Description

This course introduces the fundamental principles of aerodynamics and their applications in mechanical engineering systems. Students will study fluid flow over bodies, airfoil characteristics, lift and drag, boundary layers, compressible flow, and basic aerodynamic performance. The course emphasizes analytical understanding and practical application of aerodynamic concepts in engineering design.

CLO-1 Inviscid and Irrotational Flow

CLO-1	PLOs	ECs	Wks	CL	SDGs
Apply the principles of continuity, momentum, and energy equations to analyze inviscid, incompressible, and irrotational fluid flows.	PLO1	EC1 EC3	WK1 WK3	C3	SDG 4 SDG 9

- 1 Review of continuity, momentum, and energy equations.
- 2 Stream function and velocity potential.
- 3 Vorticity and circulation concepts.
- 4 Governing equations for irrotational and incompressible flow.

CLO-2 Airfoils and Wings

CLO-2	PLOs	ECs	Wks	CL	SDGs
Analyze incompressible and compressible aerodynamic flows over airfoils and wings, applying the Kutta–Joukowski theorem and thin airfoil theory.	PLO1 PLO2	EC1 EC3 EC5	WK1 WK3	C4	SDG 4 SDG 9

- 1 Simple plane potential flows and application to airfoils.
- 2 Kutta–Joukowski theorem and generation of lift.
- 3 Airfoil nomenclature and aerodynamic characteristics.
- 4 Classical thin airfoil theory (symmetric and cambered airfoils).

CLO-3 Compressible Flow and Shock Waves

CLO-3	PLOs	ECs	Wks	CL	SDGs
Evaluate compressible flow behavior in ducts, nozzles, and wind tunnels, including shock wave phenomena and supersonic flow.	PL01 PL02	EC1 EC3 EC5	WK1 WK3	C4	SDG 4 SDG 7 SDG 9

- 1 Isentropic compressible flow and area–velocity relations.
- 2 Quasi-one-dimensional flow through nozzles, diffusers, and wind tunnels.
- 3 Normal shock wave equations and detached shock phenomena.
- 4 Supersonic flow over wedges, cones, and blunt bodies.

CLO-4 Boundary Layer Theory

CLO-4	PLOs	ECs	Wks	CL	SDGs
Examine boundary layer theory for incompressible laminar and turbulent flows, including flow separation and drag estimation.	PL01 PL02	EC1 EC3 EC5	WK1 WK3	C4	SDG 4 SDG 9 SDG 13

- 1 Boundary layer equations for incompressible flows.
- 2 2D incompressible laminar and turbulent boundary layers.
- 3 Boundary layer separation and drag calculation methods.
- 4 Interactive boundary layer theory and applications.

READ Books / Reading Materials

- 1 Fundamentals of Fluid Mechanics (7th Edition) by John J. Bertin – Published 2025.
- 2 Boundary-Layer Theory by Hermann Schlichting and Klaus Gersten.
- 3 Viscous Fluid Flow by F. M. White.
- 4 Modern Compressible Flow: With Historical Perspective by J. D. Anderson.
- 5 Elements of Gasdynamics by Liepmann & Roshko.

HUM-163 (000003-18/U) · CREDITS: 3

8.7 ENTREPRENEURSHIP (LEC)

Course Syllabus & Outline

INFO Course Description

This course introduces students to the fundamental concepts of entrepreneurship, innovation, and business development in an engineering context. Students will learn how to identify market opportunities, develop business ideas, prepare business plans, and understand financial and managerial aspects of startups. The course emphasizes creativity, problem-solving, leadership, and entrepreneurial thinking for mechanical engineers in industrial environments.

CLO-1 Fundamentals of Entrepreneurship

CLO-1	PLOs	ECs	Wks	CL	SDGs
Understand the Fundamentals and Role of Entrepreneurship.	PLO-01	EC1	WK1	C2	SDG 8 SDG 4

- 1 Define entrepreneurship and explain its significance and concept.
- 2 Discuss reasons and motivations for becoming an entrepreneur.
- 3 Explain the entrepreneurial process and stages involved.
- 4 Describe the role of entrepreneurship in driving economic development.

