Curriculum for

Industrial Engineering

Bachelor of Engineering Program

2024

Pakistan Engineering Council
&
Higher Education Commission
Islamabad

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Contents

PREFACE

The curriculum, with varying definitions, is considered as a roadmap or plan of teaching-learning process that students of an academic programme are required to undergo. It includes objectives and learning outcomes, course contents, scheme of studies, teaching approaches, and assessment methodologies. Since knowledge in all fields and sectors is expanding at a faster pace and new disciplines are also emerging; it is imperative that curricula should be dynamic having regular review and updation.

University Grants Commission (UGC) was the authorised authority to develop, review and revise curricula beyond Class-XII vides Section 3, Sub-Section 2 (ii), Act of Parliament No. X of 1976 titled "Supervision of Curricula and Textbooks and Maintenance of Standard of Education". With the repeal of UGC Act, the same function was assigned to the Higher Education Commission (HEC) under its Ordinance of 2002, Section 10, Sub-Section 1 (v). In compliance with this provision, the HEC has been undertaking the development of curricula for new/ emerging fields and revision of curricula after regular intervals through respective National Curriculum Revision Committees (NCRCs) until 2018.

As a policy change and expanding higher education base under HEC, the curriculum review and development task has been shifted to the respective regulators and HEIs. PEC also having mandate under its Act of Parliament and especially after attaining Washington Accord full signatory status and IPEA licensing authority, took up the challenge to review and develop the curricula for engineering programs based on Outcome-Based Education (OBE) System. PEC has therefore constituted an Engineering Curriculum Review and Development Committee (ECRDC) comprising of eminent engineers and professionals from academia and industry to take up the task of curricula review and updation. Nevertheless, the basic templates developed by HEC NCRC have been followed as guidelines.

Under OBE based curriculum review and development framework, PEC held national and regional levels stakeholders and industrial consultation workshops by engaging HEIs, industry, technical and consulting organizations. The experts' feedback and suggestions were translated into the curriculum review process while taking into consideration of the dynamics of technological advancement, industrial needs and management-cum-soft skills for engineering graduates.

This curriculum document would serve as a guideline, whereas allowing HEIs to tame/ change within the framework by introducing courses in support of local/ required industrial demand as well as satisfying the revised 11 GAs (Graduate Attributes) and 13 PCs (Professional Competencies) covering core and elective courses, considered as beauty of OBE system in the international arena. At the same time, this curriculum framework would fulfill the purpose of meeting our

national, social and economic needs leading towards attainment of Sustainable Development Goals (SDGs-2030).

It would also provide the level of competency specified in Pakistan Qualification Framework to make it compatible with international educational standards.

While approving this curriculum in 10th meeting of ECRDC-Main, Engr. Lt. Gen (Retd.) Javed Mahmood Bukhari (Convener) appreciated and complemented the role of PEC by doing a great job in many endeavors. He lauded the PEC initiatives and accomplishments being made by the current Governing Body & Management Committee under the Leadership of Engr. Muhammad Najeeb Haroon (Chairman PEC) and Engineering Accreditation Board (EAB) under the Convener-ship of Engr. Dr. Niaz Ahmad Akhtar (Convener EAB/ Vice-Chairman Punjab) for promoting standards of engineering education as well as practice of engineering for ultimate achievement to promote rapid growth in socio-economic field of Pakistan.

He acknowledged the contribution and tangible input rendered by members/ experts of ECRDC-Main and respective discipline-wise Committees/ Sub-Groups and continued support of Engr. Dr. Nasir Mahmood Khan (Secretary/ Registrar-PEC) for developing these undergraduate engineering programs curricula and producing quality work output.

The Convener also expressed gratitude to PEC and HEC for collaborative efforts and synergy for uplifting the standards of education particularly in engineering field in the country. He praised the working of HEC on issuing Undergraduate Education Policy (UEP) to be implemented from Fall-2023 for all HEIs and Councils. In this regard, he appreciated PEC EAB working and notification of engineering education guidelines/ framework document, evolved based on the synthesis and mapping in the light of HEC UEP. He anticipated that these combined efforts will continue to achieve the Sustainable Development Goals (SDGs) of enhancing the quality of engineering education towards economic growth at national level.

1. Engineering Curriculum Review & Development Committee (ECRDC)

PEC in its efforts towards quality engineering education, took up the challenge of curriculum review and development for engineering programs after due consent of HEC. A high-level Engineering Curriculum Review and Development Committee (ECRDC), led by Engr. Lt. Gen (Retd.) Javed Mahmood Bukhari, Member Governing Body/ Rector, NUST was constituted (for the term 2021-2024), whereas other eminent members from industry and academia were involved in the task of curricula review and updation, besides developing curriculum for new/ emerging fields. The main responsibility of ECRDC is to oversee the entire curriculum review and development process while setting policies and guidelines for the subject ECRDCs working in their respective domains. The 9th meeting of main ECRDC and first of this term, was held on 31st May 2022 at PEC Head Office Islamabad, wherein the Convener briefed the scope, objective and ToRs of the Committee and also endorsed the subject ECRDCs comprising of eminent engineers and professionals from academia and industry.

1.	Engr. Lt. Gen (Retd.) Javed Mahmood Bukhari Convener (ECRDC-Main)/ Member PEC Governing Body/ Rector NUST, Islamabad	Convener
2.	Engr. Prof. Dr. Altaf Mukati Vice President (Academics), SZABIST University, Karachi	Dy. Convener
3.	Engr. Prof. Dr. Bhawani Shankar Chowdhry PEC Governing Body / Prof. Emeritus / Advisor MUET, Jamshoro	Member
4.	Engr. Prof. Dr. Shahid Khattak Convener, Elect Engg. & Allied Disciplines	Member
5.	Engr. Prof. Dr. Ehsan Ullah Khan Kakar Convener, Civil Engg. & Allied Disciplines	Member
6.	Engr. Prof. Dr. Syed Mushtaq Shah Convener, Mechanical Engg. & Allied Disciplines	Member

7.	Engr. Prof. Dr. Amanat Ali Bhatti Convener, Materials, Metallurgical, Mining, Petroleum and Gas Engg. & Allied Disciplines	Member
8.	Engr. Prof. Dr. Naveed Ramzan Convener, Chemical Engg & Allied Disciplines	Member
9.	Engr. Dr. Muhammad Ashraf Convener, Agricultural Engg. & Allied Disciplines	Member
10.	Engr. Muhammad Raza Chohan Convener, Common to All (Non-Engg Component)	Member
11.	Mr. Hidayatullah Kasi HEC Representative	Member
12.	Engr. Dr. Nasir Mahmood Khan	Secretary/ Registrar, PEC
13.	Engr. Niaz Ahmed Khaskheli Sr. Additional Registrar, EAD	Secretary ECRDC

2. ECRDC Agenda

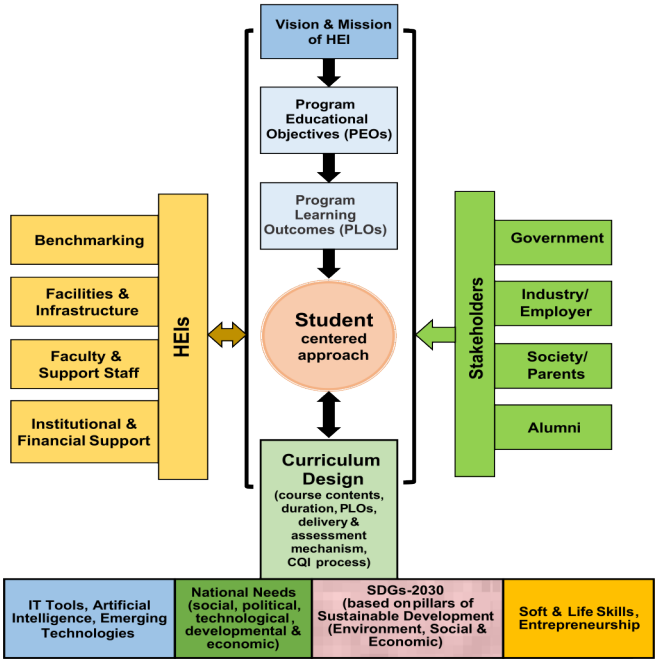
- The ECRDC is responsible to oversee the overall working of curriculum review and development for all engineering programs in terms of strategy, guidance & progress, and thereby submission to the relevant forum for adoption/ notification.

- Each Member of ECRDC will also work in the capacity of Convener for respective disciplines as mentioned against their names and as per their ToRs.

3. OBE Based Curriculum Development Framework

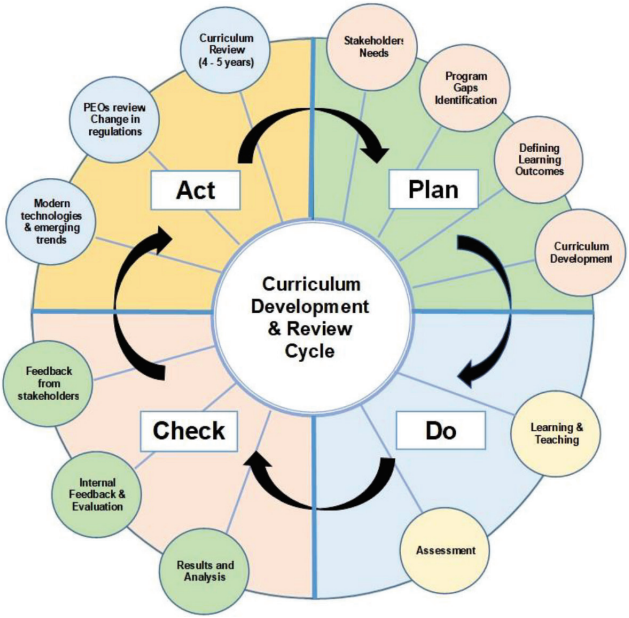
Outcome Based Education (OBE) is an approach of teaching and learning that focuses on what students should be able to attain at the end of the educational program. OBE is a student's centered system which concerns what the students will know and be able to do as learning outcomes. The curriculum development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

Outcome Based Education (OBE) Curriculum Development Framework



4. 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.

5. ECRDC for Mechanical & Allied Engineering Disciplines

The PEC Engineering Curriculum Review and Development Committee (ECRDC) of Mechanical and Allied Engineering Disciplines took up the task to review and update the curriculum for the Bachelor of Industrial Engineering degree program. The subject Committee had conducted several meetings besides multiple sessions of Sub-Groups and the concluding meeting of ECRDC (Mechanical & Allied Engineering Disciplines) was conducted on 11-3-2024 at PEC Head Office Islamabad. The Committee consisted of following members:

1.	Engr. Prof. Dr. Syed Mushtaq Shah Member, PEC Governing Body/ Vice Chancellor, Mir Chakar Khan Rind University, Sibi	Convener
2.	Engr. Prof. Dr. Riffat Asim Pasha Member, PEC Governing Body/ Chairman, Mechanical Engineering Department, UET Taxila	Member
3.	Engr. Dr. Ajaz Bashir Janjua Member, PEC Governing Body/ Director-IDePRO, Pakistan Ordinance Factories, Wah Cantt.	Member
4.	Engr. Dr. Shaikh Zahoor Sarwar Member, PEC Governing Body/ Sr. Associate Professor, Bahria University, Islamabad	Member
5.	Engr. Prof. Dr. Mirza Jahanzaib Member, PEC Governing Body/ Chairman Industrial and Manufacturing Engineering, UET Taxila	Member
6.	Engr. Mohsin Ali Khan Member, PEC Governing Body/ Ex-GM, Pakistan Steel Mill, Karachi	Member

7.	Engr. Muhammad Nasir Khalily Member, PEC Governing Body/ Divisional Superintendent, Pakistan Railways, Karachi	Member
8.	Engr. Hidayatullah Kasi HEC Representative	Member
9.	Engr. Dr. Abdul Rehman Abassi Principal Engineer, KANUPP Karachi	Co-opted Member
10.	Engr. Dr. Hamid Zaigham GM, KRL Islamabad	Co-opted Member
11.	Engr. Dr. M. A Irfan Mufti Professor, UET Peshawar	Co-opted Member
12.	Engr. Dr. Khalid Rehman Professor, GIKI Topi, Swabi	Co-opted Member
13.	Engr. Dr. Sahar Noor Professor, UET Peshawar	Co-opted Member
14.	Engr. Dr. Nadeem Ahmed Mufti Professor, UET Lahore	Co-opted Member
15.	Engr. Dr. Muhammad Shakaib Professor, NED-UET Karachi	Co-opted Member
16.	Engr. Dr. Salim-Ur-Rehman Professor, SUIT Peshawar	Co-opted Member
17.	Engr. Prof. Dr. M. Shahid Khalil Ex-Dean, UET Taxila	Co-opted Member
18.	Engr. Niaz Ahmed Sr. Additional Registrar/ HoD-EAD	Secretary ECRDCs
19.	Engr Osaf Mahmood Malik Section Head (Curriculum & Development), EAD	Additional Registrar

20.	Engr. Syed Haider Abbas Bokhari	Assistant Registrar-EAD
21.	Engr. Muhammad Junaid Khan	Assistant Registrar-EAD
22.	Mr. Muhammad Irfan	Office Superintendent

The working on curriculum development of Industrial Engineering was initiated in 2023 by previous EAD team comprising of Engr. Dr. Ashfaq Ahmed Sheikh (Sr. Additional Registrar), Engr. Ghulam Karim (Additional Registrar) and Engr. Daniyal Hameed (Assistant Registrar). The contribution of previous as well as current EAD team was highly acknowledged and appreciated by the Convener ECRDC Mechanical and Allied Engineering Disciplines.

Sub-Group Industrial Engineering

1.	Engr. Prof. Dr. Syed Mushtaq Shah Vice Chancellor, Mir Chakar Khan Rind University, Sibi	Lead Sub-Group
2.	Engr. Dr. Mirza Jahanzaib Professor, UET Taxila	Member
3.	Engr. Prof. Dr. Muhammad Tufail Pro- Vice Chancellor, NED- UET, Karachi	Member
4.	Engr. Dr. Sahar Noor Professor, UET Peshawar	Member
5.	Engr. Dr. Shahid Maqsood Professor, UET Peshawar, (Jalozai Campus)	Member
6.	Engr. Dr. Qaiser Saleem Professor, UET Lahore	Member
7.	Engr. Dr. Syed Amir Iqbal Professor, NED- UET, Karachi	Member
8.	Engr. Osaf Mahmood Malik Additional Registrar, EAD/ Section Head (Curriculum & Development)	Secretary Sub-Group

The ECRDC Mechanical and Allied Engineering Disciplines appreciated the extraordinary efforts and contribution of Engr. Prof. Dr. Syed Mushtaq Shah (Convener/ Lead Sub-Group), Engr. Prof. Dr. Mirza Jahanzaib (Member), Engr. Prof. Dr. Muhammad Tufail (Member Sub-Group), Engr. Prof. Dr. Shahid Maqsood (Member Sub-Group) & Engr. Osaf Mahmood Malik (Section Head Curriculum & Development) for compilation of course contents and proof reading of this curriculum booklet.

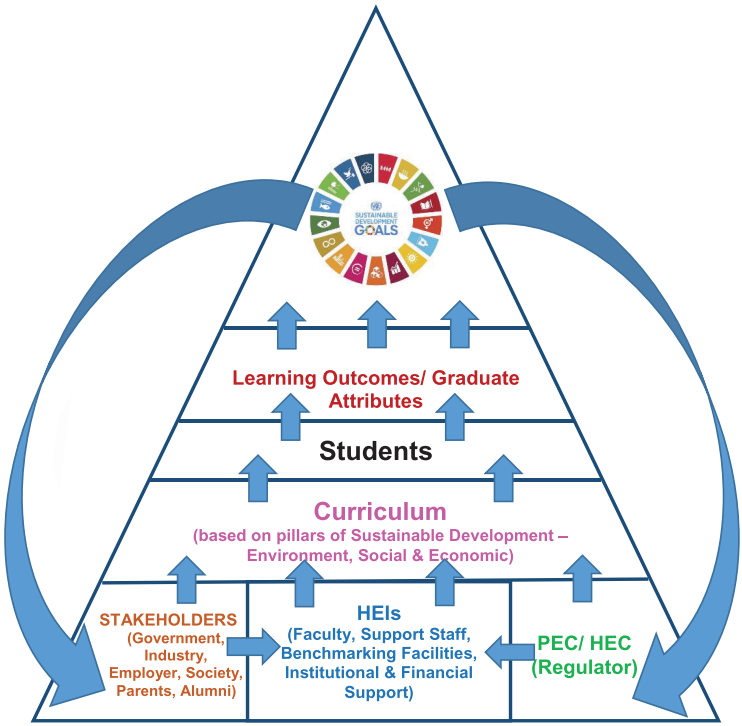
6. Agenda of ECRDC for Mechanical and Allied Engineering Disciplines

- The Subject ECRDC will work under the overall directions and supervision of main ECRDC comprising all Conveners.
- The key driving lines for the development of engineering curriculum for each discipline will be the overall policy of Pakistan Engineering Council in conjunction with international commitments (Washington Accord, IPEA etc.) and Government/ HEC policies.
- Review of polices and stakeholders' feedback for the sector(s) relevant to the respective discipline.
- Comparative study of the curricula being offered at various engineering universities/institutions already following the OBE-based system.
- Development and finalization of complete scheme and curriculum for respective discipline including all aspects.

The Convener, Engr. Prof. Dr. Syed Mushtaq Shah highlighted the important benchmarks and international best practices to be considered for the development/ revision of the curriculum while taking into account the Outcome Based Education (OBE) system. He also suggested that the Committee comprising of professors and experts from academia, industry and R&D institutions has provided a useful input and suggestions covering new developments to be incorporated in the curriculum. He also highlighted the importance of the field of emerging field for achieving sustainable development while addressing socio-economic issues and challenges envisaged in SDGs-2030 (as provided below) and well mapped with courses;

- Goal-1: No Poverty
- Goal-2: Zero Hunger
- Goal-3: Good Health and Well-being
- Goal-4: Quality Education
- Goal-5: Gender Equality
- Goal-6: Clean Water and Sanitation
- Goal-7: Affordable and Clean Energy
- Goal-8: Decent Work and Economic Growth
- Goal-9: Industrial Innovation and Infrastructure

- Goal-10: Reduced Inequalities
- Goal-11: Sustainable Cities and Communities
- Goal-12: Responsible Consumption and Production
- Goal-13: Climate Action
- Goal-14: Life Below Water
- Goal-15: Life on Land
- Goal-16: Peace, Justice and Strong Institution
- Goal-17: Partnerships for the Goals



The curriculum therefore has been designed based upon the above SDGs alongside their mapping strategy with program mission, objectives, learning attributes and the scheme of study.

7. Attainment of Graduate Attribute and Professional Competencies

The development of an engineering professional is an ongoing process with important identified stages. The first stage is the attainment of an accredited educational qualification i.e., the graduate stage. The fundamental purpose of engineering education is to build a knowledge base and attributes to enable the graduate to continue learning and to proceed to formative development that will develop the competence required for independent practice. The second stage, following a period of formative development, is professional registration. The fundamental purpose of formative development is to build on the educational base to develop the competencies required for independent practice in which the graduate works with engineering practitioners and progresses from an assisting role to taking more responsibility as an individual and as a team member until competence can be demonstrated at this level required for registration. Once registered, the practitioner must maintain and expand competence.

The baseline for developing the curriculum of engineering program and setting the graduate attributes are the defined set of Knowledge and Attitude Profiles approved by International Engineering Alliance (IEA) in version 4.0.

7.1 Knowledge and Attitude Profile

In order to inculcate different dimensions of thinking mathematical, computational, design and creativeness among students in Cognitive, Psychomotor and Affective domains, the curriculum is designed to cover the following 9x knowledge and attitude profiles. These profiles reflect an indicated volume of learning and the work attitude against which graduates must be able to perform.

- **WK1:** A systematic, theory-based understanding of the **natural sciences** applicable to the discipline and awareness of relevant **social sciences.**
- **WK2:** Conceptually-based **mathematics, numerical analysis, data analysis, statistics** and formal aspects of **computer and information science** to support detailed analysis and modelling; applicable to the discipline.
- **WK3:** A systematic, theory-based formulation of **engineering fundamentals** required in the relevant engineering discipline.
- **WK4: Engineering specialist knowledge** that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.
- **WK5:** Knowledge, including efficient resource use, environmental impacts,

whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports **engineering design and operations** in a practice area.

- **WK6:** Knowledge of **engineering practice** (technology) in the practice areas in the engineering discipline.

- **WK7:** Knowledge of the role of **engineering in society** and identified issues in engineering practice in the discipline, such as the **professional responsibility** of an **engineer to public safety** and **sustainable development** (Represented by the 17 UN Sustainable Development Goals (UN-SDG)

- **WK8:** Engagement with selected knowledge in the current **research literature** of the discipline, awareness of the power of **critical thinking** and **creative** approaches to evaluate emerging issues.

- **WK9: Ethics, inclusive behavior and conduct;** Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability, etc. with mutual understanding and respect, and of inclusive attitudes.

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

Graduate attributes (GAs) form a set of individually assessable outcomes that are the components indicative of the graduate's potential to acquire competence to practice at the appropriate level. The graduate attributes are exemplars of the attributes expected from a graduate of an accredited program. Graduate attributes are clear, succinct statements of the expected capability, qualified, if necessary, by a range indication appropriate to the type of program. The GAs have been revised in version 4.0 of IEA with distinctive change being the merger of GA-6 Engineer and Society; and GA-7 Environment and Sustainability as the single GA of 'The Engineer and the World'. There are also minor changes in the statements of revised GAs approved as version 4.0 of IEA.

The engineering curriculum is the most important instrument for grooming the students based on 11x Graduate Attributes (GAs) encompassed under the Program Learning Outcomes (PLOs). Program outcomes are the narrower statements that describe what students are expected to know and be able to do at the time of graduation. These PLOs mainly relate to the knowledge, skills and attitude that the students acquire while progressing through the program. Specifically, it is to be demonstrated that the students have acquired the defined GAs. The program must demonstrate that by the time of graduation, the students

have attained a certain set of knowledge, skills and behavioral traits, at-least to some acceptable minimum level. This minimum threshold value (i.e., KPI for PLO attainment) should not be less than 50% even to begin with; however, as the program progresses through its evolution, it is expected that this minimum threshold value would subsequently be raised to higher values through program's CQI. Specifically, it is to be demonstrated that all students of a batch to be accredited have acquired the following graduate attributes (GAs) set according to the revised framework of International Engineering Alliance (IEA) version-4.0:

- **PLO-1 Engineering Knowledge:** Apply knowledge of mathematics, natural science, engineering fundamentals and Engineering specialization to the solution of complex engineering problems (WK1-WK4).

- **PLO-2 Problem Analysis:** Identify, formulate, conduct research literature, and analyze complex Engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences (WK1-WK4).

- **PLO-3 Design/Development of Solutions:** An ability to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations (WK-5).

- **PLO-4 Investigation:** Conduct investigation of complex Engineering problems using research-based knowledge and research methods, including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions (WK-8).

- **PLO-5 Tool Usage:** Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex Engineering problems, with an understanding of the limitations (WK-2 and WK-6).

- **PLO-6 The Engineer and the World:** Analyze and evaluate sustainable development impacts to society, the economy, sustainability, health and safety, legal frameworks, and the environment while solving complex engineering problems (WK-1, WK-5, and WK-7).

- **PLO-7 Ethics:** Apply ethical principles and commit to professional ethics and norms of engineering practice and adhere to relevant national and international laws. Demonstrate an understanding of the need for diversity and inclusion (WK-9).

- **PLO-8 Individual and Collaborative Team Work:** Function effectively as an individual, and as a member or leader in diverse and inclusive teams and

in multi-disciplinary, face-to-face, remote and distributed settings (WK-9).

- **PLO-9 Communication:** Communicate effectively and inclusively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, and make effective presentations, taking into account cultural, language, and learning differences (WK-1 and WK-9).

- **PLO-10 Project Management and Finance:** Demonstrate knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, to manage projects in multidisciplinary environments (WK-2 and WK-5).

- **PLO-11 Lifelong Learning:** Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change (WK-8 and WK-9).

The graduate attributes are stated generically and are applicable to all engineering disciplines. In interpreting the statements within a disciplinary context, individual statements may be amplified and given particular emphasis but they must neither be altered in substance nor individual elements ignored. HEI is expected to prepare the PLO mapping with the whole curriculum as per their OBE design.

7.3 Professional Competence Profiles

A professionally or occupationally competent person has the attributes necessary to perform the activities within the profession or occupation to the standards expected in independent employment or practice. The professional competence profiles for each professional category record the elements of competence necessary for performance that the professional is expected to be able to demonstrate in a holistic way at the stage of attaining registration.

Professional competence can be described using a set of attributes corresponding largely to the graduate attributes, but with different emphases. For example, at the professional level, the ability to take responsibility in a real-life situation is essential. Unlike the graduate attributes, professional competence is more than a set of attributes that can be demonstrated individually. Rather, competence must be assessed holistically. Thirteen elements of professional competence as approved by the IEA for global benchmarking are mentioned as follows:

- **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.

The professional competence profiles are stated generically and are applicable to all engineering disciplines. The application of a competence profile may require amplification in different regulatory, disciplinary, occupational or environmental

contexts. In interpreting the statements within a particular context, individual statements may be amplified and given particular emphasis but must not be altered in substance or ignored.

8. Mapping of Bachelors of Engineering Program with UN SDGs

The Engineering Programs are vital for achieving the sustainable development while addressing socio-economic issues and challenges envisaged in United Nation's Sustainable Development Goals i.e. UN SDGs (Figure 1) as under;

Figure 1: United Nation's Sustainable Development Goals (UN SDGs)

Therefore, the UN SDGs have been considered in curriculum design (Figure 2). The Bachelors of Engineering Program may be mapped with the UN SDGs keeping in mind its curriculum, other pre-requisites (if any) e.g. survey camp, internship, community service etc., co- and extra- curricular activities as well as the HEI's charter (having emphasis on the particular program). The mapping can be done (through the key phrases in SDGs) on the basis of low, medium and/ or high emphasis as well as direct/indirect relevance. The non-exhausted list of considered key phrases of UN SDGs for the purpose of mapping is available in Annexure A (Note: HEI may get it shortened or lengthened as per the need of the respective engineering program). The purpose of emphasizing the SDGs is to (i) join hands with the Provincial/Federal government in playing their effective role from HEI point of view and (ii) to educate/aware the student population about the challenges of the world to be overcome in their professional careers with the help of these UN SDGs.

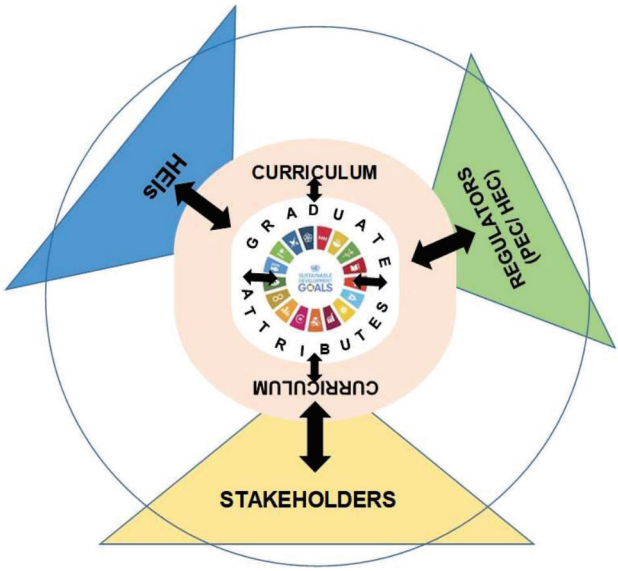


Figure 2: Consideration of UN SDGs in curriculum design

For undergraduate engineering program curriculum, mapping may be targeted through course description, objectives, learning outcomes, course contents and/or class activities. Similarly, other pre-requites can be mapped. For mapping of co- and extra- curricular activities, the nature of activities may be designed keeping in mind the relevant SDGs. For mapping of HEI's charter (having emphasis on the particular program) with the SDGs, the vision and mission of the HEI may be considered.

The following template may be adopted for the mapping of the Bachelor of Engineering program with the United Nation's Sustainable Development Goals (UN SDGs):

Sr. #	Description	UN SDGs															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
01	HEI vision and mission with focus on specific engineering program																	
02	Bachelor of Engineering Curriculum (Engg. & Non-Engg. Courses)																	
03	Final Year Design Project (FYDP)																	
04	Other pre-requisite activities (Internship, Community service, Survey camp, etc.)																	
05	Co- and Extra-Curricular Activities																	

Note: The ticks "√ " may be placed in cells where mapping is being considered by the HEI.

As an example, a non engineering course (Sociology for Engineers) has been mapped with the UN SDGs for the guidance purpose (Annexure B) and included in course outline section. HEI is expected to design the mapping considering the defined strategy.

9. Correlation Matrix PLOs-ECs-WKs-SDGs

A correlation matrix has been established to link Program Learning Outcomes (PLOs) with the corresponding engineering competencies, knowledge and attitude profiles, as well as the targeted UN Sustainable Development Goals (SDGs) by 2030. This mapping has been developed in accordance with the revised definitions of Graduate Attributes and Professional Competences (GAPCs) approved in version 4.0 of the International Engineering Alliance (IEA).

PLOs	ECs *	WKs	SDGs (Proposed)
PLO-1 **Engineering Knowledge:** Breadth, depth and type of knowledge, both theoretical and practical	**EC-1** **Comprehend and apply universal knowledge,** & **EC-2** **Comprehend and apply local knowledge**	(WK-1, WK-2, WK-3 & WK-4) **WK-1** **Natural sciences** and awareness of relevant **social sciences** **WK-2** **Mathematics & computing** **WK-3** **Engineering fundamentals** **WK-4** **Engineering specialist knowledge**	SDG-9
PLO-2 **Problem Analysis**: Complexity of analysis	**EC-3** **Problem analysis**	(WK-1, WK-2, WK-3 & WK-4) **WK-1** **Natural sciences** and awareness of relevant **social sciences** **WK-2** **Mathematics & computing** **WK-3** **Engineering fundamentals** **WK-4** **Engineering specialist knowledge**	Selected SDGs from SDG - 1 to 17 (relevance as per curriculum)

PLO-3 **Design/ Development of Solutions:** Breadth and uniqueness of engineering problems i.e., the extent to which problems are original and to which solutions have not previously been identified or codified.	**EC-4** **Design and development of solutions**	**WK-5** **Engineering design and operations**	SDG-1, 2, 3, 6, 9, 10, 11, 12, 13, 14 (relevance as per curriculum)
PLO-4 **Investigation:** Breadth and depth of investigation andexperimentation	**EC-5** **Evaluation**	**WK-8** **Research literature**	SDG-9
PLO-5 **Tool Usage:** Level of understanding of the appropriateness of technologies andtools	**EC-3** **Problem analysis** **&** **EC-5** **Evaluation**	(WK-2 & WK-6) **WK-2** **Mathematics & computing** **&** **WK-6** **Engineering practice**	SDG-9
PLO-6 **The Engineer and the World:** Level of knowledge and responsibility for sustainable development	**EC-6** Protection of society **&** **EC-7** Legal, regulatory, and cultural	(WK-1, WK-5 & WK-7) **WK1** **Natural sciences** and awareness of relevant **social sciences** **WK-5** **Engineering design and operations** **& WK7** **Engineering in Society**	Selected SDGs from SDG - 1 to 17 (relevance as per curriculum)

PLO-7 **Ethics:** Understanding and level of practice	**EC-8** **Ethics: No differentiation in this characteristic**	**WK-9** **Ethics, inclusive behavior and conduct**	SDG- 5, 10, 16
PLO-8 **Individual and Collaborative Team work:** Role in and diversity of team	**EC-10** Communication and Collaboration	**WK-9** **Ethics, inclusive behavior and conduct**	SDG- 5, 10, 16
PLO-9 **Communication:** Level of communication according to type ofactivities performed	**EC-10** Communication and Collaboration	(WK-1 & WK-9) **WK-1** **Natural sciences and awareness of relevant social sciences** & **WK-9** **Ethics, inclusive behavior and conduct.**	SDG- 5, 10, 16
PLO-10 **Project Management and Finance:** Level of management required for differingtypes of activity	**EC-9** Manage engineering activities	(WK-2 & WK-5) **WK-2** **Mathematics & computing** & **WK-5** **Engineering** **design and operations**	SDG-9, 12
PLO-11 **Lifelong Learning:**Duration and manner	**EC-11** Continuing Professional Development (CPD) and lifelong learning **EC-12** Judgement **EC-13** Responsibility for decisions	**WK-8** **Research literature**	SDG-3, 4, 8, 9, 12, 13

* Engineering Competencies (ECs) are expected to be demonstrated by graduates during their practical experiences, which have been mapped with PLOs to reflect integration in the designed curriculum.

The relationship matrix has been generically designed as a guiding framework for HEIs and is applicable to all engineering disciplines. When interpreting the matrix within a specific context, revisions or amplifications may be incorporated to highlight particular emphasis or compliance with rationalized program requirements.

10. Program Salient Features

The undergraduate engineering program has been based on the following salient features:

- **Duration:** 4 Years
- **Number of Semesters:** 8
- **Total Number of Credit Hours**: 130 - 136
    - o General Education for Engineering Discipline: Min. 38 Credit Hours
    - o Engineering Domain: Min. 72 Credit Hours
    - o FYDP/ Capstone Project: 06 Credit Hours
    - o Multidisciplinary Engineering Courses: Min. 06 Credit Hours
    - o HEIs have flexibility of 08-14 Credit Hours to add courses either in Engineering, Non-Engineering or both Domains to fulfill the program objectives in line with the overall Vision/ Mission of the Institute concerned.
- **Number of Weeks per Semester**: 15 - 18
- **Number of Credit Hours per Semester**: 15 - 18

The curriculum matrix covering the defined knowledge and attitude profiles should therefore be composed of non-engineering domain (humanities, math, management and natural sciences), and engineering domain with Industrial Engineering, foundation, breadth, depth and multidisciplinary courses (including safety) so that different streams could be encouraged within each discipline, enabling students to undertake a range of Complex Problem Solving and Complex Engineering Activities. The students may select electives from any of the streams with guidelines from their respective advisors. The knowledge areas of Non-Engineering and Engineering domains have been broadly mapped with 11x PLOs and 9x WKs using the guiding framework of IEA version 4.0 in the following table:

Knowledge Profile (WK-1 to WK-9)	Knowledge Area	Sub-Area	Courses	Credit Hours
General Education/ Non-Engineering Domain				
WK-1/ WK-2	**Natural Sciences**	Math	As per program requirements	12-15
		Physics	***Applied Physics	3-9
		Chemistry	***Applied Chemistry	
		Natural Science/ Math Elective	*** Math Elective	
WK-1/ WK-5/ WK-7/ WK-9	**Humanities**	English	**Functional English	3
			** Expository Writing	3
		Culture	** Islamic Studies or Ethics	2
			**Ideology & constitution of Pakistan	2
			*Arts & Humanities Elective (Languages or study of religion)	2
		Social Science	***Social Science Elective	2
			** Civics and Community Engagement	2
	Management Sciences	Professional Practice	***Project Management	2
			**Entrepreneurship	2
	Computer Sciences	Basic Computing	**Applications of ICT	3

Engineering Domain				
Knowledge Profile (WK-1 to WK-9)	**Knowledge Area**	**Sub-Area**	**Courses**	**Credit Hours**
WK-2/ WK-4/ WK-5/	Advanced Computer and Information Sciences	ICT/AI/ Data Science/ Cyber Security		6-9
WK-2/ WK-3	Foundation Engg Courses		Specific to Program Objectives and outcome	22-24
WK-1/ WK-2/ WK-4	Core Breadth of Engg Disciplines		Specific to Program Objectives and outcome	22-24
WK-5/ WK-6	Core Depth of Engg Disciplines		Specific to Program Objectives and outcome	22-24
				Min 72
WK-1/ WK-2/ WK-3/ WK-4/ WK-7/ WK-9	Multi disciplinary Engg Courses		Specific to Program Objectives and outcome	6
			Occupational Health and Safety (Mandatory 01 credit hours)	
WK-4/ WK-5/ WK-6/ WK-7/ WK-8/ WK-9	Final Year Design Project (FYDP)/ Capstone	Integration of innovative, creative, technical, management and presentation skills of a graduate towards final year.		6
WK-6/ WK-7/ WK-9	Industrial Training	Internship (06-08 Weeks)		Mandatory & Qualifying

WK-2/ WK-4/ WK-5/ WK-6/ WK-7/ WK-8	**Innovative and Critical Thinking (under relevant courses):** - Complex Problem Solving - Complex Engineering Activities - Semester Project - Case Studies - Open Ended Labs - Problem-Based Learning (PBL)	
	(Flexible Engineering/ Non-Engineering) Courses may be adjusted as per the requirements	8-14
	Total (Credit Hours)	**130-136**

Note: * University may offer any course within the specific broader subject domain/ cluster to meet the given credits.

** HEC designed model courses may be used by the university.

*** PEC ECRDC designed courses

Industrial Training: Internship of at least 6 - 8 weeks is a mandatory part of degree requirements to be carried out during 3rd to 4th year of program; must be supervised, monitored, evaluated, and reflected in the transcripts under a prescribed mechanism and with defined and mapped rubrics with program outcomes. The Assessment phase should focus about;

- Selection of internship inline with elective subjects/ specific streams
- Qualifying weightage: 70%
- At least 75% attendance is mandatory 10%
- Assessment report from the employer 50%
- Evaluation at relevant HEIs/ Deptt – presentation 40%

Final Year Design Project (FYDP)/ Capstone: FYDP aims to challenge innovative, creative, technical, management and presentation skills of a graduate to bring together the learning over the degree program.

- A final year design project (FYDP) is the confluence of an engineering program. Undertaking a final year design project is a compulsory requirement. It should mainly comprise literature search, individual analysis, modeling and simulation, AI (Artificial Intelligence) and computational data analytics, design of infrastructure, software, firmware and Algorithm Engineering / Informatics related to the program to demonstrate a functional concept including rapid prototyping, where applicable.
- The FYDP shall include complex engineering problems and design systems, components or processes integrating core areas and meeting specific needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
- A project of this nature should invariably lead to an integration of the knowledge and practical skills as mandated in the program outcomes. In this context, projects of multidisciplinary nature should be encouraged
- The FYDP should span over two consecutive semesters, i.e. semester 7 & 8, totaling 6-credit hours and should be fully supervised, assessed and reflected in the transcripts under a prescribed mechanism to prepare for joining industry after graduation.

Faculty: The faculty must be trained for the Outcome-Based Education (OBE) system. Their familiarity with the program objectives and outcomes, understanding of the Outcome-Based ASSESSMENT(OBA) cycle, enthusiasm for developing an effective program, and the ability to become an active player towards its overall implementation are the key factors for ensuring the attainment of program objectives. The faculty is expected to have the ability to ensure proper implementation of the program, and develop processes for evaluation, Assessment and CQI. A formal training program to groom the faculty should be instituted so as they become effective instructors in applying pedagogical skills in all aspects of Teaching, Learning and Assessment covering all domains of Knowledge, Skills and Attitude.

Personal Grooming: Personal Grooming of young faculty members and students is very important in order to develop and support their professional skills. Therefore, it is required that HEIs should conduct/arrange sessions or counseling hours on regular basis to provide guidance for personal grooming as it is important for positive self-image and increasing the confidence level of the individuals. It would help in enhancing students' self- esteem and would go a long way in developing an attractive personality by adopting habits like personal hygiene, clothing, appearance, interaction and expressive skills, etc. The students should be motivated and equipped to be entrepreneurs in their relevant field.

Presentation and Communication Skills: Special focus should be given to inculcate communication and presentation skills amongst the graduates through individual and group presentations, technical writing and discussions, throughout the program as a regular feature.

This Curriculum has been designed to guide and facilitate the universities and department to formulate their own programs according to the industrial needs, emerging trends and recent developments in the field of Industrial Engineering. The HEIs have flexibility to incorporate changes in the proposed curriculum within given range of credit hours for engineering and non-engineering domain.

11. Framework for Bachelor of Industrial Engineering Curriculum

Knowledge Profile (WK-1 to WK-9)	Knowledge Area	Sub Area	Title of Course	Credit Hours			Total
				Th	Lab	Total	
General Education/ Non-Engineering Domain							
WK-1/ WK-5/ WK-7/ WK-9	**Humanities**	English	Functional English **	3	0	3	**6**
			Expository Writing **	3	0	3	
		Culture	Islamic Studies / Ethics **	2	0	2	**6**
			Ideology and Constitution of Pakistan **	2	0	2	
			Arts and Humanities Elective *	2	0	2	
		Social Sciences	Social Sciences Elective ***	2	0	2	**4**
			Civics and Community Engagement **	2	0	2	
	Management Sciences	Professional Practice	Entrepreneurship **	2	0	2	**4**
			Project Management ***	2	0	2	
	Computer Sciences	Basic Computing	Applications of ICT **	2	1	3	**3**
WK-1/ WK-2	**Natural Sciences**	Math	Probability & Statistics	3	0	3	**12**
			Logic & Critical Thinking	3	0	3	
			Calculus & Analytical Geometry	3	0	3	
			Linear Algebra & Differential Equations	3	0	3	
		Natural Science/ Math Elective	Engineering Mechanics	2	1	3	**3**
Total (General Education/ Non-Engineering Domain)				**36**	**2**	**38**	**38**

Note: * University may offer any course within the specific broader subject domain/ cluster to meet the given credits.

** HEC designed model courses may be used by the university.

*** PEC ECRDC designed courses.

Knowledge Profile (WK-1 to WK-9)	Knowledge Area	Sub Area	Title of Course	Th	Lab	Cr. Hrs.	Total
Engineering Domain							
WK-2/ WK-4/ WK-5/ WK-6	**Advanced Computer Science**	ICT/AI/ Data Science/ Cyber Security	Computer Programming	2	1	3	6
			Computer Simulations	2	1	3	
WK-2/ WK-3	**Engineering Foundation**		Operations Research	3	1	4	24
			Metrology & Statistical Quality Control	2	1	3	
			Mechanics of Materials	2	1	3	
			Engineering Drawing and Graphics	0	2	2	
			Workshop Practice	0	1	1	
			Work Study & Methods Engineering	2	1	3	
			Basic Mechanical Engineering	2	1	3	
			Computer Aided Design	0	1	1	
			Materials Engineering	3	1	4	
WK-1/ WK-2/ WK-4	**Major Based Core (Breadth)**		Design of Mechanisms	2	1	3	24
			Industrial Repair and Maintenance	2	1	3	
			Human Factors Engineering	2	1	3	
			Manufacturing Processes	2	1	3	
			Instrumentation and Control	2	1	3	
			Manufacturing Systems	2	1	3	
			Production Planning & Control	2	1	3	
			Technical Electives- I	3	0	3	

WK-5/ WK-6	**Major Based Core (Depth)**		Industrial Facilities Design	2	1	3	22
			Production/ Industrial Automation	2	1	3	
			Design of Experiment	3	1	4	
			Technical Electives -II	3	0	3	
			Technical Electives- III	2/3	1/0	3	
			Technical Electives- IV	2/3	1/0	3	
			Technical Electives- V	2/3	1/0	3	
WK-1/ WK-2/ WK-3/ WK-4	**Multi-Disciplinary Engineering Courses**		Computer Aided Manufacturing	2	1	3	5
			Health, Safety & Environment	2	0	2	
WK-6/ WK-7/ WK-8	**Final Year Design Project (FYDP)/ Capstone**	Industrial/ Innovative/ Creative Project	FYDP (Part-I)	0	3	3	6
			FYDP (Part-II)	0	3	3	
WK-6/ WK-7	**Industrial Training**	6 – 8 weeks Industrial Training (Non-Credit)		**Mandatory & Qualifying**			
			Total (Engineering Domain)	**55-58**	**32-29**	**87**	**87**
WK-2/ WK-4/ WK-5/ WK-6/ WK-7/ WK-8	**Innovative and Critical Thinking (under relevant courses):** - Complex Problem Solving - Complex Engineering Activities - Semester Project - Case Studies - Open ended labs - Problem-based learning (PBL)						
WK-1/ WK-2/ WK-3/ WK-4	**Flexible Engineering/ Non-Engineering Courses**		Numerical Analysis & Computer Application	2	1	3	**10**
			Basic Electronics	2	1	3	
			Environment and Sustainability	2	0	2	
			Management Sciences Elective ****	2	0	2	
			Flexible Engineering/ Non-Engineering Courses	**8**	**2**	**10**	**10**
						Total (Credit Hours)	**135**

Note: Quran Translation (QT) Credits will be allowed as over and above 136 Cr. Hrs.