CLO-2 Key Entrepreneurial Skills

CLO-2	PLOs	ECs	Wks	CL	SDGs
Develop Key Entrepreneurial Skills for Success.	PLO-02	EC3	WK8 WK9	C3	SDG 4 SDG 8

- 1 Identify characteristics and qualities of successful entrepreneurs.
- 2 Explore essential entrepreneurial skills such as creative thinking, innovation, and risk-taking.
- 3 Apply critical thinking to entrepreneurial challenges and opportunities.
- 4 Evaluate the impact of adaptability and resilience in entrepreneurship.

CLO-3 Business Opportunities and Strategy

CLO-3	PLOs	ECs	Wks	CL	SDGs
Identify and Evaluate Business Opportunities for Ventures.	PLO-03	EC4	WK2 WK5	C4	SDG 9 SDG 8

- 1 Describe techniques for identifying and evaluating business opportunities.
- 2 Use various methods for generating ideas for entrepreneurial ventures.
- 3 Analyze the target market, including segmentation and customer needs.
- 4 Develop a comprehensive marketing strategy using the Four P's of Marketing.

CLO-4 Financial Literacy and Regulations

CLO-4	PLOs	ECs	Wks	CL	SDGs
Apply Financial Literacy and Regulatory Knowledge to Establish Startups.	PLO-06	EC7	WK7 WK9	C5	SDG 8 SDG 11

- 1 Understand basic financial concepts such as income, savings, investments, assets, and liabilities.
- 2 Outline different sources of funding for startups, including angel, debt, and equity financing.
- 3 Explain the regulatory requirements for establishing enterprises in Pakistan.
- 4 Discuss taxation and financial reporting obligations for businesses in Pakistan.

READ Books / Reading Materials

- 1 Entrepreneurship: Successfully Launching New Ventures by Bruce R. Barringer and R. Duane Ireland.
- 2 Entrepreneurship: Theory, Process, and Practice by Donald F. Kuratko.
- 3 New Venture Creation: Entrepreneurship for the 21st Century by Jeffry A. Timmons, Stephen Spinelli Jr.
- 4 Entrepreneurship: A Real-World Approach by Rhonda Abrams.
- 5 The Lean Startup by Eric Ries.
- 6 Effectual Entrepreneurship by Stuart Read, Saras Sarasvathy, Nick Dew, et al.

HUM-163 (000003-18/U) · CREDITS: 3

8.8 FINAL YEAR DESIGN PROJECT-II (LAB)

Course Syllabus & Outline

INFO Course Description

This course represents the culmination of undergraduate studies where students execute and finalize their engineering projects. Students will focus on implementing their proposed solutions, conducting rigorous testing and optimization, applying effective project management to adhere to resource constraints, and communicating their technical outcomes and societal impacts via a comprehensive final report and presentation.

CLO-1 Solution Implementation

CLO-1	PLOs	ECs	Wks	CL	SDGs
Implement the proposed solution by applying engineering knowledge, technical skills, and problem-solving strategies.	PLO-01	EC1	WK1 WK3	C2	SDG 3 SDG 8

- 1 Apply theoretical concepts and technical skills to build or simulate the proposed solution.
- 2 Conduct hands-on assembly, programming, or modeling tasks as required by the project scope.
- 3 Troubleshoot challenges during implementation, adjusting the approach as needed.
- 4 Document the implementation process, detailing steps, issues encountered, and solutions.

CLO-2 Testing and Optimization

CLO-2	PLOs	ECs	Wks	CL	SDGs
Analyze and refine the project's outcomes based on testing, optimization, and stakeholder feedback.	PLO-02	EC3	WK6 WK8	C3	SDG 8 SDG 11

- 1 Develop and conduct tests to assess the functionality, efficiency, and accuracy of the solution.
- 2 Gather data from tests and compare with expected results, identifying areas for improvement.

- 3 Engage with stakeholders or peers for feedback on project performance and potential refinements.

- 4 Make necessary adjustments to optimize performance and re-test to confirm improvements.