12. Scheme of Studies for Bachelor of Industrial Engineering Curriculum

1st Year				
First Semester				
Sr. No	**Course Title**	**(Credit Hours)**		**Total Credit Hours**
		Theory	**Lab**	
1	Functional English	3	0	3
2	Calculus and Analytical Geometry	3	0	3
3	Applications of ICT	2	1	3
4	Basic Electronics	2	1	3
5	Engineering Drawing and Graphics	0	2	2
6	Engineering Mechanics	2	1	3
	Total	**12**	**5**	**17**

Second Semester				
Sr. No	**Course Title**	**(Credit Hours)**		**Total Credit Hours**
		Theory	**Lab**	
1	Linear Algebra and Differential Equations	3	0	3
2	Workshop Practice	0	1	1
3	Ideology and Constitution of Pakistan	2	0	2
4	Basic Mechanical Engineering	2	1	3
5	Materials Engineering	3	1	4
6	Islamic Studies/Ethics	2	0	2
7	Computer Aided Design	0	1	1
	Total	**12**	**4**	**16**

2nd Year				
Third Semester				
Sr. No	**Course Title**	**(Credit Hours)**		**Total Credit Hours**
		Theory	**Lab**	
1	Probability and Statistics	3	0	3
2	Arts and Humanities Elective *	2	0	2
3	Social Sciences Elective **	2	0	2
4	Health, Safety & Environment	2	0	2
5	Mechanics of Materials	2	1	3
6	Numerical Analysis & Computer Application	2	1	3
7	Computer Programming	2	1	3
	Total	**15**	**3**	**18**

Fourth Semester				
Sr. No	**Course Title**	**(Credit Hours)**		**Total Credit Hours**
		Theory	**Lab**	
1	Logic & Critical Thinking	3	0	3
2	Design of Mechanisms	2	1	3
3	Manufacturing Systems	2	1	3
4	Metrology & Statistical Quality Control	2	1	3
5	Computer Simulation	2	1	3
6	Environment and Sustainability	2	0	2
	Total	**13**	**4**	**17**

3rd Year				
Fifth Semester				
Sr. No	**Course Title**	**(Credit Hours)**		**Total Credit Hours**
		Theory	**Lab**	
1	Civics and Community Engagement	2	0	2
2	Production Planning & Control	2	1	3
3	Manufacturing Process	2	1	3
4	Operations Research	3	1	4
5	Work Study & Methods Engineering	2	1	3
6	Project Management	2	0	2
	Total	**13**	**4**	**17**

Sixth Semester				
Sr. No	**Course Title**	**(Credit Hours)**		**Total Credit Hours**
		Theory	**Lab**	
1	Industrial Facilities Design	2	1	3
2	Human Factors Engineering	2	1	3
3	Expository Writing	3	0	3
4	Computer Aided Manufacturing	2	1	3
5	Instrumentation and Control	2	1	3
6	Management Sciences Elective****	2	0	2
	Total	**13**	**4**	**17**

4th Year				
Seventh Semester				
Sr. No	**Course Title**	**(Credit Hours)**		**Total Credit Hours**
		Theory	**Lab**	
1	Design of Experiment	3	1	4
2	Industrial Repair and Maintenance	2	1	3
3	Technical Elective – I ***	3	0	3
4	Technical Elective – II ***	3	0	3
5	FYDP (Part-I)	0	3	3
	Total	**11**	**5**	**16**

Eighth Semester				
Sr. No	**Course Title**	**(Credit Hours)**		**Total Credit Hours**
		Theory	**Lab**	
1	Entrepreneurship	2	0	2
2	Technical Elective – III ***	2/3	1/0	3
3	Technical Elective – IV ***	2/3	1/0	3
4	Technical Elective -V ***	2/3	1/0	3
5	FYDP (Part-II)	0	3	3
6	Production/ Industrial Automation	2	1	3
	Total	**10/13**	**7/4**	**17**

* List of Arts and Humanities Electives (2+0)	** List of Social Science Electives (2+0)
• Communication and Presentation Skills • Beginners Spanish • Elementary Arabic • Elementary French • Elementary Chinese • History • Philosophy • Professional Ethics • Any other relevant course/ language decided by the HEI as per requirement.	• Sociology for Engineers • Sociology • 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 • Any other relevant course decided by the HEI as per requirement.

*** List of Technical Electives (2+1 or 3+0)	
• Lean Manufacturing • Quality Engineering • Virtual Reality • Smart Manufacturing and Industry 4.0 • Finite Element Analysis • Sustainable Manufacturing • Reliability Analysis • Metal Forming and Cutting Analysis • Computer Integrated Manufacturing (CIM) • Tool and Die Design • Logistic Management • Enterprise Resource Planning • Additive Manufacturing • Human Robot Interaction	• Warehouse Management • Computer Aided Process Planning • Applications of AI in Manufacturing and Services Sector • Advanced Manufacturing Processes • Cybersecurity for Industrial Control Systems • Data Analytics for Industrial Engineers • Advanced Engineering Optimization • Introduction to Thermal Fluid • Soft Computing & Data Mining • Lean Six Sigma • Mechanics of Machine • Any other relevant course decided by the HEI as per requirement.

**** List of Electives for Management Sciences Course (2+0)
• Managerial Accounting
• Total Quality Management
• Management of Technical Organization
• Supply Chain Management
• Any other relevant course decided by the HEI as per requirement.

13. Program Specific Labs

The following labs specific to engineering discipline be ensured to cover relevant knowledge domains but not limited to:

- Engineering Workshop
- Engineering Drawing
- Human Factor Engineering
- Work Study Methods
- Metrology
- Instrumentation and control
- CAD/CAM
- Manufacturing Processes
- Computer Lab
- HEI specific expertise optional labs such as Industry 4.0 / CIM / Advance Manufacturing/Safety Centre/ Production/Industrial Automation and Robotics etc.

Note:

i. "Labs/ Practical: The course practical/ labs should be defined and synchronized with the course outline (Theory part)."

ii. "All safety protocols, manuals and log books etc. should be maintained and complied by each lab."

14. Course Details and Teaching-Assessment Approaches

In the following sections, Course Outlines and teaching-Assessment approaches are given for guidance based on a typical semester system. The instructors may adopt or adapt accordingly defining CLOs, course delivery plan, innovative teaching approaches and Assessment techniques.

The Course Learning Outcomes (CLOs) are guidelines only, Higher Education Institutions (HEIs) have the flexibility to modify them based on the difficulty level of the course and the mapping with the specific Program Learning Outcomes (PLOs).

Suggested Teaching & Assessment Methods include Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Project/Field Visits Group discussion, Community Service, Report Writing Social Impact Review and Social Audit of Engg Project.

Further, Assessment may be carried out through Midterm, Report writing/ Presentation, Assignments, Term Project, Quizzes and Final Term Exam etc.

14.1 Non- Engineering Domain

FUNCTIONAL ENGLISH
UGE Policy V1.1: General Education Course

Credits: 3+0
Pre-Requisite: Nil

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. Additionally, the course will enable them to navigate the globalized world with ease and efficacy, making a positive impact in their functional interactions.

COURSE LEARNING OUTCOMES

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

1. Apply enhanced English communication skills through effective use of word choices, grammar and sentence structure.
2. Comprehend a variety of literary / non-literary written and spoken texts in English.
3. Effectively express information, ideas and opinions in written and spoken English.
4. Recognize inter-cultural variations in the use of English language and to effectively adapt their communication style and content based on diverse cultural and social contexts.

COURSE OUTLINE

1. Foundations of Functional English:

- Vocabulary building (contextual usage, synonyms, antonyms and idiomatic expressions)

- Communicative grammar (subject-verb-agreement, verb tenses, fragments, run-ons, modifiers, articles, word classes, etc.)
- Word formation (affixation, compounding, clipping, back formation, etc.)
- Sentence structure (simple, compound, complex and compound-complex)
- Sound production and pronunciation.

2. Comprehension and Analysis:

- Understanding purpose, audience and context.
- Contextual interpretation (tones, biases, stereotypes, assumptions, inferences, etc.).
- Reading strategies (skimming, scanning, SQ4R, critical reading, etc.).
- Active listening (overcoming listening barriers, focused listening, etc.).

3. Effective Communication:

- Principles of communication (clarity, coherence, conciseness, courteousness, correctness, etc.).
- Structuring documents (introduction, body, conclusion and formatting).
- Inclusivity in communication (gender-neutral language, stereotypes, cross-cultural communication, etc.).
- Public speaking (overcoming stage fright, voice modulation and body language).
- Presentation skills (organization content, visual aids and engaging the audience).
- Informal communication (small talk, networking and conversational skills).
- Professional writing (business e-mails, memos, reports, formal letters, etc.).

PRACTICAL REQUIREMENT

As part of the overall learning requirements, students will also be exposed to relevant simulations, role-plays and real-life scenarios and will be required to apply skills acquired throughout the course in the form of a final project.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Understanding and Using English Grammar" by Betty Schrampfer 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. “Improving Reading: Strategies, Resources, and Common Core Connections” by Jerry Johns and Susan Lenski.
9. “Comprehension: A Paradigm for Cognition” by Walter Kintsch.
10. “Communication Skills for Business Professionals” by J.P Verma and Meenakshi Raman.

EXPOSITORY WRITING
UGE Policy V1.1: General Education Course

Credits: 3+0
Pre-Requisite: Functional English

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. Additionally, the course will highlight the significance of critical thinking enabling students to produce original and engaging written texts.

COURSE LEARNING OUTCOMES

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

1. Understand the essentials of the writing process integrating pre-writing, drafting, editing and proof reading to produce well-structured essays.
2. Demonstrate mastery of diverse expository types to address different purposes and audiences.
3. Uphold ethical practices to maintain originality in expository writing.

COURSE OUTLINE

1. Introduction to Expository Writing:
- Understanding expository writing (definition, types, purpose and applications)
- Characteristics of effective expository writing (clarity, coherence and organization)
- Introduction to paragraph writing

2. The Writing Process:
- Pre-writing techniques (brainstorming, free-writing, mind-mapping, listing, questioning and outlining etc.)
- Drafting (three stage process of drafting techniques)
- Revising and editing (ensuring correct grammar, clarity, coherence, conciseness etc.)
- Proof reading (fine-tuning of the draft)
- Peer review and feedback (providing and receiving critique)

3. **Essay Organization and Structure:**
   - Introduction and hook (engaging readers and introducing the topic)
   - Thesis statement (crafting a clear and focused central idea)
   - Body Paragraphs (topic sentences, supporting evidence and transitional devices)
   - Conclusion (types of concluding paragraphs and leaving an impact)
   - Ensuring cohesion and coherence (creating seamless connections between paragraphs)
4. **Different Types of Expository Writing:**
   - Description
   - Illustration
   - Classification
   - Cause and effect (exploring causal relationships and outcomes)
   - Process analysis (explaining step-by-step procedures)
   - Comparative analysis (analyzing similarities and differences)
5. **Writing for Specific Purposes and Audiences:**
   - Different types of purposes (to inform, to analyze, to persuade, to entertain etc.)
   - Writing for academic audiences (formality, objectivity, and academic conventions)
   - Writing for public audiences (engaging, informative and persuasive language)
   - Different tones and styles for specific purposes and audiences
6. **Ethical Considerations:**
   - Ensuring original writing (finding credible sources, evaluating information etc.)
   - Proper citation and referencing (APA, MLA, or other citation styles)
   - Integrating quotes and evidences (quoting, paraphrasing, and summarizing)
   - Avoiding plagiarism (ethical considerations and best practices)

PRACTICAL APPLICATIONS AND CAPSTONE PROJECT

As part of the overall learning requirements, students will be required to build a writing portfolio having a variety of expository texts and present the same at the end of the course showcasing proficiency in expository writing.

SUGGESTED INSTRUCTIONAL/ 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.
9. "The Art of Styling Sentences" by Ann Longknife and K.D. Sullivan.
10. "Writing Today" by Richard Johnson-Sheehan and Charles Paine

ISLAMIC STUDIES
UGE Policy V1.1: General Education Course

Credits: 2+0
Pre-Requisite: Nil

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.

COURSE LEARNING OUTCOMES

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

1. Demonstrate enhanced knowledge of Islamic foundational beliefs, practices, historical development, spiritual values and ethical principles.
2. Describe basic sources of Islamic law and their application in daily life.
3. Identify and discuss contemporary issues within the Muslim world including social challenges, gender roles and interfaith interactions.

COURSE OUTLINE

1. Introduction to Islam:

- Definition of Islam and its core beliefs.
- The Holy Quran (introduction, revelation and compilation).
- Hadith and Sunnah (compilation, classification, and significance).
- Key theological concepts and themes (Tawhid, Prophethood, Akhirah etc.).

2. Sirah of the Holy Prophet (Peace Be Upon Him) as Uswa-i-Hasana:

- Life and legacy of the Holy Prophet PBUH
- Diverse roles of the Holy Prophet PBUH (as an individual, educator, peace maker, leader etc.)

3. Islamic History and Civilization:

- World before Islam.
- The Rashidun Caliphate and expansion of Islamic rule.

- Muslims contributions to philosophy, science, medicine, mathematics, and culture.

4. Islamic Jurisprudence (Fiqh):

- Fundamental sources of Islamic jurisprudence.
- Pillars of Islam and their significance.
- Major schools of Islamic jurisprudence.
- Significance and principles of Ijtihad.

5. Family and Society in Islam:

- Status and rights of women in Islamic teachings.
- Marriage, family, and gender roles in Muslim society.
- Family structure and values in Muslim society.

6. Islam in the Modern World:

- Relevance of Islam in the modern world (globalization, challenges and prospects).
- Islamophobia, interfaith dialogue, and multiculturalism
- Islamic responses to social, ethical, and technological changes

7. Introduction to Islamic Trade and Finance:

- Islamic Financing Structures
- The Stability of Islamic Financial System
- Financial Engineering
- Regulation of Islamic Financial Institutions

SUGGESTED INSTRUCTIONAL/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 & 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.

Note: This course is compulsory for Muslim and optional for non-Muslim undergraduate students. Non-Muslim students can opt for any course of at least the same or more credits in subjects such as religious studies, ethics, theology, comparative religion, Christian ethics, etc.

IDEOLOGY AND CONSTITUTION OF PAKISTAN
UGE Policy V1.1: General Education Course

Credits: 2+0
Pre-Requisite: Nil

DESCRIPTION

This course is designed to provide students with a fundamental exploration of the ideology and the constitution of Pakistan. The course focuses on the underlying principles, beliefs, and aspirations that have been instrumental in shaping the creation and development of Pakistan as a sovereign state. Moreover, the course will enable students to understand the core provisions of the Constitution of the Islamic Republic of Pakistan concerning the fundamental rights and responsibilities of Pakistani citizens to enable them function in a socially responsible manner.

COURSE LEARNING OUTCOMES

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

1. Demonstrate enhanced knowledge of the basis of the ideology of Pakistan with special reference to the contributions of the founding fathers of Pakistan.
2. Demonstrate fundamental knowledge about the Constitution of Pakistan 1973 and its evolution with special reference to state structure.
3. Explain about the guiding principles on rights and responsibilities of Pakistani citizens as enshrined in the Constitution of Pakistan 1973.

COURSE OUTLINE

1. **Introduction to the Ideology of Pakistan:**
   - Definition and significance of ideology.
   - Historical context of the creation of Pakistan (with emphasis on socio-political, religious, and cultural dynamics of British India between 1857 till 1947).
   - Contributions of founding fathers of Pakistan in the freedom movement including but not limited to Allama Muhammad Iqbal, Muhammad Ali Jinnah., etc.
   - Contributions of women and students in the freedom movement for separate homeland for Muslims of British India.
2. **Two-Nation Theory:**
   - Evolution of the Two-Nation Theory (Urdu-Hindi controversy, Partition of Bengal, Simla Deputation 1906, Allama Iqbal's Presidential

Address 1930, Congress Ministries 1937, Lahore Resolution 1940).
- Role of communalism and religious differences.

3. Introduction to the Constitution of Pakistan:
- Definition and importance of a constitution.
- Ideological factors that shaped the Constitution(s) of Pakistan (Objectives Resolution 1949).
- Overview of constitutional developments in Pakistan.

4. Constitution and State Structure:
- Structure of Government (executive, legislature, and judiciary).
- Distribution of powers between federal and provincial governments.
- 18th Amendment and its impact on federalism.

5. Fundamental Rights, Principles of Policy and Responsibilities:
- Overview of fundamental rights guaranteed to citizens by the Constitution of Pakistan 1973 (Articles 8-28).
- Overview of Principles of Policy (Articles 29-40).
- Responsibilities of the Pakistani citizens (Article 5).

6. Constitutional Amendments:
- Procedures for amending the Constitution.
- Notable constitutional amendments and their implications.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "The Idea of Pakistan" by Stephen P. Cohen.
2. "Ideology of Pakistan" by Javed Iqbal.
3. "The Struggle for Pakistan" by I.H. Qureshi.
4. "Pakistan the Formative Phase" by Khalid Bin Sayeed.
5. "Pakistan: Political Roots and Development" by Safdar Mahmood.
6. "Ideology of Pakistan" by Sharif-ul-Mujahid.
7. "The Struggle for Pakistan: A Muslim Homeland and Global Politics" by Ayesha Jalal.
8. "Jinnah, Pakistan and Islamic Identity: The Search for Saladin" by Akbar S. Ahmed.
9. "The Making of Pakistan: A Study in Nationalism" by K.K. Aziz.
10. "Pakistan: A New History" by Ian Talbot.
11. "Pakistan in the Twentieth Century: A Political History" by Lawrence Ziring.
12. "The Constitution of Pakistan 1973". Original.
13. "Constitutional and Political Development of Pakistan" by Hamid Khan.
14. "The Parliament of Pakistan" by Mahboob Hussain.
15. "Constitutional Development in Pakistan " by G.W. Choudhury.
16. "Constitution-Making in Pakistan: The Dynamics of Political Order" by G.W. Choudhury.

*** List of Arts and Humanities Electives (2+0)**
• Communication and Presentation Skills • Beginners Spanish • Elementary Arabic • Elementary French • Elementary Chinese • History • Philosophy • Professional Ethics

COMMUNICATION AND PRESENTATION SKILLS

Credits: 2+0
Pre-Requisite: Nil

DESCRIPTION

"Communication and Presentation Skills" is designed to enhance students' abilities to communicate effectively in professional and academic settings. The course covers various aspects of communication including writing, reading, listening, and speaking skills. Students learn techniques for improving vocabulary, writing essays and letters, critical reading, active listening, verbal and non-verbal communication, and presentation strategies. Emphasis is placed on developing effective communication skills essential for job interviews and successful interactions in the workplace.

COURSE LEARNING OUTCOME

By the end of the course, students will be able to:

1. Write clearly, concisely, and grammatically correctly in various forms, avoiding errors.
2. Read critically to understand information better and improve vocabulary.
3. Deliver engaging presentations with effective communication and visuals.
4. Adapt communication style to audience and context, demonstrating active listening.
5. Select and use audio-visual aids to enhance presentations.
6. Demonstrate effective communication skills in diverse contexts.

COURSE OUTLINE

Writing Skills

- Vocabulary Building
- Writing Skills: Essays and Letters
- Common Writing Errors
- Purposeful Writing

Reading Skills

- Skimming and Scanning
- Critical Reading
- Reading for Understanding
- Techniques and strategies to develop sound vocabulary.

Listening Skills

- Introduction to Communication Process
- Seven Cs of Communication
- Types of Listening
- Listening for Comprehension

Speaking Skills

- Verbal and Non-Verbal Communication
- Basics of Presentation Skills
- Presentation Strategies and public speaking skills.
- Use of Audio-Visual Aids
- Basics of Group Communication
- Listening Skills
- Communicate effectively in job interviews.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Anchor in English-II (Lessons 1-5), A SPELT Publication
2. Christopher Fry, "Summary Writing (Book-I)", Oxford University Press
3. College Essays by John Langlan
4. Barron's TOFFL iBT Edition
5. Communication Skills for Engineers by Sunita Marshal and C.Muralikrishna
6. Writing for Computer science by Justin Zobel Research Methodologies – A step by step guide for beginners, Ranjit Kumar.

BEGINNERS SPANISH

Credits: 2+0
Pre-Requisite: Nil

DESCRIPTION

"Beginners Spanish" introduces students to the fundamentals of the Spanish language, focusing on basic communication skills and grammatical structures. The course covers essential vocabulary and expressions for greeting, introducing oneself and others, describing people and places, discussing daily activities, and expressing opinions. Additionally, students learn grammatical concepts such as verb conjugation, noun gender and number, and basic sentence structure to develop a foundation for further language proficiency.

COURSE LEARNING OUTCOME

By the end of the course, students will be able to:

1. Greet and introduce yourself and others in basic Spanish, stating your profession, nationality, activities, and family members.
2. Comprehend the Spanish alphabet, numbers, telling the time, days of the week, months, and weather descriptions.
3. Describe people, places, your likes and dislikes, using basic vocabulary and simple sentence structures.
4. Communicate in basic Spanish for everyday situations like eating out, shopping, daily activities, and work, in both formal and informal settings.

COURSE OUTLINE

- Greeting and introducing yourself and others: profession, nationality, activities and family
- the alphabet numbers, telling the time, days of the week, the months, the weather
- describing people and places, likes and dislikes
- Spanish in context: eating out, shopping, daily activities, work formal and informal situations
- describing past events
- expressing opinions.
- Grammatical structures: pronunciation, present tense: regular, irregular and reflexive verbs, personal pronouns, definite and indefinite articles, adjectives and nouns: gender and number, asking a question, demonstrative adjectives and pronoun, prepositions of place, verbs, adverbs of frequency, introduction to the past tense (pretérito indefinido).

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Ele Actual A1 by Virgilio Boribio, Publisher: Editorial SM; ISBN: 978-84-675-4741-

ELEMENTARY ARABIC

Credits: 2+0
Pre-Requisite: Nil

DESCRIPTION

"Elementary Arabic" provides students with a foundational understanding of the Arabic language, focusing on basic vocabulary, grammar, and conversational skills. The course covers essential greetings, introductions, and everyday life vocabulary, along with fundamental grammar concepts such as verb conjugation, noun and adjective formation, and sentence structure. Students will develop proficiency in speaking, listening, reading, and writing Arabic at an introductory level.

COURSE LEARNING OUTCOME

By the end of the course, students will be able to:

1. Greet and introduce yourself and others in basic Arabic, utilizing both formal and informal forms of address.
2. Formulate basic questions in Arabic using proper structure to inquire about everyday topics.
3. Describe yourself and others using relevant vocabulary and adhering to singular and plural noun/adjective formation and gender agreements.
4. Construct grammatically correct sentences in the present tense, incorporating conjugated verbs, definite and indefinite articles, and possessive adjectives.

COURSE OUTLINE

Vocabulary

- Greetings and introductions
- Formal and informal address
- Question formation for asking basic questions
- Speaking about yourself and others
- Arabic numbers
- Everyday life vocabulary

Grammar

- Conjugating verbs in the present tense
- Formation of singular and plural nouns and adjectives
- Feminine and Masculine Forms
- Definite and indefinite articles
- Possessive adjectives (feminine and masculine)
- Adjectives and adjective agreements
- Sentence structure

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Al-Kitaab fii TaCallum al-Arabyya: A Textbook for Beginning Arabic (Part 1), 3rd Edition, Brustad, Al-Batal, AlTonsi, Georgetown University Press, 2011. ISBN: 978-1-58901-736-8

ELEMENTARY FRENCH

Credits: 2+0
Pre-Requisite: Nil

DESCRIPTION

"Elementary French" offers students an introduction to the French language, covering essential vocabulary and grammatical structures for basic communication. Students will learn to engage in social interactions, discuss daily activities, express preferences, and describe personal experiences. The course emphasizes practical language skills necessary for everyday situations, such as greetings, shopping, and discussing food and leisure activities.

COURSE LEARNING OUTCOME

By the end of the course, students will be able to:

1. **Engage** in basic social interactions using greetings, numbers, and calendar expressions.
2. **Express** likes and dislikes on various topics, including weekend and school activities.
3. **Describe** aspects of your family, home, shopping experiences, and food preferences through basic vocabulary.
4. **Formulate** grammatically correct sentences in the present tense using regular and irregular verbs, subject pronouns, possessive adjectives, and the verbs "aller" and "venir" to express the future and immediate past.

COURSE OUTLINE

- Social greetings, Number, Calendar and time, expressing likes and dislikes, Talking about weekend and school activities, Family and the home, Shopping, Food
- Grammatical structures:
  - Subject pronouns and the verb être
  - Present tense regular –er verbs
  - Agreement and placement of adjectives
  - The verb aller and its use in expressing the future
  - The verb venir and the immediate past
  - Possessive adjectives
  - Present tense irregular verbs
  - Interrogative pronouns qui and que
  - Partitive article

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Débuts. Siskin, Williams-Gascon, Field. McGraw-Hill

ELEMENTARY CHINESE

Credits: 2+0
Pre-Requisite: Nil

DESCRIPTION

"Elementary Chinese" introduces students to the fundamentals of Mandarin Chinese, focusing on developing basic speaking, listening, reading, and writing skills. Students will learn Hànyǔ Pīnyīn for accurate pronunciation and recognize around 260 Chinese characters. The course covers essential grammar structures, vocabulary, and sentence patterns to enable students to communicate in simple everyday situations.

COURSE LEARNING OUTCOME

By the end of the course, students will be able to:

1. Utilize Hanyu Pinyin to accurately sound and read Chinese characters, mastering standard pronunciation.
2. Recognize and write approximately 260 basic Chinese characters, applying them in simple communication.
3. Construct grammatically correct sentences by understanding fundamental word order and the usage of particles in Chinese.
4. Formulate different types of questions to effectively seek information in daily situations.

COURSE OUTLINE

- Use Hanyu Pīnyīn to speak and read with standard Chinese pronunciation.
- Read and write about 260 Chinese characters.
- Understand the basic word order of Chinese sentences and the use of particles.
- Use different types of questions.
- Identify people and things
- Use time expressions and numbers.
- Use adjectives to describe people and things.
- Express possession and existence
- Express wishes, obligations, capabilities, possibilities and permissions.
- State likes and dislikes.
- Explain where something is located.
- Describe how an action is performed.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Kung Fu (I): An Elementary Chinese Text. By John C. Jamieson and Lin Tao. Hong Kong:Chinese University Press, 2002

HISTORY

Credits: 2+0
Pre-Requisite: Nil

COURSE LEARNING OUTCOME

By the end of the course, students will be able to:

1. Define the concept of history, distinguishing its key characteristics and recognizing its evolving nature.
2. Describe the intricate relationship between memory, historical records, and the construction of history, critically examining their interconnected roles.
3. Evaluate the nature of historical inquiry, including its methods, limitations, and potential biases.
4. Articulate the practical applications of studying history, recognizing its significance in informing decision-making, shaping identities, and contributing to a deeper comprehension of contemporary issues.
5. Explain the epistemological nature of history, including its methods of knowledge production and the challenges it faces.
6. Identify and categorize different forms of historical narratives based on their focus, methodology, and purpose.

COURSE OUTLINE

- What is History?
- Memory, Record and History
- Nature of History:
- Utility, Benefits & importance of History:
- Epistemological nature of History:
- Forms and Classification of History

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Burke, Varieties of Cultural History, Cornell University Press, 1977
2. Carlo, Ginzburg. Clues. Myths, and the Historical Method, John Hopkins: University Press, 1992
3. Carr, E. H., What is History? Harmondsworth: Penguin, 1961
4. Carr, E. H., What is History? Harmondsworth: Penguin, 1961
5. Cohn, Bernard. An Anthropologist among Historians and Other Essay, Oxford University Press, 1988
6. Collingwood, R. G. The Idea of History. Oxford: Oxford University Press, 1978.
7. Daniels, Studying History: How and Why, New Jersey, 1981.

8. Gertrude Himmalfarb. The New History and the Old, Cambridge: Harvard University Press, 1987
9. Govranski. History Meaning and Methods, USA, 1969
10. Hegel. Elements of the Philosophy of Right. Cambridge University Press, 1991

PHILOSOPHY

Credits: 2+0
Pre-Requisite: Nil

COURSE LEARNING OUTCOME

By the end of the course, students will be able to:

1. Examine the fundamental nature of philosophy, exploring its scope, purpose, and relevance to the engineering discipline.
2. Apply principles of arguments and logic in the context of philosophical analysis, developing the ability to construct and evaluate logical reasoning.
3. Assess the scope and limits of knowledge within the realm of epistemology, considering their impact on the acquisition and application of knowledge in engineering contexts.
4. Examine different perspectives on knowledge within epistemology, relating these perspectives to engineering practices and the development of technological solutions.
5. Analyze the concept of induction, exploring its role in reasoning and its applications in the engineering field.
6. Compare and contrast the philosophical perspectives of rationalism and empiricism, considering their implications for the understanding of engineering phenomena.
7. Explore philosophical perspectives on meaning, considering how these perspectives influence the interpretation and significance of concepts within engineering contexts.

COURSE OUTLINE

- Introduction: The Nature of Philosophy
- Arguments and Logic in Philosophy
- Epistemology – Skepticism and Certainty
- Epistemology: The Scope and Limits of Knowledge
- Epistemology: Knowledge
- Induction
- Rationalism and Empiricism
- Philosophy and Meaning

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Hales, S. D. (2021). This is philosophy: An introduction. John Wiley & Sons.
2. Hospers, J. (2013). An introduction to philosophical analysis. Routledge.
3. Hurley, P. J. (2014). A concise introduction to logic. Cengage Learning.
4. Rachels, J., & Rachels, S. (1986). The elements of moral philosophy (p. 9). Philadelphia: Temple University Press.

5. Solomon, R. C., & Higgins, K. M. (2013). The big questions: A short introduction to philosophy. Cengage Learning.
6. Stewart, D. (2010). Fundamentals of Philosophy. 6th. Boston: Pearson

PROFESSIONAL ETHICS

Credits: 2+0
Pre-Requisite: Nil

DESCRIPTION

The objective of this course is to grasp ideals and principles as they have been spelled out in a variety of traditional ethical systems and to apply these conceptual structures and guidelines to major problems and dilemmas of engineering practices in a corporate culture.

COURSE LEARNING OUTCOME

By the end of the course, students will be able to:

1. Understand the ethical principles and theories underpinning engineering practice, including moral autonomy and professional obligations.
2. Critically analyze codes of ethics and apply ethical frameworks to evaluate engineering decisions in various contexts.
3. Assess safety, risk, and environmental considerations in engineering design, incorporating principles of sustainable development and risk-benefit analysis.
4. Navigate complex ethical dilemmas related to confidentiality, conflict of interest, and whistle-blowing, considering the rights and responsibilities of employees and employers.
5. Demonstrate ethical leadership and engage in responsible engineering practices that prioritize public welfare, environmental stewardship, and social justice.

COURSE OUTLINE

- Profession; What is a Profession? and Professional Ethics.
- Ethics; What is Ethics?, Why study Ethics?, Professional Ethics, Difference between Laws, morals, and Ethics: Character Ethics, Personality Ethics, Value &Virtue Ethics, and Characteristics of Code of Ethics
- Personality Traits, Desirable Personality Traits and Undesirable Personality Traits, Trust and Honesty, Sincerity, Truthfulness, Politeness, Respect & Etiquettes,
- Human values, values, morals and ethics, Moral Code of Islam, Struggle for Rizq e Halaal. To identify and adopt the legitimate, lawful and ethical sources of earning / livelihood.
- Moral development, moral dilemma, dealing with moral dilemma, moral autonomy, Fulfilment of Promise, Pride and Arrogance, Malpractice, Engineer's moral rights, right of professional conscience, professional rights and Ethical theories, intellectual property rights, patents, design, trademark etc.

- Professional ethics, role of professional bodies, Engineering code of ethics, Engineering ethics, training in preventive ethics, questionable engineering practices, Micro and Macro ethics, examples of moral problems in engineering. Time management, Cooperation
- Inter-Personal Relations (Employer-Employee relationship), employee rights, professionalism and loyalty, right to protest, obligation of confidentiality, effect of change of job on confidentiality, conflict of interest. Grievances, Welfare, health & safety of personnel, whistleblowing and its features, types, procedures to be followed and conditions to be satisfied before whistle blowing
- Problem-Solving, Decision-Making, Engineers responsibilities towards society welfare, environment degradation, bio-centric ethics, Ecocentric ethics, Human centered environmental ethics, Global examples of catastrophic engineering incidents. Safety, responsibilities and rights; safety and risks, responsible engineering, cost of unsafe designed product, Moral thinking, tests in moral problems solving, problem solving in engineering ethics, case studies.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Engineering Ethics: Concepts and Cases by Charles E. Harris Jr, 2018, 6th Ed., Cengage Learning, ISBN:978-1337554503
2. Ethics in Engineering by Mike Martin, 2022, 5th Ed., McGraw Hill, ISBN: 9781260721744
3. Attributes of Muslim Professionals in the Light of Quran & Sunnah by Akram Muhammad Zeki, 2021, Ilum Press, ISBN: 9789674911201

CIVICS AND COMMUNITY ENGAGEMENT
UGE Policy V1.1: General Education Course

Credits: 2+0
Pre-Requisite: Nil

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.

COURSE LEARNING OUTCOMES

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

1. Demonstrate fundamental understanding of civics, government, citizenship and civil society.
2. Understand the concept of community and recognize the significance of community engagement for individuals and groups.
3. Recognize the importance of diversity and inclusivity for societal harmony and peaceful co-existence.

COURSE OUTLINE

1. **Introduction to Civics and Citizenship**
   - Definition of civics, citizenship, and civic engagement
   - Historical evolution of civic participation
   - Types of citizenship: active, participatory, digital etc.
   - The relationships between democracy and citizenship
2. **Civics and Citizenship**
   - Concepts of civics, citizenship, and civic engagement.
   - Foundations of modern society and citizenship.
   - Types of citizenship: active, participatory, digital, etc
3. **State, Government and Civil Society**
   - Structure and functions of government in Pakistan.
   - The relationship between democracy and civil society.
   - Right to vote and importance of political participation and representation.

4. **Rights and Responsibilities**
   - Overview of fundamental rights and liberties of citizens under Constitution of Pakistan 1973.
   - Civic responsibilities and duties.
   - Ethical considerations in civic engagement (accountability, non-violence, peaceful dialogue, civility, etc.)
5. **Community Engagement**
   - Concept, nature and characteristics of community.
   - Community development and social cohesion.
   - Approaches to effective community engagement.
   - Case studies of successful community driven initiatives.
6. **Advocacy and Activism**
   - Public discourse and public opinion.
   - Role of advocacy in addressing social issues.
   - Social action movements.
7. **Digital Citizenship and Technology**
   - The use of digital platforms for civic engagement.
   - Cyber ethics and responsible use of social media.
   - Digital divides and disparities (access, usage, socioeconomic, geographic, etc.) and their impacts on citizenship.
8. **Diversity, Inclusion and Social Justice:**
   - Understanding diversity in society (ethnic, cultural, economic, political etc.).
   - Youth, women and minorities' engagement in social development.
   - Addressing social inequalities and injustices in Pakistan.
   - Promoting inclusive citizenship and equal rights for societal harmony and peaceful co-existence.

SUGGESTED PRACTICAL ACTIVITIES (OPTIONAL)

As part of the overall learning requirements, the course may have one or a combination of the following practical activities:

1. **Community Storytelling:** Students can collect and share stories from community members. This could be done through oral histories, interviews, or multimedia presentations that capture the lived experiences and perspectives of diverse individuals.

2. **Community Event Planning:** Students can organize a community event or workshop that addresses a specific issue or fosters community interaction. This could be a health fair, environmental cleanup, cultural festival, or educational workshop.

3. **Service-Learning:** Students can collaborate with a local nonprofit organization or community group. They can actively contribute by volunteering their time and skills to address a particular community need, such as tutoring, mentoring, or supporting vulnerable populations.

4. **Cultural Exchange Activities:** Students can organize a cultural exchange event that celebrates the diversity within the community. This could include food tastings, performances, and presentations that promote cross-cultural understanding.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Civics Today: Citizenship, Economics, & 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.

List of Social Science Electives (2+0)
• Sociology for Engineers
• Sociology
• Social phycology
• Critical Thinking
• Human Resource Management
• Organizational Behavior
• Engineering Law
• Engineering Economics
• Applied Psychology
• Engineering Management
• Financial Management
• Marketing Management
• Leadership and Personal Grooming

SOCIOLOGY FOR ENGINEERS

Credits: 2+0
Pre-Requisite: Nil

DESCRIPTION

This course is meant to provide engineering students, with an opportunity to view the discipline of sociology from the engineering perspective and will highlight its application to engineering profession. This will also enable the engineers to fit their technical ideas into a socially acceptable product /project in a more successful manner.

COURSE LEARNING OUTCOMES

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

1. Introduce to the methods and philosophy of the social science to help their understanding of the socio-cultural dimension of human existence as a fundamental reality in engineering projects etc.
2. To provide opportunity for students to begin the process of considering social problems/ issues while designing engineering products.
3. To allow engineers to play a pro-active role in critical discussions of social issues specifically.
4. To demonstrate comprehension of roles and functions of various social institutions, state organizations, Professional bodies and relationships for analyzing their social impact Assessment.

COURSE CONTENT

- **Fundamental Concepts and Importance of Sociology for Engineers**

  What is sociology? Nature, Scope, and Importance of Sociology, Sociological Perspectives and Theories, Social Interactions, Social Groups/ Social Institutions & heir interface with Engineering Project/services, Sociology & Impact of Technology & Engineering Products/Projects on Society.

- **Cultural Impacts of Engineering Projects on Society**

  Definition of Culture, Types of Culture & Elements of Culture, Culture & Power, Authority, Dominance Socialization and Personality, Role of Engineering Projects on Culture, social norms and values of Society, Cultural Infusion of Engineers in Society.

- **Theoretical Perspective of Sociology: Diffusion and Innovation; Adoption and Adaptation; Social development; Community Development**

  Community Development & Social consequences of Industrialization, Development Processes of Societal Development, Cooperation and Conflict in Community Development in Engineering Context.

- **Understanding of Societal & Ethical Norms and Values for Engineers**

  Engineering Ethics, Engineering product/services for Less privileged, Role of Engg & Technology in addressing Social inequality, Core Social Values/ Norms affecting Engg Performance

- **Organizational Social Responsibility (OSR) of Engineers**
  - Extent to which development intends to sensitize societal and under privileged needs
  - Gender inclusiveness and balance
  - Special and Disadvantaged Community of the Area o Planning for community inclusiveness
  - Societal Obligation of Engineers
- **Engineers, Society and Sustainability**

  Social System and Concept of Sustainable Development Technology and Development, Population Dynamics in Pakistan, Causes and Consequences of Unplanned Urbanization, Community Development, Programs in Pakistan, Community Organization & Engineering Projects, Population, Technological & Industrial expansion and Development with focus on social/human/ethical dimensions.

- **Industrial & Organizational Psychology**

  Interpersonal Relations, Interpersonal Behavior, Formation of Personal Attitudes, Language and Communication, Motivations and Emotions, Impact of Technology on human feelings and level of Sensitivity

- **Climate Change and Ecological Friendliness from Engineering Perspective**

  Ecological Processes, Ecosystem and Energy, Impact of Engineering Projects on Eco System & Human Ecology, Industrial & Environmental impact on Population & General Masses, Technological Intervention, Ecosystem and Physical Environment, Social Impact of Technology & Engineering Products & Services (Solid Waste Disposal, Pollution control etc.).

- **Social Approaches and Methodologies for Development Administration & Stakeholders Analysis:**

  All Phases of the Project (pre, post and execution) Structured, Focused Group, Stakeholder Consultative Dialogues etc. Dynamics of Social Change, Sociology of Change and Industrial Development, Social Change due to Technology Driven Economic Growth.

- **Case Studies of Different Development Projects in Social Context**
- **SIA (Social Impact Assessment):**

  Base line and need-assessment, evaluation and impact assessment surveys of the development projects. Role of Engg & Technology for Creating Social Cohesiveness & Societal Integration. Technology Based change in Collective

Behavior, Social Audit of Engineering Projects

- **Engineering Intervention for Social Stratification**

  Factors of Social Stratification, Engineering Interventions for addressing Social Stratification, Social Mobilization through Technological Innovation.

SUGGESTED INSTRUCTIONAL/READING MATERIALS

1. Godhade, J. B., and S.T. Hunderkari. 2018. Social Responsibility of Engineers. International Journal of Academic Research and Development. Vol. 03; Special Issue. March, 2018.
2. Nichols,S.P.andWeldon,W.F.2017. Professional Responsibility: The Role of Engineering in Society Center for Electro-mechanics, The University of Texas at Austin, USA.
3. Aslaksen,E.W.2016. The Relationship between Engineers and Society: is it currently fulfilling its potential? Journal and Proceedings of the Royal Society of New SouthWales,Vol.148.Nos.455-456. Gumbooya Pty Lte, Allambie Heights, Australia.
4. Bell, S. Engineers, Society and Sustainability. Synthesis Lectures on Engineers, Technology, and Society. Edited by Caroline Baillie, University of Western Australia. Morgan and Claypool Publishers
5. Jamison,A.,Christensen,S.H.,andLars,B.2011.A Hybrid Imagination: Science and Technology in cultural perspective
6. Vermaas,P.,Kroes,P.,Poet,l.,andHoukes,W.2011. APhilosophyofTechnology:FromTechnical Artefacts to Socio technical systems.
7. Mitcham,C.,andMunoz,D.2010.HumanitarianEngineering. MorganandClaypoolPublishers. Riley,D.2008.Engineering and Social Justice. Morgan and Claypool Publishers.
8. Bugliarello,G.1991.TheSocial Functions of Engineering: A Current Assessment, A Chapter in“ Engineering as A Social Enterprise. Sociology

SOCIOLOGY

Credits: 2+0
Pre-Requisite: Nil

COURSE LEARNING OUTCOMES

1. To introduce the necessary subject knowledge and understanding required for the successful study of Sociology and related Social Science disciplines at undergraduate.
2. To develop skills of application, analysis and evaluation in the context of the study of Social Science.
3. To develop a knowledge and understanding of sociology both at a global and national level.
4. To introduce the planning and organization skills necessary to develop as independent, autonomous learners.
5. To develop the confidence and competence of the students as learners and to assist them in taking some responsibility for their own learning through directed study and reading.