CLO-3 Project Management Execution

CLO-3	PLOs	ECs	Wks	CL	SDGs
Demonstrate project management skills by adhering to timelines, resource allocation, and teamwork for successful execution.	PLO-04	EC5	WK2 WK5	C4	SDG 8 SDG 9

- 1 Create a project timeline and allocate tasks to team members, ensuring deadlines are met.
- 3 Hold regular team meetings to review progress, address challenges, and foster collaboration.

- 2 Monitor the use of resources (e.g., materials, budget, and time), making adjustments as needed.
- 4 Document project management activities, including task allocation, timeline adherence, and resource tracking.

CLO-4 Final Reporting and Presentation

CLO-4	PLOs	ECs	Wks	CL	SDGs
Deliver a final report and presentation that effectively communicate the project outcomes, technical details, and societal implications.	PLO-06	EC7	WK7 WK9	C5	SDG 8 SDG 11

- 1 Prepare a structured report that includes project background, methods, final results, and societal impact.
- 3 Develop a presentation that summarizes key project aspects, emphasizing societal relevance.

- 2 Create visual aids (graphs, schematics, images) to clearly communicate technical data and outcomes.
- 4 Practice and deliver the presentation to an audience, responding to questions and gathering feedback.

READ Books / Reading Materials

- 1 "A Student's Guide to Academic and Professional Writing in Education" by Katie O. Arostegui.
- 3 "Engineering Your Future: An Australasian Guide" by David Dowling, Lesley M. Sepelt, and others.
- 5 "Engineering Project Management for the Global High Technology Industry" by Sammy G. Shina.

- 2 "Project Management for Engineering, Business, and Technology" by John M. Nicholas and Herman Steyn.
- 4 "Presentation Zen: Simple Ideas on Presentation Design and Delivery" by Garr Reynolds.

DEPARTMENTAL STANDARDS

APPENDIX A: MASTER ASSESSMENT RUBRICS

Standardized Outcome-Based Evaluation Tools

INFO Appendix Description

To ensure standardization across all courses within the Mechanical Engineering program, the Board of Studies has established the following Master Rubrics. Instructors must utilize these rubrics for evaluating Complex Engineering Problems (CEPs), Open-Ended Labs (OELs), Final Year Design Projects (FYDPs), and formal presentations. Course profiles reference these rubrics rather than duplicating them.

A.1 Master Complex Engineering Problem (CEP) Rubric

Application: Used in cognitive lecture courses (e.g., Solid Mechanics II, Thermodynamics) where students are tasked with solving open-ended, complex theoretical problems.

Attribute	Exemplary (4)	Competent (3)	Developing (2)	Unacceptable (1)	Wt
Depth of Knowledge (WP1)	Applies deep, specialized knowledge to justify every step of the solution.	Applies sufficient advanced knowledge, but lacks depth in some theoretical justifications.	Applies basic principles only, missing critical advanced engineering concepts.	Fails to apply relevant engineering knowledge to the problem.	25%
Problem Analysis (WP2)	Identifies and deeply analyzes all constraints, boundaries, and conflicting parameters.	Identifies most constraints; analysis is adequate but lacks depth on conflicting factors.	Identifies only obvious constraints; superficial analysis of the core complexities.	Fails to identify core problem parameters and underlying conflicts.	30%
Solution Design (WP3)	Develops an innovative, well-justified solution for a completely	Develops a functional, correct solution, using standard rather	Provides a generic solution that barely addresses the spe-	Solution is fundamentally flawed, unwork-	25%

	unfamiliar scenario.	than innovative approaches.	cific, unfamiliar complexities.	able, or entirely copied.	
Modern Tool Usage (WP6)	Selects and expertly uses appropriate tools (e.g., MATLAB, ANSYS) with full validation.	Uses tools correctly but struggles with validation or advanced simulation features.	Misapplies tools or relies entirely on basic approximations.	Fails to use necessary modern engineering tools for the complex problem.	20%

A.2 Master Open-Ended Lab (OEL) Rubric

Application: Used for psychomotor and design evaluations in laboratory courses (e.g., Mechanical Workshop, Manufacturing Processes Lab) where students design their own experiments or prototypes.