COURSE CONTENT

- Introduction: Sociological Perspective,
- The Development of Sociology,
- The Role of Values in Sociology, Prejudice In Early Sociology,
- Theoretical Perspective in Sociology. Culture: Components of Symbolic Culture, Subcultures and Counter Cultures, Cultural Universals, Animals and Culture,
- Technology and Global Village, Sociology and New Technology.
- Socialization: Social Development of Self, Mind, and Emotions,
- Socialization into Gender Social Structure and Interaction,
- Social Institutions. Research in Sociology: Research Model, Research Methods. Experiments, Ethics,
- Bureaucracy and Formal Organizations, Rationalization of Society, Formal Organizations and Bureaucracy,
- Voluntary Associations Social Classes, Economy, Politics, Power and Authority, Family, Medicine, Health and Illness, Population and Urbanization, Social Movements
- Social Psychology with special reference to attitudes, attributions and behavior, Emotions, Cognition and Thinking, Reasoning, Problem-Solving and Creativity, Personality, Intelligence, and Abnormal Behavior, etc.

- Introduction to the Field of Organizational Behaviour
- Conflict and Negotiation in the Workplace
- Leadership in Organizational Settings and Organizational Culture
- Ethics: In General an introduction and the development of ethical theory.
- Ethics in Islam, a comprehensive view with different ethics approaches and Ethics Theories
- Research Methods for Society and Sociology

SUGGESTED INSTRUCTIONAL/READING MATERIALS

1. Henslin, Sociology: A Down-to-Earth Approach, latest edition.
2. D. Kendall, Sociology in our Times. Wadsworth Pub Co, latest edition.

SOCIAL PSYCHOLOGY

Credits: 2+0
Pre-Requisite: Nil

COURSE LEARNING OUTCOMES

To impart knowledge of social psychology of attraction; attitudes and prejudice; altruism and aggression; personal and social identities; conformity; group influence and their applications in the real world

COURSE CONTENT

- Principles of sociology and psychology with emphasis on the individual and his/her reciprocal interaction with groups,
- basic psychological factors, attribution and perception of others, attitudes and attitudinal change, social attitudes, altruism, helping others, aggression, hurting others, prejudice, disliking others, discrimination and stereotypes,
- language and communication, society and cultures, culture and personality, small groups and their relation to the individual, leadership and group dynamics. Attraction, attitudes and prejudice; altruism and aggression; personal and social identities, conformity, group influence, moral and ethical issues, harassment,
- corruption and its control, thinking processes and decision making.

SUGGESTED INSTRUCTIONAL/READING MATERIALS

1. Edward Alsworth Ross, "Social Psychology", Macmillan, latest edition.
2. Emory Stephen Bogardus, "Essentials of Social Psychology", Univ. of Southern, California Press, latest edition.
3. Hewstone, M., & Stroebe, W. (Eds.), "Introduction to Social Psychology", 3rd ed., Oxford: Blackwell Publishers, latest edition.
4. Lesko, W.A. "Readings in social psychology General, classic, and contemporary selections, latest edition,

CRITICAL THINKING

Credits: 2+0
Pre-Requisite: Nil

COURSE LEARNING OUTCOMES

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

1. Define critical thinking and identify its benefits in the workplace.
2. List the characteristics of a critical thinker and distinguish them from other types of thinking.
3. Identify the steps involved in the critical thinking process.
4. Explain the importance of asking questions, actively listening, and challenging assumptions.
5. Describe common creative thinking techniques like brainstorming, mind mapping, and De Bono's thinking hats.
6. List and explain root cause analysis techniques like the 5 Whys and Ishikawa Diagram.
7. Identify and adapt your REACH profile to support critical thinking.
8. Describe strategies for effectively presenting recommendations to decision-makers and stakeholders.

COURSE CONTENT

- Course Overview
- Introduction
- Introduction to Critical Thinking
- Benefits of critical thinking in the workplace
- Critical thinking as a management skill
- What are the characteristics of a critical thinker?
- Other Types of Thinking
- 5 Different thinking styles
- Module Reflection
- A Critical Thinker's Mindset
- Can you develop a critical thinker's mindset?
- The Critical Thinking Process
- Step 1 - Identifying the problem
- Step 2 - Gather and evaluate your information
- Step 3 - Generate alternative solutions
- Step 4 - Select and implement a solution
- Step 5 - Evaluate your solution
- Developing Critical Thinking Skills

- Asking questions
- Active listening
- Challenging assumptions
- Creative Thinking Techniques
- Brainstorming
- Imagining the opposite
- Mind mapping
- De Bono's thinking hats
- Root Cause Analysis Techniques
- Identifying the cause of a problem
- Ishikawa Diagram (Fishbone Diagram)
- 5 Whys technique
- SWOT analysis
- Using Your REACH Profile to Support Critical Thinking
- Adapting your profile
- Presenting Your Recommendations
- Seeking approval from decision makers and Stakeholders

SUGGESTED INSTRUCTIONAL/READING MATERIALS

1. Critical Thinking for Students Roy van den Brink-Budgen (4th Edition)
2. Thinking, Fast and Slow Daniel Kahneman (2011)

HUMAN RESOURCE MANAGEMENT

Credits: 2+0
Pre-Requisite: Nil

COURSE LEARNING OUTCOMES

At the conclusion of the course, the students will be able to:

1. Understand key challenges and trends in Human Resource Management (HRM).
2. Compare and contrast global and local HRM practices.
3. Explain basic principles of HRM from Islamic and indigenous perspectives.
4. Apply job analysis techniques, including HR planning, job description, and specification.
5. Differentiate between compensation and benefit packages and their management.
6. Explain staffing strategies, covering recruitment techniques, sources, and selection tests.
7. Identify key elements of employee relations.

COURSE CONTENT/ COURSE OUTLINE

- Emerging Human resource management challenges.
- Trends in HRM
- Global vs local HRM practices
- HRM from Islamic and indigenous perspective
- Basic Islamic philosophy of managing human resource
- Conducting Job analysis.
- HR Planning
- Job Description
- Job Specification
- Staffing
- Recruiting and selecting employees
- Recruitment techniques
- Sources of recruitment
- Selection tests and Interviewing techniques
- Employee development
- Performance appraisals
- Performance management
- Training and development

- Performance appraisals
- Performance management
- Training and development
- Training the employees
- Types of training
- Technique of training
- Project Description and discussion
- Compensations
- Managing compensation
- Types of compensation
- Rewarding performance
- Pay for Performance
- Designing and administering benefits
- Types of benefits
- Employee relations

SUGGESTED INSTRUCTIONAL/READING MATERIALS

1. By Luis R. Gomez Mejia, David B. Balkin, Robert L. Cardy Managing Human Resources. (Fourth ed.)

ORGANIZATIONAL BEHAVIOUR

Credits: 2+0
Pre-Requisite: Nil

DESCRIPTION

"Organizational Behaviour" delves into understanding human behaviour within organizational settings, exploring topics such as structure, learning, stress management, motivation, leadership, group dynamics, and organizational culture. Through theoretical frameworks and practical applications, students gain insights into individual and group behaviours, organizational dynamics, and strategies for effective management.

COURSE LEARNING OUTCOMES

At the conclusion of the course, the students will be able to:

1. Analyze the structures and controls within organizations, including bureaucratic systems, managerial roles, and contingency theories.
2. Evaluate individual learning processes, stress management techniques, and the impact of individual differences on organizational behaviour.
3. Examine motivational theories and their application in enhancing job satisfaction and organizational performance.
4. Assess group dynamics, including social interactions, group processes, and leadership styles, to foster effective teamwork and collaboration.
5. Understand the significance of organizational culture, its role in shaping organizational identity and behaviour, and strategies for managing and evaluating organizational culture.

COURSE CONTENT/COURSE OUTLINE

- **Introduction to Organizational Behaviour**
  - Organizational Disciplines and topics
  - Psychological Perspective
  - Social-Psychological Perspectives
- **Structure and Control in Organizaion**
  - Introduction of Bureaucracy
  - Managerial Work
  - Contingency theory
  - Organizational Design
- **Individual and Work Learning**
  - Learning Theories
  - Learning and Work
- **Stress**
  - Types of Stress and Work
  - Occupational Stress Management

- **Individual Differences**
  - Personality and its factors
  - Personality dimensions and social learning Intelligence
- **Motivation and Job Satisfaction**
  - Needs at Work
  - Theories of Motivation and job satisfaction
  - Correlates of Job satisfaction
- **Group and Work**
  - Social Interaction
  - Dramaturgy and impresion Management
  - Social Skill

Group and Inter group Behaviour

- Group Structure & Norms
- Group Processes
- How throne Studies
- **Leadership**
- Leadership as an attribute
- Leadership Style
- **Patterns of Work**
- Work-the classical approach
- Marx, Weber, & The critique of labor
- Foucault & Disciplinary Power
- Conflict and Consent in Work
- The labor Process debate
- Work place control and resistance
- Industrial conflict and industrial relations
- **Organizational Culture**
- Organizational culture and strategic management
- Exploring organizational culture
- Evaluating concept of culture

SUGGESTED INSTRUCTIONAL/READING MATERIALS

1. Finchan, R., & Rhodes, P. Principles of Organizational Behaviour. Oxford, 3rd edition, 2003.
2. Noe, R., Hollenbeck, J., Gerhart, B., & Wright, P. Human Resource Management. McGraw Hill, 5th edition, 2006.
3. Newstrom, J. W. Organizational Behaviour. McGraw Hill, 12th edition, 2007.
4. Luthan, F. Organizational Behaviour. McGraw Hill Inc., 2005.
5. Robins, S. Organizational Behaviour. McGraw Hill Inc., 2005.

ENGINEERING LAW

Credits: 2+0
Pre-Requisite: Nil

COURSE LEARNING OUTCOMES

At the conclusion of the course, the students will be able to:

1. Define key terms: legal studies, law, sources of law.
2. Comprehend the fundamental principles of contract law as they relate to engineers.
3. Recognize the duty of care for engineers and grasp the concept of negligence in engineering. Gain insight into aspects of employment law relevant to engineers.
4. Understand intellectual property concepts, including designs, patents, copyright, and their application in engineering.
5. Learn how to enforce rights to intellectual property in the context of engineering.

COURSE CONTENT/COURSE OUTLINE

- Introduction to legal studies,
- Concepts and sources of law,
- Basic principles of the law contract as it relates to engineers,
- The duty of care for engineers and the concept of negligence,
- Aspects of employment law;
- Intellectual property,
- Designs, patents,
- Copyright in engineering,
- Enforcing rights to intellectual property.

SUGGESTED INSTRUCTIONAL/READING MATERIALS

1. R E laidlaw, C R Young, A R Dick, Engineering Law, University Press, 1958.
2. C F Allen, Business law for engineers, University of Michigan library, 1919.

ENGINEERING ECONOMICS

Credit: 2+0
Pre-Requisites: Nil

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.

COURSE LEARNING OUTCOMES

Upon completion, participants gain expertise in making strategic economic decisions, evaluating project cash flows, and navigating economic uncertainties in engineering projects. The course equips individuals to analyze costs, assess financial viability, and contribute effectively to engineering economic decision-making processes.

COURSE OUTLINE

Engineering Economics

- Role of engineers in business
- Economic decisions v/s design decisions
- Large scale engineering projects and types of strategic economic decisions
- Fundamental principles of engineering economics

Interest Rate and Economic Equivalence

- Interest: The Cost of Money
- Economic Equivalence
- Development of Formulas for Equivalence Calculation
- Unconventional Equivalence Calculations

Understanding Money and Its Management

- Nominal and Effective Interest Rates
- Equivalence Calculations with Effective Interest Rates and with Continuous Payments
- Changing Interest Rates
- Debt Management
- Investing in Financial Assets

Present-Worth Analysis

- Project Cash Flows
- Initial Project Screening Methods: payback Screening and Discounted Cash Flow Analysis
- Variations of Present-Worth Analysis
- Comparing Mutually Exclusive Alternatives

Annual Equivalent-Worth Analysis
- Annual Equivalent-Worth Criterion
- Capital Costs versus Operating Costs
- Applying Annual-Worth Analysis
- Life-Cycle Cost Analysis
- Design Economics

Rate-of-Return Analysis
- Rate of Return and Methods of Finding It
- Internal Rate-of-Return Criterion
- Mutually Exclusive Alternatives

Cost Concepts Relevant to Decision Making
- General Cost Terms; Classifying Costs for Financial Statements
- Cost Classifications for Predicting Cost Behavior
- Future Costs for Business Decisions
- Estimating Profit from Production

Depreciation and Corporate Taxes
- Asset Depreciation: Economic versus Accounting
- Book and Tax Depreciation Methods (MACRS)
- Depletion
- Income Tax Rate to be used in Economic Analysis
- The Need for cash Flow in Engineering Economic Analysis

Developing Project Cash Flows
- Cost-Benefit Estimation for Engineering Projects
- Developing Cash Flow Statements

Project Risk and Uncertainty
- Origins of Project Risk
- Methods of Describing Project Risk: Sensitivity, Break-Even and Scenario Analysis

Special Topics in Engineering Economics
- Replacement Decisions
- Capital Budgeting Decisions
- Economic Analysis in the Service Sector

SUGGESTED INSTRUCTIONAL/ 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.

APPLIED PSYCHOLOGY

Credit Hours: 2+0
Pre-Requisites: Nil

COURSE OUTLINE

Understanding Psychology
- Psychology: Scientific perspective
- Historical perspective
- Schools of psychology
- Methods of psychology
- Ethical issues
- Fields of psychology and their application

Biological Basis of Behavior
- Neuron and its function
- Central nervous system
- Peripheral nervous system
- Endocrine system

Sensation and Perception
- Senses: Vision, audition, smell, taste and kinesthetic
- Introduction to perception
- Gestalt principles
- Binocular and monocular cues
- Illusions and extra sensory perception

Learning
- Definition of learning
- Types of learning: Classical and operant conditioning
- Punishment and its effects
- Latent and observational learning

Memory
- Definition and types of memory
- Processes and techniques of improving memory
- Forgetting: Nature and causes

Cognition and Language
- Concept of cognition
- Problem solving
- Judgment and decision making
- Language development
- Language and cognition
- Language and culture

Intelligence and Creativity
- Concept of intelligence
- Theories of intelligence
- Assessment of intelligence

- Mental retardation
- Concept of creativity and its stages

Motivation and Emotion

- Introduction to motivation
- Factors affecting motivation
- Introduction to emotions
- Types of emotions
- Physiology and emotion
- Theories of emotion

Personality

- Defining personality
- Theories of personality
- Personality assessment

Social Thinking and Social Influence

- Social facilitation
- Attribution theory
- Crowd behavior
- Conformity, Obedience
- Helping behavior

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Atkinson R. C., & Smith, E. E. (2000).Introduction to psychology (13th ed.). NY: Harcourt
2. Brace College Publishers.
3. Coon, D., &Mutterer, J. (2008).Introduction to psychology: Gateways to mind and behavior
4. (12th ed.). USA: Wadsworth Cengage Learning.
5. Fernald, L. D., & Fernald, P.S (2005).Introduction to psychology. USA; WMC Brown Publishers

ENGINEERING MANAGEMENT

Credit Hours: 2+0
Pre-Requisites: Nil

DESCRIPTION

This course delves into the multifaceted aspects of technology commercialization, offering a comprehensive exploration of industrial networks, product and process development, and the critical skills required for successful business ventures. Participants will gain practical knowledge and experience in navigating the journey from concept to market, with a focus on problem-solving, teamwork, and outreach activities.

COURSE LEARNING OUTCOMES

Upon completion, participants will possess the skills and knowledge necessary for successfully commercializing new technological inventions. They will be adept at navigating the various stages, from proof of concept to market distribution, and equipped to develop robust business plans aligned with market demands and technological advancements.

COURSE OUTLINE

- Industrial networks
- Fundamentals of Product and Process development
- Business Community and New Generations of Managers
- Practical Skills Knowledge and Experience in Commercialization of New Technological Inventions
- Use of Multidisciplinary Science Based Knowledge,
- Problem Solving, Teamwork and Outreach Activity,
- Major steps in proof of concept to intellectual property protection,
- Prototype development
- Fabrication and assembly routes
- Materials procurement,
- Identification and creation of new markets
- Development of business plan
- Appropriate technology and marketing
- Distribution and financing
- Routes and strategies for specific technology under development.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. R. A. Bulgelman, Strategic Management of Technology and innovation, latest Edition McGraw Hill.

FINANCIAL MANAGEMENT

Credit Hours: 2+0
Pre-Requisites: Nil

COURSE OUTLINE

Risk and return (Required rate)

- Risk and Return Fundamentals: Definition, and Meanings; Basic Model; Risk Preference, Risk Preferences Behaviors; Risk of a Single Asset: (1) Risk Assessment including Scenario Analysis and Probability Distribution and (2) Risk Measurement including Standard Deviation and Coefficient of Variation; Risk of a Portfolio: Portfolio Return and Standard Deviation, Correlation, Diversification; The Capital Asset Pricing Model (CAPM): (1) Types of risk and (2) The CAPM Model covering Beta Coefficient, The Equation, The Graph, The security Market Line (SML) and Shifts in the security Market Line

Short-term Financing Decisions (Current Assets and Current Liabilities)

- Current Asset Investment Policies
- Working Capital Management
- Working Capital Terminologies: Gross VS Net; Trade-off between Profitability and Risk

Cash Operating / Conversion Cycle

- Calculating Cash Conversion Cycle; Funding Requirement of the Cash Conversion Cycle; Cash Management Alternative Strategies; Cash Budget

Management of Marketable Securities

- Inventory Management
- Inventory Levels and Costs; Common Techniques for managing Inventory

Receivables Management

- Credit Selection and Standards; Credit Terms and Policy; Credit Monitoring

Management of Receipts and Disbursements

- Float; Speeding-up Receipts and Slowing-down Payments; Cash Concentration; Zero-balance Accounts

Generic Current Assets' Management

- Financing Current Assets; Alternative Current Asset Financing Policies; Advantages and disadvantages of Short Term Financing

Management of Current Liabilities

- Sources of Short Term Financing; Spontaneous Liabilities; Accounts Payable Management; Accruals; Unsecured Sources of Short Term Financing; Bank Loans; Commercial Papers; Secured Sources of Short Term Financing; Accounts Receivables as Collaterals; Inventory as Collateral

Leverage and Capital Structure

- Leverage; Meanings and Use of Leverage; Breakeven Analysis; Operating Leverage; Financing Leverage; Capital Structure; Types/Dimensions of Capital; External Assessment of Capital Structure; Theory of Capital Structure; Target/Optimal Capital Structure, and its Determination; EBIT – EPS Approaches to Capital Structure; Variations in Capital Structures; Comparing Alternative Capital Structures; Capital Structure and Risk; Value Estimation; Maximizing Value VS Maximizing EPS

Payout Policy

- Mechanics of Payout Policy; Factors affecting Dividend Policy; Classification of Dividend Policies (General and w.r.t. Pakistan)

Long-term Debt Management

- Long-term Debt Considerations; Corporate Bonds; Preferred Stock; Leases; Mergers of Definition of Mergers; Convertible Securities; Options of Major Types of Options

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Brigham F Eugene, Houston F Joel (Latest edition), Fundamentals of Financial Management, South Western Publishers, Ohio
2. Lawrence J. Gitman, Latest Edition, 'Principles of Managerial Finance'
3. Horne Van, Jr. Wackowicz (Latest Edition), Fundamentals of Financial Management,
4. Apprentice Hall International Inc, New Jersey

MARKETING MANAGEMENT

Credit Hours: 2+0
Pre-Requisites: Nil

COURSE OUTLINE

- Defining Marketing For The 21st Century. Importance and scope of Marketing.
- Discussion on Course Outline:
- Some fundamental Marketing Concepts, How Marketing Management changed. How does the Marketing affect customer Value? Discussion on Project Outline
- Identifying Market Segments and Targets. Different levels of market segmentation & requirements of effective segmentation? How companies divide a market into segments?
- Creating and delivering Customer Value, satisfaction and loyalty. What is the lifetime value of customers and how can marketers maximize it? How can companies cultivate strong customer relationship? How can companies both attract and retain customers?
- Analyzing Consumer Markets & Globalization How do consumer characteristics influence buying behavior & major psychological processes influence consumer Reponses to the marketing program?
- Crafting the Brand Positioning How can a firm choose and communicate an effective positioning in the market & how brands are differentiated.
- Creating Brand Equity Neuro Marketing How brands create brand Equity
- Setting Product Strategy Product characteristics & classification How companies differentiate products?
- How should a company set prices initially for products or services? When should company initiate a price change? How should a company respond to a competitor's price change?
- Designing and Managing Value Networks and Channels. The students need to recognize the importance of designing marketing channel system
- Managing Retailing, Wholesaling Why companies choose different marketing channels and how these marketing channels perform?
- Designing & Managing Integrated Marketing Communications Role of Marketing Communication. What are the guidelines for effective marketing communication mix?
- Managing Mass Communications: What steps are required in developing an advertising program? How should sales promotion decisions be made? What are the guidelines for effective brand-building events and experiences?
- Sales Promotions, Events Public Relations. Service Marketing Presentation

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Marketing Management 16th Edition (A South Asian Perspective) by Philip Kotler & Kevin Lane Keller.
2. Basic Marketing (1st Edition) by Salman Zaheer
3. Blue Ocean Strategy by Renée Mauborgne and W. Chan Kim

LEADERSHIP AND PERSONAL GROOMING

Credit Hours: 2+0
Pre-Requisites: Nil

COURSE OUTLINE

Fundamentals of Leadership and Servant Leadership

- What is leadership; Leadership Traits; Servant Leadership

Foundations of Community Development

- The frame work for community and economic development; Seven theories for seven community developers; Bases of community development; Process of community development; Challenges of the process

Social Capital, Community Building and Community Development Practice

- Social capital; Community social capacity and how does it influence development • Intentional action to increase social capacity; Factors that influence the success of community-building efforts; Principles and process of practicing community development; How does community development practice relate to economic development? Professional standards of ethical practices in community development

Community development assessment,

- Community Asset mapping and surveys, Assessing local economy.
- Community Mapping; Surveys Forms; The importance of asset mapping.

Building Powerful Community Organizations

- Bringing a group together; Scanning the functions of Community Organizations present in the market; The idea generation; Developing Vision, Mission and Goals; Structuring the Organization; Defining SOPs

Marketing your Organization

- Marketing a Community Organization; Effective role and guidelines for conducting meetings

Mobilizing Resources: Raising Money

- Community development finance; Finding sources of money; Securing grants for community development projects; Preparing grant proposals

Measuring Progress

- Community development indicators, Best practices & Benchmarking

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. The heart of leadership: A leader people want to follow by Mark Miller, Berret-Kohler Publisher 2013.
2. Leadership and Art of Struggle by Steven Snyder & B. Geage Berret Kohler Publisher 2013.
3. Strategic Leadership: How to think and plan by John Adair, Kogan Page Ltd 2010

ENTREPRENEURSHIP
UGE Policy V1.1: General Education Course

Credits: 2+0
Pre-Requisites: Nil

DESCRIPTION

This course is designed to promote entrepreneurial spirit and outlook among students, encouraging them to think critically, identify opportunities, and transform their ideas into successful ventures. It aims at imparting them with the requisite knowledge; skills and abilities, enabling them to seize the identified opportunities for initiating ventures and successfully navigating the challenges that come with starting business and managing it. The course covers topics relevant to entrepreneurship including setting up and initiation of business (including requirements for registration and incorporation with regulators such as SECP and others), market research, opportunity identification, business planning, financial literacy for managing finances and securing funding, marketing and sales, team building and innovation. Overall, the course is geared towards personal growth and professional development for pursing innovative ideas, availing opportunities and initiating start-ups.

COURSE LEARNING OUTCOMES

By the end of this course, students shall have:

1. Knowledge of fundamental entrepreneurial concepts, skills and process;
2. Understanding on different personal, social and financial aspects associated with entrepreneurial activities;
3. Basic understanding of regulatory requirements to set up an enterprise in Pakistan, with special emphasis on export;
4. Ability to apply knowledge, skills and abilities acquired in the course to develop a feasible business plan for implementation.

COURSE OUTLINE

1. Introduction to Entrepreneurship:

- Definition and concept of entrepreneurship;
- Why to become an entrepreneur?
- Entrepreneurial process;
- Role of entrepreneurship in economic development.

2. Entrepreneurial Skills:

- Characteristics and qualities of successful entrepreneurs (including stories of successes and failures);

- Areas of essential entrepreneurial skills and ability areas such as creative and critical thinking, innovation and risk taking.

3. Opportunity Recognition and Idea Generation:

- Opportunity identification, evaluation and exploitation;
- Idea generation techniques for entrepreneurial ventures.

4. Marketing and Sales:

- Target market identification and segmentation;
- Four P's of Marketing;
- Developing a marketing strategy;
- Branding.

5. Financial Literacy:

- Basic concepts of income, savings and investments;
- Basic concepts of assets, liabilities and equity;
- Basic concepts of revenue and expenses;
- Overview of cash-flows;
- Overview of banking products including Islamic modes of financing;
- Sources of funding for startups (angel financing, debt financing, equity financing etc.)

6. Team Building for Startups:

- Characteristics and features of effective teams;
- Team building and effective leadership for startups

7. Regulatory Requirements to Establish Enterprises in Pakistan:

- Types of enterprises (e.g., sole proprietorship; partnership; private limited companies etc.);
- Intellectual property rights and protection;
- Regulatory requirements to register an enterprise in Pakistan, with special emphasis on export firms;
- Taxation and financial reporting obligation.

PRACTICAL REQUIREMENTS

As part of the overall learning requirements, students shall be tasked with presenting a comprehensive business plan at the end of the course for a hypothetical or real business idea. This practical exercise will allow them to apply the knowledge, skills and abilities acquired in the course to develop a feasible business plan and where possible explore the possibility of implementing the plan with support and assistance from established business-persons and entrepreneurs.

SUGGESTED INSTRUCTIONAL/ 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., and Rob Adams.
4. "Entrepreneurship: A Real-World Approach" by Rhonda Abrams.
5. "The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses" by Eric Ries.
6. "Effectual Entrepreneurship" by Stuart Read, Saras Sarasvathy, Nick Dew, Robert Wiltbank, and Anne-Valérie Ohlsson.

PROJECT MANAGEMENT

Credits: 2+0
Pre-Requisite: Nil

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.

COURSE LEARNING OUTCOMES

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

1. To develop competencies in project costing, budgeting, and financial appraisal;
2. To gain exposure to project Planning Control and Management, using standard tools and schedule variance analysis;
3. To appreciate the elements of risk and quality in hi-tech projects;
4. To learn Project Management by "practice", through the medium of "End of Semester Group Project"
5. To appreciate and understand the use of computers in Project Management, especially a tool like MS Project & Primavera etc.

COURSE OUTLINE

- **Project Management Concepts**
  History of Project Management, Introduction to Project Management, Project, Program & Portfolio Management, Project characteristics, Objectives& Requirements, Project Phases/Stages, Project Life Cycle, Project Environment, Project Scope & Project Charter, Project Manager, Project Stakeholder Analysis

- **Project Proposal Development**
  Project Proposal, Characteristics of good proposal, Types of Proposals, Request for Proposal, Request for Quotation etc). Proposal Templates etc

- **Project Feasibility**
  Brief review of various aspects of Project Feasibility like Technical, Social, Managerial, Economic, Financial & Marketing, Administrative etc.

- **Project Selection Criteria (Economic Analysis of Engineering Projects)**

  Using Break Even Analysis, Cost Benefit Ratio, Internal Rate of Return, Net Present Value etc.

- **Project Contract & Procurement Management**

  Engineering contracts, Type of contracts, understanding of procurement Process & Cycle, PPRA Rules

- **Project Planning and Scheduling**

  Project Planning (Resource & HR Planning), Work Breakdown Structure, Project Network & Scheduling, Manning Schedule and Activity Charts, Critical Path Method (CPM)/Project Evaluation & Review Techniques

- **Project Costing & Estimation**

  Cost Estimation in Projects, Cost components in projects and methods for cost estimation in projects, Cost Control in Projects, Estimation of Outstanding Work, Earned Value Management, Schedule & cost variance analysis

- **Project HRM & Communication Management**

  Effective organization and communication for Successful Projects, Project Organizational Structures (Project matrix and project based organizations), Project HR Plan preparation, HR Need Assessment and HR Matrix, Building and Managing effective project team, Selection & control mechanism of HRM in Projects, Effective Communication Plan.

- **Project Risk Management**

  Definitions Project Risk, Project Risk Management Tools, Types of Project Risk, Project Risk Assessment, Risk Identification and Mitigation, Monitoring & Controlling Risk, Generic Risk Management Strategies & Technique.

- **Computer Application in Project Management**

  Basic/Elementary Introduction and hands on basic exposure of use of MS Project & Primavera P6 Software in Project Management

- **Project Quality Management**

  Defining Quality, Quality Assurance, Quality Management, 7 Quality Improvement Tools as applied to Project Management, Project Quality Management Plan, Quality Management Processes and Strategies

- **Project Closure & Termination**

  Project Evaluation, defining project success, Project Completion Criteria, Project Audit, Project Termination &When to close a project, the termination process, Project Close Up & lesson learnt, & Project Archive

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

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

APPLICATIONS OF ICT
UGE Policy V1.1: General Education Course

Credits: 2+1
Pre-Requisite: Nil

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.

COURSE LEARNING OUTCOMES

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

1. Explain the fundamental concepts, components, and scope of Information and Communication Technologies (ICT).
2. Identify uses of various ICT platforms and tools for different purposes.
3. Apply ICT platforms and tools for different purposes to address basic needs in different domains of daily, academic, and professional life.
4. Understand the ethical and legal considerations in use of ICT platforms and tools.

COURSE OUTLINE

1. Introduction to Information and Communication Technologies:

- Components of Information and Communication Technologies (basics of hardware, software, ICT platforms, networks, local and cloud data storage etc.).
- Scope of Information and Communication Technologies (use of ICT in education, business, governance, healthcare, digital media and entertainment, etc.).
- Emerging technologies and future trends.

2. Basic ICT Productivity Tools:

- Effective use of popular search engines (e.g., Google, Bing, etc.) to explore World Wide Web.

- Formal communication tools and etiquettes (Gmail, Microsoft Outlook, etc.).
- Microsoft Office Suites (Word, Excel, PowerPoint).
- Google Workspace (Google Docs, Sheets, Slides).
- Dropbox (Cloud storage and file sharing), Google Drive (Cloud storage with Google Docs integration) and Microsoft OneDrive (Cloud storage with Microsoft Office integration)
- Evernote (Note-taking and organization applications) and OneNote (Microsoft's digital notebook for capturing and organizing ideas).
- Video conferencing (Google Meet, Microsoft Teams, Zoom, etc.).
- Social media applications (LinkedIn, Facebook, Instagram, etc.).

3. ICT in Education:

- Working with learning management systems (Moodle, Canvas, Google Classrooms, etc.).
- Sources of online education courses (Coursera, edX, Udemy, Khan Academy, etc.).
- Interactive multimedia and virtual classrooms.

4. ICT in Health and Well-being:

- Health and fitness tracking devices and applications (Google Fit, Samsung Health, Apple Health, Xiaomi Mi Band, Runkeeper, etc.).
- Telemedicine and online health consultations (OLADOC, Sehat Kahani, Marham, etc.).

5. ICT in Personal Finance and Shopping:

- Online banking and financial management tools (JazzCash, Easypaisa, Zong PayMax, 1LINK and MNET, Keenu Wallet, etc.).
- E-commerce platforms (Daraz.pk, Telemart, Shophive, etc.)

6. Digital Citizenship and Online Etiquette:

- Digital identity and online reputation.
- Netiquette and respectful online communication.
- Cyberbullying and online harassment.

7. Ethical Considerations in Use of ICT Platforms and Tools:

- Intellectual property and copyright issues.
- Ensuring originality in content creation by avoiding plagiarism and unauthorized use of information sources.
- Content accuracy and integrity (ensuring that the content shared through ICT platforms is free from misinformation, fake news, and manipulation).

PRACTICAL REQUIREMENTS

As part of overall learning requirements, the course will include:

1. Guided tutorials and exercises to ensure that students are proficient in commonly used software applications such as word processing software (e.g., Microsoft Word), presentation software (e.g., Microsoft PowerPoint), spreadsheet software (e.g., Microsoft Excel) among such other tools students may be assigned practical tasks that require them to create documents, presentations and spreadsheets etc.
2. Assigning of tasks that involve creating, managing, and organizing files and folders on both local and cloud storage systems.. students will practice file naming conventions, creating directories, and using cloud storage solutions (e.g., Google Drive, OneDrive).
3. The use of online learning management systems (LMS) where students can access course materials, submit assignments, participate in discussion forums, and take quizzes or tests. This will provide students with the practical experience with online platforms commonly used in education and the workplace.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. “Discovering Computers” by Vernmaat, Shaffer, and Freund.
2. “GO! With Microsoft Office” Series by Gaskin, Vargas, and McLellan.
3. “Exploring Microsoft Office” Series by Grauer and Poatsy
4. “Computing Essentials” by Morley and Parker
5. “Technology in Action” by Evans, Martin and Poatsy

PROBABILITY AND STATISTICS

Credits: 3+0
Pre-Requisite: Calculus

DESCRIPTION

To develop an understanding of the basic concepts of probability and statistics for Engineers

COURSE LEARNING OUTCOMES

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

1. To be able to acquire the use of graphical and descriptive statistics and probability in engineering.
2. To classify probability distributions and determine probabilities for discrete and continuous distributions and apply them in engineering problems.
3. Recognize the concept of sample correlation coefficient and analyze engineering problems using simple and multiple linear regression.

COURSE CONTENTS

1. **Data types:**
   - Data types (nominal, ordinal, discrete, continuous).
2. **Data visualization:**
   - Histograms, stem and leave plots, box, and whisker plots.
3. **Measure of central tendency and measure of dispersion:**
   - Mean, median, mode
   - Range, variance, standard deviation
4. **Moments:**
   - Skewness
   - Kurtosis
5. **Introduction to classical Probability theory:**
   - Events
   - Multiplication rule
   - Permutation
   - Additive rule
6. **Conditional Probability:**
   - Conditional probability
   - Bayes theorem
7. **Probability distribution:**
   - Discrete distribution (Hypergeometric, Poisson, Binomial)

- Continuous distribution (Normal, Uniform)

8. **Correlation and Regression analysis:**
   - Correlation
   - Simple regression
   - Multiple regression
9. **Hypothesis testing:**
   - t-test

PRACTICAL REQUIREMENTS (If Any)

- Graphical representation of data by bar graph, histograms, pie chart and frequency polygon
- Generation of box and whisker plots
- Generation of stem and leaf plot
- Computation the measure of central tendency using formulas in excel, excel commands and data analysis tab in excel
- Calculating the measure of dispersion using formulas in excel, excel commands and data analysis tab in excel
- Visualization for data skewness and data kurtosis
- Performing correlation testing (Pearson/Spearman) with visualization
- Conduction of simple linear regression
- Conduction of multiple linear regression
- Conduction of Hypothesis testing (1-sample t-test)

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Walpole, Myers, Myers, and Ye, Probability & Statistics for Engineers & Scientists, Prentice Hall.
2. D. C. Montgomery, Engineering Statistics, John Wiley.
3. Mark L. Berenson and David Levine, Business Statistics.

COMMENTS

1. Students must have the knowledge data types at the beginning of course.

2. Statistical insights can be obtained graphically and numerically; therefore, data presentation techniques such as histograms, stem and leaf plot, box and whisker plot must be included.

3. The Bayes theorem is based on conditional probability; therefore, it should be included in course.

4. The inclusion of hypothesis testing (only t-test) at this stage will be greatly beneficial for students in design of experiment. It will aid students to get an idea on the statistics applications. Also, having the knowledge of hypothesis testing can be easily extended to mean/variance, 1-sample and 2-sample testing in the design of experiment.

5. The inclusion of lab with this course will be greatly beneficial because it's the need of today's world. Also, by conducting the suggested labs the soft skill will be developed that will also help students in solving inventory models in production planning and control course and design of experiment

LOGICAL & CRITICAL THINKING

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

The primary objective of this course is to impart a functional ability to reason well; to improve analytical skills and instincts, familiarizing with elementary methods of argument composition, analysis and reasoned decision making. Logic and Critical Thinking will improve your ability to identify, analyze, and evaluate arguments by other people and also to construct arguments of your own in order to convince others and to help you decide what to believe or do. This course introduces general standards of good reasoning and offers tools to improve your critical thinking skills. These skills will help you determine when an argument is being given, what its crucial parts are, and what it assumes implicitly. You will also learn how to apply deductive and inductive standards for assessing arguments and how to detect and avoid fallacies.

- Understand and appreciate arguments that you and other people present
- Determine whether or not an argument is deductively valid
- Analyze and assess five common forms of inductive arguments
- Recognize fallacies

COURSE LEARNING OUTCOMES

1. The ability to understand the relationship between language and reasoning, and to define and clarify the expressions **(Comprehension).**
2. To distinguish between Deductive and inductive reasoning, and apply the relevant criteria or the evaluation of each kind of reasoning. Distinguish formal and informal logical fallacies **(Application)**
3. The ability to seek out and analyze evidence, Reliable sources and other information relevant to the support of conclusions of reasoning **(Analysis).**

COURSE CONTENTS

The contents of the course include: Introduction to logic and critical thinking, categorical propositions, and categorical syllogism, propositional logic, critical thinking, fallacies and rules of effective critical thinking. Making sense of arguments, Faulty Reasoning, Judging Scientific Theories, inductive and deductive reasoning.

LEARNING SKILLS/ OUTCOMES

- Logic
- Critical thinking
- Business communication
- Reason

SUGGESTED INSTRUCTIONAL/ READING MATERIALSS

1. Vaughn Lewis, The Power of Critical Thinking, Oxford University Press, 2005.
2. Paulsen David W., Cederblom Jerry, Critical Reasoning, Wadsworth, 2000.
3. Restall Greg, Logic: An Introduction, Routledge, 2005.
4. Walter Sinnott-Armstrong and Robert Fogelin, Understanding Arguments: An Introduction to Informal Logic, Ninth Edition, Concise.

CALCULUS AND ANALYTICAL GEOMETRY

Credit Hours: 3+0
Pre-Requisites: Nil

DESCRIPTION

The objective of the Calculus and Analytical Geometry course is to provide students with a solid foundation in calculus and analytical geometry. Through theoretical concepts and practical exercises, students will learn to analyze functions, calculate derivatives and integrals, solve equations, and apply geometric principles to real-world problems.

COURSE LEARNING OUTCOMES

1. To develop a clear understanding of fundamental concepts of single variable calculus
2. To apply concepts of differentiation and integration to solve complex engineering problems

COURSE OUTLINE

(i) Analytical Geometry:

a. Review of vectors, scalars and vector products.
b. Three dimensional coordinate system and equation of straight line and plane

(ii) Functions Limit and Continuity

a. Review of functions and graphs,
b. Limits & Continuity,
c. Techniques of Finding Limits,
d. Discontinuity,
e. Limits of Sine and Cosine and Exponential Functions

(iii) Differentiation:

a. Introduction to Derivatives
b. Examples of Derivatives
c. Derivative as Rate of Change
d. Derivative's Rules
e. Implicit Differentiation
f. Higher order derivative
g. Leibnitz Theorem

(iv) Applications of Derivatives:

a. Applications of Derivatives
b. Monotonic functions
c. Optimization problems
d. Relative and Absolute extrema
e. First and second derivative tests

f. Point of inflection
g. Concavity
h. Curvature
i. Indeterminate Forms and L' Hospital rule
j. Differentials

(v) Integration:

a. Integrals and Properties of Integrals
b. Techniques of Integration
c. Integration by Parts
d. Definite Integrals
e. Integration of Trigonometric
f. Exponential and Inverse Functions
g. Integration by Partial Fractions
h. Reduction Rules

(vi) Applications of Integration:

a. Applications of Integration
b. Area under the curve
c. Area between curves
d. Solids of Revolution
e. Volume of Solids of revolution by disk
f. washer, Cylindrical shell & Cross Section Methods
g. Center of Pressure and Depth of Center of Pressure
h. Center of mass
i. Arc length

(vii) Improper Integrals:

a. Improper Integral
b. Integrals and Singularities
c. Convergence of improper integrals

(viii) Infinite Sequence and Series:

a. Sequence and Infinite Series
b. Convergence and Divergence of sequences and series
c. Positive Term Series
d. Integral Test
e. Basic Comparison Test
f. Limit Comparison Test
g. Ratio and Root tests
h. Alternating series
i. Absolute and Conditional Convergence

(ix) Power and Taylor Series:

a. Power series
b. Maclaurin and Taylor Series and its Applications

SUGGESTED INSTRUCTIONAL/ READING MATERIALSS

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

LINEAR ALGEBRA & DIFFERENTIAL EQUATIONS

Credit Hours: 3+0
Pre-Requisites: Nil

DESCRIPTION

The course aims to provide students with essential mathematical skills in linear algebra and differential equations. Through theory and practice, students learn to solve linear systems and analyze differential equations, preparing them for real-world applications in science and engineering.

COURSE LEARNING OUTCOMES

The knowledge units in this area collectively encompass the following:

1. To comprehend basic concepts of Linear Algebra and optimization
2. To apply techniques of Linear Algebra and optimization for solution of engineering problem.

COURSE OUTLINE

Linear Algebra:

- Basic Concepts. Matrix Addition. Scalar Multiplication Matrix Multiplication
- Linear Systems of Equations. Gauss Elimination.
- Solution of Linear Systems: Existence, Uniqueness, General Form
- Inverse of a Matrix. Gauss-Jordan Elimination.
- Vector Spaces, Sub Spaces and Linear Transformations
- Linear dependence, linear independence, spanning set, basis
- Eigenvalues and Eigenvectors

Differential Equations:

- Separable Variables.
- Homogeneous Equations.
- Exact Equations and Integrating Factors.
- Linear Equations.
- Equations of Bernoulli, Ricatti and Clairaut.
- Applications of Linear and Non-Linear First Order ODEs.
- Linear Differential Equations of Higher Order: Preliminary Theory, Initial and Boundary Value Problems, Linear Dependence and Linear Independence.
- Homogeneous Linear Equations with constant coefficients.
- Non-Homogeneous Linear Equations with constant coefficients: Undetermined Coefficients, Variation of Parameters.
- Non-Homogeneous Linear Equations with Variable Coefficients: Cauchy-Euler Equation.

- Laplace Transform: Laplace Transform and Inverse Transform
- Unit step function, Dirac delta function
- Solution of 1st and higher order initial value problem using Laplace Transform

SUGGESTED INSTRUCTIONAL/ READING MATERIALSS

1. Dennis G. Zill and Michael Cullen, Differential Equations (3rd Edition).
2. E. Kreyszig, Advanced Engineering Mathematics, 9th ed.
3. Glyn James, Modern Engineering Mathematics.

ENGINEERING MECHANICS

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

The objectives of Engineering Mechanics are to teach students the fundamental principles of mechanics and their application in engineering. Through theory and practice, students learn to analyze forces, motion, and deformation of bodies, enabling them to solve engineering problems in statics, dynamics, and mechanics of materials.

COURSE LEARNING OUTCOMES

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

1. Know about mechanics fundamental concepts, force system, equilibrium of structures trusses), friction and virtual work. (Knowledge).
2. Determine Resultant of force vectors using Scalar or Vector approach. Compute moments about a point and about an axis by Scalar or Vector approach. Determine couple, draw Free Body Diagram and apply equations of equilibrium in 2 and 3 dimensions. (Application).
3. Analyze structures such as trusses, joints and friction in mechanical elements. Determine work and energy problems.