Attribute	Exemplary (4)	Competent (3)	Developing (2)	Unacceptable (1)	Wt
Experimental Design (PLO 4)	Formulates a flawless experimental methodology with clear variables and controls.	Designs a workable experiment, though minor variables or controls are loosely defined.	Experimental design is flawed, requiring significant instructor intervention to work.	Unable to formulate a viable experimental procedure.	30%
Execution & Tool Use (PLO 5)	Operates lab equipment flawlessly; gathers highly accurate and precise data independently.	Operates equipment safely and gathers usable data with minimal guidance.	Struggles with equipment operation; data gathered is inconsistent or contains significant errors.	Unsafe or completely incorrect operation of laboratory equipment.	30%
Data Analysis (PLO 4)	Thoroughly analyzes data, identifies error sources, and draws highly logical conclusions.	Analyzes data correctly and draws valid conclusions, but error analysis is brief.	Basic data presentation without deep analysis or meaningful conclusions.	Data analysis is missing, falsified, or entirely incorrect.	25%
Safety & Ethics (PLO 8)	Strictly adheres to all safety protocols; maintains an immaculate workspace.	Follows major safety rules; workspace is generally clean and organized.	Requires reminders regarding safety protocols (e.g., PPE); workspace is disorganized.	Blatant disregard for safety protocols or ethical data collection.	15%

A.3 Master Final Year Design Project (FYDP) Rubric

Application: Utilized in Semester 7 & 8 (FYDP I & II) to evaluate capstone project outcomes, aligning with complex engineering design, project management, and societal impact.

Attribute	Exemplary (4)	Competent (3)	Developing (2)	Unacceptable (1)	Wt
Problem Formulation (PLO 2)	Defines a highly complex, real-world engineering problem with exhaustive literature review.	Defines a standard engineering problem with a solid, relevant literature review.	Problem is overly simple or literature review is superficial.	Problem formulation is unclear or lacks technical relevance.	20%
Design & Optimization (PLO 3)	Synthesizes an optimized, highly effective design considering all societal/environmental constraints.	Produces a functional design that meets primary objectives with standard constraints considered.	Design is functional but ignores key optimization parameters or constraints.	Design fails to meet the basic stated objectives or safety standards.	40%
Project Management (PLO 11)	Executes project perfectly on schedule, effectively managing all resources and budget constraints.	Meets project goals within acceptable timeline and budget deviations.	Significant delays or resource mismanagement hinder project progress.	Complete failure to manage time, budget, or team resources.	20%
Societal Impact (PLO 6 / PLO 7)	Exhaustively evaluates and integrates solutions for public health, safety, and sustainability.	Adequately addresses the primary societal and environmental impacts of the design.	Vaguely acknowledges societal impact but fails to integrate it into the design.	Ignores the societal, health, or environmental consequences of the project.	20%

OBE FRAMEWORK

PROGRAM ASSESSMENT STRATEGY

Direct and Indirect Assessment Methods

POLICY CLO and PLO Attainment Mechanism

The Department of Mechanical Engineering utilizes a combination of Direct and Indirect assessment methods to evaluate the attainment of Course Learning Outcomes (CLOs) and Program Learning Outcomes (PLOs). The standard attainment threshold is set at **50% for individual students** and **50% for the cohort**.

WEIGHTS Assessment Weightage Distribution

Assessment Type	Assessment Tools Used	CLO Attainment Weightage
Direct Assessment	Midterm Exams, Final Exams, Quizzes, Assignments, Open-Ended Labs (OEL), Complex Engineering Problems (CEP), Presentations.	80%
Indirect Assessment	Course End Survey (CES) distributed to students at the completion of the semester.	20%

ASSESS Direct Assessment Breakdown

Assessment Tool	Weightage	Targeted CLOs
Assignments / Quizzes	15%	CLO-1, CLO-2
Complex Engg. Problem (CEP)	10%	CLO-3
Midterm Examination	25%	CLO-1, CLO-2
Final Examination	50%	All CLOs

Note: The above constitutes 100% of the Direct Assessment score. The final CLO attainment for this course will be calculated as: **$(0.8 \times \text{Direct Score}) + (0.2 \times \text{Indirect Course End Survey Score})$** .

List of Elective Courses

The engineering curriculum offers a diverse range of elective courses across arts, humanities, social sciences, mathematics, and technical domains. These courses are designed to foster well-rounded engineering professionals equipped with multidimensional skill sets. The department of Mechanical Engineering can choose from the list of subjects to be offered in the relevant semester based on the need and availability of the resource person / faculty member.

Arts and Humanities Electives (2+0)

- Communication and Presentation Skills
- History
- Philosophy
- Professional Ethics

Social Sciences Electives (2+0)

- Sociology for Engineers
- Social Psychology
- Critical Thinking
- Human Resource Management
- Organizational Behavior
- Engineering Law
- **Engineering Economics**
- Applied Psychology
- Engineering Management
- Financial Management
- Marketing Management
- Leadership and Personal Grooming

Mathematics Electives

- **Applied Statistics**
- Probability and Stochastic
- Multivariable Calculus

Technical Electives (3 Cr hrs.)

- Mechanical Engineering Design Analysis
- Stress Analysis
- Composite Materials
- Renewable Energy Technology
- Gas Dynamics
- **Aerodynamics**
- Computational Fluid Dynamics
- Automotive Engineering
- Advanced Manufacturing Systems
- Maintenance Engineering
- Product Design and Development
- Micro-Electromechanical Systems (MEMS)
- Power Plant

4TH BOARD OF STUDIES

Concluding Note: The Journey of the 4th Board of Studies

- “ *Far more than a routine academic update, this document reflects shared expertise, critical evaluation, and a collective commitment to elevating engineering education standards.*
- “ *Insights from the Industrial Advisory Board, inter-departmental meetings, the Board of Faculty, and external reviewers ensured a holistic and highly relevant curriculum.*
- “ *The 4th Board of Studies stands as a dynamic blueprint designed to produce competent, adaptable, and innovative engineers ready for tomorrow's challenges.*

Bringing this comprehensive curriculum document to its final form has been a rigorous, deeply collaborative, and immensely rewarding journey. The compilation of the 4th Board of Studies (BoS) represents far more than a routine academic update; it is the culmination of shared expertise, critical evaluation, and a collective commitment to elevating our engineering education standards.

This document is the result of countless hours of deliberation and refinement. The insights gathered from the Industrial Advisory Board (IAB) provided a crucial bridge between academic theory and real-world industry demands. These perspectives, combined with dynamic inter-departmental meetings and invaluable feedback from the Board of Faculty (BoF), ensured that our approach remained holistic and multi-disciplinary. Furthermore, rigorous scrutiny by external reviewers from partner universities helped benchmark the program against leading national standards, ensuring the curriculum remains both competitive and highly relevant.

At the core of this revision is a steadfast commitment to the Outcome-Based Education (OBE) framework, strictly aligned with the latest HEC and Pakistan Engineering Council (PEC) guidelines. Key integrations include:

- **Comprehensive Mapping:** Detailed alignment of *Course Learning Outcomes (CLOs)* with *Program Learning Outcomes (PLOs)* to ensure every module serves a distinct educational purpose.
- **Cognitive Rigor:** Strategic implementation of Bloom's Taxonomy levels across all assessments to foster higher-order thinking and problem-solving skills.
- **Practical & Analytical Depth:** Formal integration of Complex Engineering Problems (CEPs) and Open-Ended Labs (OELs) to challenge students beyond conventional textbook scenarios.
- **Standardized Evaluation:** Development of robust, transparent rubrics tailored for Lab work, Theory assessments, and the Final Year Design Project (FYDP).

I extend my deepest gratitude to my colleagues, external academic peers, and industry partners who lent their time and expertise to this endeavor. The 4th Board of Studies stands not just as a set of regulations, but as a dynamic blueprint designed to produce highly competent, adaptable, and innovative engineers ready to meet the challenges of tomorrow.



Engr. Arshad Ali is the Author & Compiler of the 4th Board of Studies Curriculum Document. This compilation reflects a rigorous collaborative effort to align the curriculum with Outcome-Based Education, HEC guidelines, and Pakistan Engineering Council requirements. With contributions from academic colleagues, external reviewers, and industry partners, the document serves as a practical blueprint for quality engineering education.

Engr. Arshad Ali

Author & Compiler

4th Board of Studies Curriculum Document



DEPARTMENT OF
MECHANICAL ENGINEERING

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