COURSE CONTENT

Foundations of Mechanics: Fundamental concepts and definitions.

Force Systems: Force, rectangular components, moment, resultant couple (two- and three-dimensional systems).

Equilibrium: Mechanical systems, isolation and equilibrium conditions for two- and three-dimensional systems. Structures: Plane trusses, method of joints, method of sections, frames. Friction: Types of friction, application of friction in wedges, screws, journal bearings, thrust bearings, flexible belts. Virtual **Work:** Introduction, work, virtual displacement and virtual work, principle of virtual work, potential energy and stability.

PRACTICAL REQUIREMENTS (If Any)

The course practical/labs should be defined and synchronized with the course outline"

SUGGESTED INSTRUCTIONAL/ READING MATERIALSS

1. Vector Mechanics for Engineers: Statics and Dynamics, by Ferdinand Beer and Johnston, Jr., E. Russell, 2015.
2. Engineering Mechanics (Statics) by R. C. Hibbler, 13th Edition, 2012.
3. Engineering Mechanics Dynamics & Mastering Engineering Package, by Russell C. Hibbeler, 12th Edition, 2009.
4. Engineering Mechanics: Statics by James L. Meriam and L. G. Kraige, 2014.
5. Engineering Mechanics: Dynamics by James L. Meriam and L. G. Kraige, 2015.

14.2 Engineering Domain

COMPUTER PROGRAMMING

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

The objective of this course is to provide an overview of the role of computing in industrial and manufacturing processes, covering the historical development and impact of computing on engineering, hardware and software fundamentals, various productivity programs, basic programming languages, communication and networking, cybersecurity, contemporary trends in technology, algorithm design, and advanced topics in industrial software and automation tools for engineering applications.

COURSE LEARNING OUTCOMES

1. Understand and implement fundamental programming and computing concepts.
2. Apply programming skills, operators, algorithms and pseudo codes to solve engineering problems.
3. Apply computing concepts to industrial and manufacturing scenarios.
4. Analyse and visualize data in an engineering context and its applications in automation and control.
5. Comprehend ethical and security considerations in computing.

COURSE CONTENT

Introduction to computer: **Role of computing in industrial and manufacturing processes, Historical development of computing and its impact on engineering;** hardware and software, Word processing programs, Spread sheets programs, Presentation Programs, Introduction to programming languages, Communication and networking, Email, Introduction to Cyber Security and Privacy, Contemporary trends in computer hardware and software

Introduction to the computer and programming languages,. Constants and variables, Arithmetic operations, Intrinsic functions, Algorithm design, Flowcharts, and Pseudo codes, IF statements, Do loop, While loop, Data files, Formatted Input and Output, Logical and character data type, Arrays: One-dimensional, Two- dimensional; Subprograms: Functions and subroutines,

Introduction to classes and objects. Best practices in an engineering context; Advanced Topics in Computing: Introduction to industrial software and automation tools, Programming for automation and control applications

PRACTICAL REQUIREMENTS (If Any)

The course practical/labs should be defined and synchronized with the course outline"

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Travis E. Oliphant, Python for Scientists and Engineers, Addison-Wesley Professional, 2019, ISBN-13: 978-0134853987.
2. Alex J. DeCaria, Python Programming and Visualization for Scientists, CRC Press, 2014, ISBN-13: 978-1466572267.
3. Holly Moore, MATLAB for Engineers, 5th Edition, 2017.
4. Edward B. Magrab, An Engineer's Guide to MATLAB, 3rd Edition, 2011.
5. Paul Deitel and Harvey Deitel, C++ How to Program, 10th Edition.

COMPUTER SIMULATIONS

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

The objective of this course is to introduce and explore simulation concepts and fundamental elements such as entities, attributes, resources, and events, with practical applications through hand simulations, model building, input and output analysis, animation, intermediate modeling, and statistical analysis of outputs from steady-state simulations in manufacturing systems

COURSE LEARNING OUTCOMES

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

1. Define fundamental concepts and techniques of modelling and simulation.
2. Apply mathematical and statistical techniques to transform the real-world systems into simulation models.
3. Validate, and interpret the results of simulation model.

COURSE CONTENT

Introduction and simulation concepts, fundamental concepts (entities, attributes, resources, queues, statistical accumulators, events), simulation with hand, modules (create, entity data, process flow chart, resource data, queue data, dispose flow chart and connecting flow chart modules), Building model (electronic assembly and test system, enhanced electronic assembly and test system), Input analyser, Output module, animation, intermediate modelling, small manufacturing system model (building model of data and logic modules) and statistical analysis of output from steady state simulation of small manufacturing systems, entity transfer, variables and expressions and call centre model.

PRACTICAL REQUIREMENTS (If Any)

The course practical/labs should be defined and synchronized with the course outline"

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Simulation with ARENA, Latest Edition.
2. Simulation Modeling with SIMIO: A Workbook, Latest Edition.
3. Jerry Banks, Discrete System Simulation, Prentice Hall, Latest Edition.

OPERATION RESEARCH

Credits: 3+1
Pre-Requisite: Applied Linear Algebra

DESCRIPTION

To enable the students to understand the application of linear programming in manufacturing and service industries, modeling and solving complex problems, understand the transportation and network problems and determining the feasible and optimum solution of constraint-based problem using computer.

COURSE LEARNING OUTCOMES

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

- Be able to understand the characteristics of different types of decision-making environments and basic concepts of linear programming, transportation problems, assignments problem and network analysis.
- Apply different optimization methods and techniques on LP, Integer programming and network problems
- Be able to develop critical thinking and analyze the real-life problems into optimization problems.

COURSE CONTENT

Introduction to Linear Programming, Application of Linear Algebra to Industrial Problems, Graphical method of solving L.P. problems, Simplex method, Duality and Sensitivity, solving large scale problems using computer, Integer programming (Branch & Bond), Transportation and Assignment Problems, Network problems, shortest path, minimum spanning tree, maximum flow problems.

PRACTICAL REQUIREMENTS (If Any)

- Hands on Experience using Optimization Software such as Lingo, TORA, Excel Solver etc.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1- Hamdy A. Taha, Operation Research, 9th Edition.
2- Frederick S. Hillier, Gerald J. Lieberman, Introduction to Operations Research, 9th Edition, McGraw-Hill, 2010.

METROLOGY AND STATISTICAL QUALITY CONTROL

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

To expose students to the principles of measurement, gauges and modern quality concepts and their practical use, the basics of statistics and probability techniques and their usages in quality applications.

COURSE LEARNING OUTCOMES

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

1. To define metrology, geometric dimensioning and tolerances (GDT), its importance and applications. (Knowledge)
2. To discuss frequency distributions and probability models, calculate measures of central tendency, dispersion, skewness. **(Application).**
3. Classify sources of variations in processes for quality improvement and determine process capability indices. Form control charts for variables and attributes and analysis of quality costs. **(Analysis).**

COURSE CONTENT

General principles of measurement, Geometric dimensioning and tolerances, Gauges and comparators, Interferometers and associated devices, Surface texture measurement, Calibration and measuring machines.

Study of frequency distributions and probability models in quality control, Sources of variation, Preparation and use of various control charts, Process Capability Indices, Construction of different sampling plans, Methods to quality improvement and analysis of quality costs, Computer applications in SQC using Minitab.

PRACTICAL REQUIREMENTS (If Any)

Use of gauges and measuring instruments such as Vernier calipers, micro meters, gauge blocks, slip gauges, Go, No-Go gauges etc. Applications of comparators and surface measuring instruments, Coordinate Measuring Machines, Data collection, tally sheets, Pareto analysis, fishbone diagrams. Control charts for variables and attributes using Minitab or SPSS.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. D. H. Besterfield, Quality Control, Pearson Education.
2. Eugene L. Grant, Statistical Quality Control, 7th Edition, Tata Mc-Graw-Hill, 2005.

3. Douglas C. Montgomery, Introduction to Statistical Quality Control.
4. J. F. W. Galyer, C. R. Shotbolt, Engineering Metrology, Cassell Publishers Ltd.
5. Hitoshi Kume, Statistical Methods for Quality Improvement, Association for Overseas Technical Scholarships (A.O.T.S.) Japan.

MECHANICS OF MATERIALS

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

The objective of this course is to provide a comprehensive understanding of the behavior of materials under various loading conditions, covering topics such as stress and strain, axial load, torsion, bending, shear, deflection of beams, and the principles of material failure and safety analysis.

COURSE LEARNING OUTCOMES

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

1. Describe mechanical behavior of materials under tensile, compressive, torsional, and combined loadings, and Factor of safety.
2. Explain causes of Failure and its prevention.
3. Investigate the method of determining hardness, fatigue, and creep.

COURSE CONTENT

Mechanics of Deformable Bodies, Deformation, Strain, General stress- strain relationships, Elastic load-deformation behavior of materials, Lateral strain, Thermal strain, Bending: Pure bending, Moment-curvature Relationship, Beam Deflection; Torsion and Twisting, Energy Methods, Stress and strain transformations, Mohr's stress/strain circle, Stress and strain transformation in composites, Yield and failure criteria of materials.

PRACTICAL REQUIREMENTS (If Any)

- To study the Universal testing machine.
- To determine the shear strength (single and double) of metallic and nonmetallic (wood etc.) specimen.
- To determine the hardness of different metallic specimens using a) Brinell b) Rockwell c) any other testing equipment.
- To determine Modulus of Elasticity of a) rectangular section b) I-section beam using bending test.
- To determine the Modulus of Elasticity of a metallic specimen using tensile test.
- To determine the stiffness of a) leaf b) helical coil spring by plotting load vs deflection graph.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Beer, Johnston, Dewolf, Mechanics of Materials, Latest Edition.
2. Hibbeler, R. C., Mechanics of Materials, Latest Edition.

1. Beer, Johnston, Dewolf, Mechanics of Materials, Latest Edition.
2. Hibbeler, R. C., Mechanics of Materials, Latest Edition.
3. Lardner, T. J., Archer, R. R., Crandall, S. H., Dahl, N. C., An Introduction to the Mechanics of Solids, Latest Edition.
4. Dowling, N. E., Mechanical Behavior of Materials, Latest Edition

ENGINEERING DRAWING AND GRAPHICS

Credits: 0+2
Pre-Requisite: Nil

DESCRIPTION

The objective of this course is to equip students with practical skills in engineering drawing and drafting, focusing on creating and interpreting technical drawings, understanding geometric dimensions and tolerances, and applying industry standards for effective communication in engineering design and documentation.

COURSE LEARNING OUTCOMES

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

1. Understand the basic concepts of standard mechanical engineering drawing.
2. Explain engineering visualization principles and projection theory and apply those principles in engineering drawing development.
3. Produce orthographic projections, sectional views, and isometric views of different mechanical parts.
4. Produce Assembly drawing for catalogues, manuals etc.

COURSE CONTENT

Introduction to Engineering Drawing: Principles of Engineering Graphics, drawing instruments, Scales Plane, sketching layouts, lines, lettering, and Dimensioning. Conic sections. Technical Drawing Standards and presentation, conventional representation of dimensioning and sectioning. Abbreviations and symbols. Projection of points, lines, Planes and solids.

Introduction to drawing instruments, safety guidelines, layout, Lettering, Free-hand Sketching, Scaling and line types. Hands on practice of Geometric drawings, Drawing Sheet Planning, Orthographic Projections. Practice projections and surface development. Practice and drawing of three views of different objects using orthographic projection. Conversion of orthographic projection into isometric view. Creating drawings of engineering fasteners like rivets, cotter joints, threads, etc. Introduction to Geometric dimensioning and Tolerances. Practice of various Assembly Drawings. Principles of Orthographic and Isometric projection, Development of surfaces. Fits, Tolerances and Allowances. Assembly drawing, Assembly Drawing for Installation, catalogues, and instruction manuals.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. N.D. Bhutt, Engineering Drawing, 50th Edition, Charotar Publishing House, 2010, ISBN: 9380358172.
2. Gary Bertoline, Eric Wiebe, Nathan Hartman, William Ross, [Title not provided], McGraw-Hill Education, 2010, ISBN-10: 0073522635.
3. A.C. Parkinson, First Year Engineering Drawing, 6th Edition, Pitman Publishing, 1962, ISBN: 0273413937.
4. Wempen Minasi, Doctor, The Complete PC Upgrade and Maintenance Guide, 16th Edition, Sybex, 2005, ISBN-13: 978-0782144314.

WORKSHOP PRACTICE

Credits: 0+1
Pre-Requisite: Nil

DESCRIPTION

The course aims to provide students with comprehensive training in various manufacturing and fabrication techniques, covering metal cutting, welding, sheet metal work, carpentry, electrical work, and more, while emphasizing safety and culminating in a project that integrates these skills.

COURSE LEARNING OUTCOMES

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

1. To describe the basic principles of industrial automation, including sensors, actuators, control systems and basic concepts of programmable Logic controllers.
2. To comprehend Relay logic, ladder logic, Computer Numeric control and classify automation systems.
3. To apply and write ladder logic and G and M codes for automated processes.

COURSE CONTENT

The course covers various manufacturing and fabrication techniques, including metal cutting and shaping operations such as turning, milling, drilling, grinding, and lathe operations. It also includes welding and joining techniques like arc welding, spot welding, soldering, and brazing, with a focus on safety. Additionally, students learn sheet metal work, carpentry, woodworking, fitting, assembly skills, basic electrical and electronics work, and use of hand tools and measuring instruments. The course also introduces functions of forge and foundry shops. Finally, students apply these skills in a project that integrates multiple workshop techniques.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. W. A. J. Chapman, Workshop Technology Vol. I & II
2. Serope Kalpakjian and Steven Schmid, Manufacturing Processes for Engineering Materials
3. Rajender Singh, Introduction to Basic Manufacturing Processes and Workshop Technology
4. Raghuwanshi B.S., Workshop Technology
5. Charles Hayes, Basic Welding and Fabrication
6. LUDWIG, Metal Work

7. Ostwald, Manufacturing Processes
8. V. Ramesh Babu, Engineering Workshop Practice for JNTU, VRB Publishers Pvt. Ltd.

WORK STUDY & METHODS ENGINEERING

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

The objective of this course is to enable students to understand and apply work study and methods engineering principles to analyze, improve, and optimize work processes, enhance productivity, reduce costs, and enhance overall efficiency in industrial settings

COURSE LEARNING OUTCOMES

1. To understand nature of work, methods engineering & work measurement techniques.
2. To employ the knowledge of method & time study in Line Balancing, work optimization, Charting and Diagramming Techniques.
3. To analyze Work Design & Micro motion Analysis, Compensation System, Motivation & Job Satisfaction and Human Factors in human-machine systems and industry 4.0

COURSE CONTENT

The Nature of Work, Productivity, Manual work and worker-machine systems, Work Flow and Batch Processing, Manual Assembly Lines, Logistics Operations, Introduction to Methods Engineering and Operations Analysis, Charting and Diagramming Techniques for Operations Analysis, Facility Layout Planning and Design, Techniques of work optimization, energy expenditure and bodily functions, Introduction to Work Measurement, Direct Time Study, Pre-determined motion time studies (PMTS), Motion Study and Work Design, Work Sampling, Learning Curves and Micro motion analysis, Process improvement and work management techniques i.e. (Lean production, six sigma etc), Work management in human-machine systems, Exploring the impact of Industry 4.0 on work study and methods engineering, Integration of digital tools for process optimization and automation, Kaizen and continuous improvement techniques.
Practical applications of course concepts in industrial settings, Utilizing big data analytics and data-driven decision-making approaches to extract valuable insights from the vast amount of data generated in industrial processes, Sustainable manufacturing practices that prioritize resource efficiency, waste reduction, and environmental sustainability, digital twin technology to create virtual replicas of physical systems.

PRACTICAL REQUIREMENTS (If Any)

Study through videos

1. Study of simple assembly operations
2. Estimation of process duration through PMTS
3. Development and use of process flow charts
4. Any other lab on discretion of the instructor.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Benjamin W. Niebel, Motion and Time Study, McGraw-Hill, Latest Edition.
2. I.L.O., Time and Motion Study, Latest Edition.
3. Ralph M. Barnes, Motion and Time Study: Design and Measurement of Work, Latest Edition.

BASIC MECHANICAL ENGINEERING

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

The main objective of the Mechanical Technology course is to provide students with a fundamental understanding of thermodynamics, heat and mass transfer, and various machine components used in the industry. The course aims to introduce students to the basic concepts of energy conservation, thermodynamics laws, cycle concepts, and their applications in various mechanical systems. Additionally, the course aims to teach students about the principles of refrigeration and air conditioning and the functioning of turbo-machinery, including turbines, compressors, and engines.

COURSE LEARNING OUTCOMES

1. To Understand fundamental concepts thermodynamics, fluid mechanics, heat transfer and related topics.
2. To Analyze and select machine components, including bearings, couplings, brakes, clutches, and gears.
3. To Understand the practical applications of these components in mechanical systems and turbo machinery.

COURSE CONTENT

The Mechanical Technology course includes the following contents:

- Introduction to thermodynamics: Basic concepts, Thermodynamic systems, Properties, First Law of Thermodynamics, Second Law of Thermodynamics, Entropy, Carnot cycle, and its efficiency.
- Heat Transfer: Conduction, Convection, and Radiation heat transfer mechanisms. Heat exchangers, types, and their applications.
- Mass Transfer: Fick's law, Diffusion, Mass transfer coefficients, and their applications.
- Refrigeration and Air Conditioning: Basic refrigeration cycle, Vapour compression refrigeration cycle, refrigerants, and refrigeration system components. Principles of air conditioning, psychrometry, and air conditioning system components.
- Machine Components: Bearings, Couplings, Brakes, Clutches, Gears, and Gear trains, and their applications.
- Turbo-machinery: Turbines, Compressors, Fans, Pumps, and their types, principles, and applications.

PRACTICAL REQUIREMENTS (IF ANY)

The course practical/labs should be defined and synchronized with the course outline"

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Yunus A. Cengel, Michael A. Boles, Thermodynamics: An Engineering Approach, McGraw-Hill, ISBN 9780073398174.
2. M. J. Moran, H. O. Shapiro, Fundamentals of Engineering Thermodynamics, John Wiley & Sons, ISBN 9781118412930.
3. T. D. Eastop, A. McConkey, Applied Thermodynamics for Engineering Technologists, Pearson Education, ISBN 9780582091931.
4. J. B. Heywood, Internal Combustion Engine Fundamentals, McGraw-Hill, ISBN 9780070286375.
5. J. E. Shigley, Uicker, Theory of Machines and Mechanisms, McGraw-Hill, ISBN 9780073290980.
6. R. C. Juvinall, K. M. Marshek, Fundamentals of Machine Component Design, John Wiley, ISBN 9780471244172.
7. M. M. El Wakil, Power Plant Technology, McGraw-Hill, ISBN 9780072871029.

COMPUTER AIDED DRAWING (CAD)

Credits: 0+1
Pre-Requisite: Nil

DESCRIPTION

The objective of this course is to familiarize students with the principles and practices of computer-aided drawing (CAD), enabling them to proficiently utilize CAD software to create, modify, and annotate technical drawings, enhancing their ability to communicate and document engineering designs effectively.

COURSE LEARNING OUTCOMES

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

1. Demonstrates the ability to apply different solid modelling operations on CAD software.
2. Apply knowledge to create 3D assemblies using CAD software.

COURSE CONTENT

- Introduction to CAD
- 2D and 3D Modeling and Viewing
- Modeling Aids and Tools
- Wireframe Modeling
- Solid Modeling
- Assembly Modeling
- CAD Software's
- Modeling of machine components in 3D

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Ibrahim Zeid, Mastering CAD/CAM, McGraw Hill, Boston, 2005.

MATERIALS ENGINEERING

Credits: 3+1
Pre-Requisite: Nil

DESCRIPTION

The objective of the Material Engineering Course is to acquaint students with a range of industrial materials, including their properties and structural transformations that occur throughout manufacturing processes.

COURSE LEARNING OUTCOMES

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

1. To define engineering materials, their types, classification of materials and their structure. (Comprehension)
2. To analyze the structure, mechanical and physical properties of materials, outline their applications (Application).
3. To analyze properties of engineering materials, categorize heat treatment process and able to outline their environmental effects. (Analysis)

COURSE CONTENT

Types of materials, crystalline & amorphous materials, Solid solutions and phase diagrams, application of materials. Ferrous and Non-Ferrous Metals and alloys, their major properties and their heat treatment. Ceramics, Glasses, Rubbers & Refractory Materials, Polymers, Composites, Environmental Degradation, corrosion. Indigenous materials.

PRACTICAL REQUIREMENTS (If Any)

The course practical/labs should be defined and synchronized with the course outline"

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. William F. Smith, Javed Hashmi, Ravi Prakash, Materials Science and Engineering.
2. Donald R. Askeland, The Science and Engineering of Materials.
3. Mikell P. Groover, Fundamentals of Modern Manufacturing.

DESIGN OF MECHANISMS

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

To provide an understanding of the fundamental concepts of mechanisms and their analysis, including kinematic diagrams, vector analysis, and design techniques, with a focus on the design of slider-crank, crank shaper, gears and cam mechanisms.

COURSE LEARNING OUTCOMES

1. To understand the fundamental concept of mechanisms
2. Analyze the engineering structures and mechanisms under static and dynamic conditions
3. Applying the laws of motion to components/structures under influence of forces

COURSE CONTENT

The fundamental concepts of mechanisms and their analysis. It includes topics such as mechanism terminology, kinematic diagrams, and techniques for mechanism analysis. The course also covers vector analysis, position and displacement analysis, velocity analysis, and acceleration analysis. Additionally, it covers the design and development of mechanisms, with a focus on the design of the slider-crank and crank shaper mechanisms. The course covers the gear trains, design of cams, including types of cams and followers, graphical disk cam profile design, and design limitations.

PRACTICAL REQUIREMENTS (IF ANY)

The course practical/labs should be defined and synchronized with the course outline"

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. R. L. Norton, Design of Machine, ISBN: 9780077493078, Publisher: McGraw-Hill Education, Year: 2013.
2. David H. Myszka, Machines and Mechanisms, ISBN: 9780132729838, Publisher: Pearson, Year: 2012.
3. Thomas Bevan, The Theory of Machines, ISBN: 9789332549588, Publisher: Pearson, Year: 2015.
4. John J. Uicker, Gordon R. Pennock, Joseph E. Shigley, Theory of Machines and Mechanisms, ISBN: 9780195371239, Publisher: Oxford University Press, Year: 2016.

5. J. A. Collins, Mechanical Design of Machine Elements and Machines, ISBN: 9781439887806, Publisher: CRC Press, Year: 2015.
6. Hamilton H. Mabie, Charles F. Reinholtz, Mechanisms and Dynamics of Machinery, ISBN: 978-0471802372, Publisher: John Wiley & Sons Inc., Year: 1986.
7. Robert L. Norton, Kinematics and Dynamics of Machinery, ISBN: 978-0071226201, Publisher: McGraw-Hill Education, Year: 2008.
8. Richard G. Budynas, Keith J. Nisbett, Shigley's Mechanical Engineering Design (includes the theory of machines), ISBN: 978-0073398204, Publisher: McGraw-Hill Education, Year: 2014.
9. Joseph Edward Shigley, John Joseph Uicker, Gordon R. Pennock, Theory of Machines and Mechanisms, ISBN: 978-0190264482, Publisher: Oxford University Press, Year: 2017.
10. R.S. Khurmi, Theory of Machines, ISBN: 978-8121925248, Publisher: S Chand & Company Ltd., Year: 2005.

INDUSTRIAL REPAIR AND MAINTENANCE

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

The course aims to provide a comprehensive understanding of industrial maintenance practices, including corrective, preventive, and predictive maintenance methods, maintenance planning and scheduling, lockout/tagout procedures, and operation and maintenance of various industrial equipment and systems, emphasizing safety, economic aspects, and maintenance linkage.

COURSE LEARNING OUTCOMES

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

1. Explain different types of maintenance procedures, and their significance.
2. Prepare maintenance schedules and procedures for different industry equipment's, gadgets, and elements.

COURSE CONTENT

Introduction to industrial maintenance, Importance of industrial maintenance, corrective maintenance, preventive maintenance, predictive maintenance, total productivity maintenance, Maintenance Planning and scheduling, Lockout/ tagout procedures, operation and maintenance of pumps, valves, cylinders, motors, sensors, and control systems. Importance of plant maintenance, factors influencing the maintenance, Considerations in designing plant maintenance, Economic aspects of maintenance, care and maintenance of common industrial equipment (like bearings, piping, filters, pumps, compressors, and lubricating systems), maintenance linkage to safety, Different systems/types of maintenance.

PRACTICAL REQUIREMENTS (If Any)

Apply different techniques and tools for fault diagnosis, repair and maintenance for industrial parts and systems like pumps, motors, engines, compressors etc.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Andrew K.S. Jardine, Albert H. C. Tsang, Maintenance, Replacement, and Reliability, Latest Edition.
2. Ricardo Manzini, Alberto Regattieri, Maintenance for Industrial Systems, Latest Edition.
3. Thomas A. Wester-Kamp, Maintenance Manager's Standard Manual, Latest Edition.

HUMAN FACTORS ENGINEERING

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

TO familiarize students with key concepts and principles related to human factors and ergonomics, including human characteristics relevant to design, information presentation methods, workplace design principles, environmental factors, human error detection and reduction strategies, and the role of controls in advanced technology, aiming to optimize system performance, safety, and user satisfaction.

COURSE LEARNING OUTCOMES

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

1. Understand the physical and cognitive capabilities of humans to fit the job to the man
2. Apply ergonomic principles on various organs of Human Body at their workplace.
3. Analyze human factors engineering concepts for existing and design of Human machine systems.

COURSE CONTENT

Introduction to Human Factors Engineering, Human Characteristics relevant to ergonomics. Information on Human Role in Artificial Intelligence, information by text, graphics and symbols. Anthropometry, Anthropology, Principles of workplace design, Equipment and work space, Failure of design, Climatic Factors, Noise and Vibration, Effects of noise on various organs and their prevention, visibility (Illumination, contrast, quality, color etc.) and its effects, Basic concepts of Human Error detection and reduction. The role of controls in advanced technology, Control devices.

PRACTICAL REQUIREMENTS (If Any)

Study of various types of workplaces

1. Noise measurement at different places
2. Illumination measurement at different places
3. Any other lab on discretion of the instructor.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS	
1	John D. Lee and Christopher D. Wickens, An Introduction to Human Factors Engineering, Latest Edition.
2	Salvendy G., Handbook of Industrial Engineering: Technology and Operations, Latest Edition.
3	Sanders and Mc Cormick, Human Factors Engineering & Design, Latest Edition.
4	John R. Wilson and Sarah Sharples, Evaluation of Human Work, Latest Edition.

MANUFACTURING PROCESSES

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

To equip students with foundational knowledge and practical skills necessary for understanding, analyzing, and implementing various manufacturing techniques, enabling them to contribute effectively to the production of high-quality products in industrial settings.

COURSE LEARNING OUTCOMES

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

1. To be able to know basic concepts of various manufacturing processes. (knowledge)
2. To be able to recognize the strong interrelationships between material properties and manufacturing processes. (comprehension)
3. To be able to apply basic formulae for calculation of various process parameters. (analysis)

COURSE CONTENT

Basic concepts of manufacturing processes, Casting processes, Furnaces, Forming and Joining processes, Welding, Brazing and soldering, Adhesive bonding, Traditional and non-traditional machining operations, capabilities and limitations, Rapid prototyping operations, Manufacturing of parts using polymer, composite and powder metallurgy, Process selection

PRACTICAL REQUIREMENTS (IF ANY)

To Study various Safety Rules for Machining Shop.

1. To Study the Different Materials, their properties and uses in Metal Cutting.
2. To Study various parts and cutting tools used for a Lathe Machine.
3. To Study Various Operations that can be performed on a Lathe Machine.
4. To Make a Screw Jack (or some other component) according to given dimensions using different machining operations such as Turning, Facing, Threading, Knurling etc.
5. To Study and perform various welding processes such as Oxyacetylene gas welding and cutting, Electric Arc welding, Spot welding etc.
6. To Study and perform Non-Traditional Machining (NTM) operations such as Electrical discharge machining (EDM) and Wire EDM etc.
7. Make a check list of the findings related to manufacturing of parts from given drawing
8. Develop a process plan for the given parts (machined, sheet metals, casting etc.)
9. Calculate the blank size of the given sheet metal part.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. L. Alting, Manufacturing Engineering Processes, Publisher: Marcel Dekker.
2. Paul De Garmo, Black and Kohser, Materials & Processes in Manufacturing, Publisher: Prentice Hall.
3. M. F. Ashby and K. Johnson, Materials and Designs: The Art and Science of Material Selection in Product Design, Publisher: Butterworth and Heinemann.
4. M. P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, Publisher: John Wiley.

INSTRUMENTATION AND CONTROL

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

Through problem solving and laboratory practice, this course provides a foundation in continuous-time linear control system theory. Further to that it provides a basic understanding of Controller, Sensors, transducers, discrete Electronic components and a rationale for their selection.

COURSE LEARNING OUTCOMES

1. To Describe various Electrical/Electronic Equipment and sensors, applications and unit of measurements.
2. To Discuss basic concepts of Control System, Characteristic Curve, Laplace transform and Microcontrollers.
3. To apply the knowledge of Transfer functions, LTI Systems, PID Controllers and Block Diagrams.

COURSE CONTENT

Basic concepts, characteristics, functions of instruments especially for indicating and recording, length, weight, volume, temperature, pressure, flow level, etc. Measuring errors and calibration. Introduction to the principles of automatic control systems encountered in Mechanical Engineering; Open-loop and closed loops systems. Control Modelling: Block diagrams, transfer functions, Laplace transforms, root locus, Bode diagram Frequency response.
Design parameters: Response Time, relative stability, Overshoot, settling time etc. Classical control systems modelling Temperature, speed, level, flow, proportional, integral and derivative controls, mode of operation of hydraulic, pneumatic, and electrical components, amplifiers servomotors, process controllers, regulating Programmable Logic Controllers.

PRACTICAL REQUIREMENTS (If Any)

The course practical/labs should be defined and synchronized with the course outline"

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Gene F. Franklin, J. David Powell, Abbas Emami-Naeini, Feedback Control of Dynamic Systems, Global Edition, 2014.
2. Norman Nise, Control System Engineering.
3. Richard C. Dorf, Robert H. Bishop, Modern Control Systems, 13th Edition, 2017.
4. Franklyn W. Kirk, Thomas A. Weedon, Phillip Kirk, Instrumentation, 5th Edition, 2010.
5. Ogata, Modern Control System, 5th Edition, 2010.

MANUFACTURING SYSTEMS

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

The course aims to equip students with a thorough grasp of the principles, methodologies, and technologies essential for designing, analyzing, and optimizing manufacturing systems, empowering them to enhance productivity, quality, and efficiency in industrial environments.

COURSE LEARNING OUTCOMES

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

- To know the basic concept of lean manufacturing, flexible manufacturing, cellular manufacturing and material handling system. (Knowledge)
- Have skills to analyze the different manufacturing systems, material handling system and assembly lines. (Analysis)
- Be able to design and improve the manufacturing system and its relative parameters. (Synthesis)

COURSE CONTENT

Introduction to Lean Manufacturing, Manufacturing automation fundamentals and strategies, High volume manufacturing systems, Flow lines, Assembly lines, Automated material handling and storage systems, Process planning, Group technology, Cellular manufacturing systems, Computer networks of manufacturing, Computer integrated manufacturing systems, Flexible manufacturing systems, Modeling of manufacturing systems.

PRACTICAL REQUIREMENTS (IF ANY)

1. Working applications of switches, sensors, encoders, servo and stepper motors, speed controller and PID controller
2. Use of Manufacturing System Simulation Software.
3. Demonstration of FMS or Industry 4.0
   Any other lab on discretion of the instructor.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. M. P. Groover, Automation, Production Systems and Computer Integrated Manufacturing, Publisher: Prentice Hall.
2. Askin and Standridge, Modelling and Analysis of Manufacturing Systems, Publisher: John Wiley and Sons.

PRODUCTION PLANNING AND CONTROL

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

Through problem solving and laboratory practice, this course provides a foundation in continuous-time linear control system theory. Further to that it provides a basic understanding of various gauges, transducers, and a rationale for their selection.

COURSE LEARNING OUTCOMES

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

- To Describe various Electrical/Electronic Equipment and sensors, applications, basic concepts of Control System and unit of measurements.
- To Discuss, Characteristic Curve, Laplace transform and Microcontrollers,
- To solve Transfer functions, LTI Systems, PID Controllers and Block Diagrams

COURSE CONTENT

Basic concepts, characteristics, functions of instruments especially for indicating and recording, length, weight, volume, temperature, pressure, flow level, etc. Measuring errors and calibration. Introduction to the principles of automatic control systems encountered in Mechanical Engineering; Open-loop and closed loops systems. Control Modelling: Block diagrams, transfer functions, Laplace transforms, root locus, Bode diagram Frequency response.

Design parameters: Response Time, relative stability, Overshoot, settling time etc. Classical control systems modelling Temperature, speed, level, flow, proportional, integral and derivative controls, mode of operation of hydraulic, pneumatic, and electrical components, amplifiers servomotors, process controllers, regulating Programmable Logic Controllers.

PRACTICAL REQUIREMENTS (If Any)

As part of overall learning requirements, the course will include:

Guided tutorials and exercises to ensure that students are proficient in commonly used software applications such as Matlab, TIA and Industrial Process control among such other tools students may be assigned practical tasks that require them to perform practical's and create Simulations etc.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Valves, position transducers, Feedback Control of Dynamic Systems by Gene F. Franklin, J. David Powell and Abbas Emami-Naeini, Global Edition, 2014.
2. Modern Control Systems by Richard C. Dorf and Robert H. Bishop, 13th Edition, 2017.
3. Instrumentation by Franklyn W. Kirk, Thomas A. Weedon and Phillip Kirk, 5th Edition, 2010.
4. Modern Control System by Ogata, 5th Edition, 2010.

INDUSTRIAL FACILITIES DESIGN

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

To enable the students to understand facility design, Material handling equipment analysis, warehousing, layout and location and flow of material, Exposure to relevant computer software.

COURSE LEARNING OUTCOMES

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

- To acquire the knowledge and understanding of the different stages of Location Analysis, Facilities Planning, Layouts, and Material Handling Systems.
- To solve Facility Location and Layout problems by Applying analytical facilities location and layout methods.
- To design and propose layout and material handling systems.

COURSE CONTENT

Selection of single and multiple facility Location and Site selection, Facility design types and stages, processes, material handling equipment types, selection and analysis. Area allocation and space requirements, process and product requirement, flow analysis, fabrication of individual parts, total plant flow, Plant layout analysis and evaluation, Utilities Layout, Computerized facility layout and location, layout algorithms like CRAFT, ALDEP, CORELAP etc, Strategies for storages.

PRACTICAL REQUIREMENTS (If Any)

Hands on experience using relevant computer software

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Dileep R. Sule, Manufacturing Facilities: Location, Planning, and Design, 3rd Edition, Publisher: CRC Press, Taylor and Francis.
2. Tompkins, White, Bozer & Tanchoco, Facilities Planning, 4th Edition, 2010, Publisher: John Wiley & Sons.

PRODUCTION/INDUSTRIAL AUTOMATION

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

The course covers industrial automation with particular reference to CNC and PLC. After this course, the students would be able to understand the automation requirements of a modern industrial set-up.

COURSE LEARNING OUTCOMES

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

- By the end of this course, students will be able to:
- To describe the basic principles of industrial automation, including sensors, actuators, control systems and basic concepts of programmable Logic controllers.
- To comprehend Relay logic, ladder logic, Computer Numeric control and classify automation systems.
- To apply and write ladder logic and G and M codes for automated processes.

COURSE CONTENT

Industrial and specially Manufacturing Automation, Automation Theory; Computer Numerical Control (CNC) Machining Requirements, Limitations of Conventional Machining, Introduction of Numerical Control, Building blocks of CNC, CNC Programming, Machining Codes, Sensors/actuators/control cards used in CNC machines.

Programmable Logic Controllers (PLC) Introduction to PLC, PLC Architecture and Operation, Advantages / Limitations of PLC, Ladder Logic and other Programming Formats, Relay Logic, Timers, Counters, Comparator, Math Instructions, Bit Shift Registers, Advanced instructions, industrial data communication protocols, SCADA, HMI.

PRACTICAL REQUIREMENTS (If Any)

As part of overall learning requirements, the course will include:

1. Guided tutorials and exercises to ensure that students are proficient in commonly used software applications such as LogixPro, TIA, Sematic Step 7-Micro/win among such other tools students may be assigned practical tasks that require them to perform practical and create Simulations etc.
2. PLC introduction and Programming (Ladder Diagram)
3. Simulation and Interfacing with Programmable Logic Controller (PLC)
4. SCADA System (Automation Applications)

5. Study and use of Robot for various applications
6. Any other lab on discretion of the instructor.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Jon Stenerson, Fundamentals of PLCs, Sensors and Communication, 3rd Edition, Publisher: Prentice Hall, Location: Upper Saddle River, New Jersey, Year: 2004.
2. C. Ray Asfahl, Robots and Manufacturing Automation, Publisher: John Wiley & Sons, Latest Edition.
3. P. N. Rao, CAD/CAM Principles and Applications, Publisher: McGraw Hill, Latest Edition.
4. E. A. Parr, Programmable Controllers, Publisher: Newnes, Latest Edition.
5. Mikeel P. Groover, Automation Production Systems and Computer Integrated Manufacturing, Publisher: Prentice Hall, Latest Edition.
6. Steve Krar, Arthur Gill, Peter Smid, Paul Wanner, Machine Tool Technology Basics, Latest Edition.
7. Frank Petruzella, Programmable Logic Controllers, Publisher: McGraw-Hill, Year: 2016.

DESIGN OF EXPERIMENT

Credits: 3+1
Pre-Requisite: Nil

COURSE LEARNING OUTCOMES

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

1. Explain the importance of Design of Experiments (DOE).
2. Apply different DOE concepts to solve real life problems.

COURSE CONTENT

Introduction to design of experiments and its applications in industry, Hypothesis testing on means and variances, Analysis of variance, fixed and random effects models, error analysis, Block designs, randomized complete and incomplete block design, Latin square design, factorial design, fixed, random and mixed factors design, Introduction to response surface methodology. Packages like Minitab & Design Expert can be used.

PRACTICAL REQUIREMENTS (If Any)

Lab Outline: Block Design, Analysis of Variance, Hypothesis testing, Factorial Design, Taguchi Analysis, Robust Parameter Design

Lab Equipment: Cluster of computers with relevant software's such as MS Excel, SPSS, Minitab etc.

Suggested Labs

1. Comparison of results of paired t-test with those from pooled and unpooled variance for a given data set.
2. Coding/ scaling of variables while designing an experiment.
3. Validation of modeling assumptions (normality, constant variance, randomness).
4. Transformation and its effect on the validity of modelling assumptions.
5. Blocking of a nuisance variable.
6. Performing full factorial and fractional factorial analyses and comparison of coefficients by undoing the confounding effect.
7. Contrast formulation and comparisons.
8. Applications of nested design.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Douglas C. Montgomery, Design and Analysis of Experiments, Latest Edition.
2. Wu and Hamada, Experiments: Planning, Analysis, and Parameter Design Optimization, Latest Edition.

*** List of Proposed Technical Electives (2/3+1/0=3 Cr. Hrs.)
• Lean Manufacturing • Quality Engineering • Virtual Reality • Smart Manufacturing and Industry 4.0 • Finite Element Analysis • Sustainable Manufacturing • Reliability Analysis • Metal Forming and Cutting Analysis • Computer Integrated Manufacturing (CIM) • Tool and Die Design • Logistic Management • Enterprise Resource Planning • Additive Manufacturing • Human Robot Interaction • Warehouse Management • Computer Aided Process Planning • Applications of AI in Manufacturing and Services Sector • Advanced Manufacturing Processes • Cybersecurity for Industrial Control Systems • Data Analytics for Industrial Engineers • Advanced Engineering Optimization • Introduction to Thermos-Fluid • Soft Computing & Data Mining • Lean Six Sigma • Mechanics Of Machines

LEAN MANUFACTURING

Credits: 3 Cr. Hrs.
Pre-Requisite: Production Planning and Control, Work study and Methods Engineering

DESCRIPTION

The course objective for Lean Manufacturing is to equip students with the principles and techniques of lean production, aiming to eliminate waste, streamline processes, improve efficiency, and enhance overall productivity in manufacturing operations.

COURSE LEARNING OUTCOMES

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

- Understand basic principles of lean system and product design and its implementation.
- Apply lean principle to reduce waste and improve production of the sytem
- Analyze systems with lean principles and improve the system
- Evaluate system performance with various lean implementation strategies.

Learning Domains and Levels:

Maximum Level of Cognitive Domain	Maximum Level of Affective Domain	Maximum Level of Psychomotor Domain
C5	A3	

COURSE CONTENT

Interchangeable Parts, Interchangeable People, The Toyodas, The Toyota Production System, Taiichi Ohno, Kaizen, Shigeo Shingo, Just-in-Time, Lean Manufacturing / Lean Operations, Lean Supply Chain, Lean Product Development, Lean Software Development, The Seven Principles of Lean Development, Eliminate Waste, Principle, Build Quality In , Create Knowledge, Defer Commitment, Deliver Fast, Respect People, Optimize the Whole, 5S system, bottleneck analysis, PDCA, Root Cause analysis, SMED, The Seven Wastes, Task Switching, Delays, Defects, Mapping the Value Stream, Queuing Theory, Little's Law, Variation and Utilization, Reducing Cycle Time, Responsibility-Based Planning and Control, Performance Evaluations, Just-in-Time Commitment, Mistake-Proofing, Configuration Management, Synergy, Six Sigma, Theory of Constraints

PRACTICAL REQUIREMENTS (If Any)

The course practical/labs should be defined and synchronized with the course outline

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Mary Poppendieck, Tom Poppendieck, Implementing Lean Software Development: From Concept to Cash, 1st edition, Published by Addison-Wesley rofessional (September 7, 2006) © 2007
2. John Davis Lean Manufacturing Implementation Strategies that Work: A Roadmap to Quick and Lasting Success (Volume 1), Industrial Press, Inc.; Illustrated edition (March 8, 2009)

QUALITY ENGINEERING

Credits: 3 Cr. Hrs.
Pre-Requisite: Nil

DESCRIPTION

The objective of the Quality Engineering course is to provide students with the knowledge and skills required to design, implement, and maintain quality management systems, ensuring products and processes meet or exceed customer expectations and industry standards.

COURSE LEARNING OUTCOMES

1. To demonstrate proficiency in utilizing advanced statistical tools and techniques for data analysis, hypothesis testing, and process optimization, enabling data-driven decision-making and problem-solving
2. To apply advanced quality improvement methodologies, such as Lean Six Sigma, Kaizen, balanced score cards to identify opportunities for process optimization and achieve significant performance enhancements.
3. To conduct advanced research projects in the field of Total Quality Management, contributing to the development of innovative quality management approaches and solutions and furthering the knowledge in the field.

COURSE CONTENT

Understanding quality, commitment and leadership, design for quality, planning for quality, quality system requirements, quality measuring tools and the improvement cycle, Quality assurance, ISO 9001, Six sigma, Kaizen, Balanced score card.

PRACTICAL REQUIREMENTS (If Any)

Use of Minitab/SPSS/Excel

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. John S. Oakland, Total Quality Management with Text Cases, Latest Edition.
2. D.H. Besterfield, C. Besterfield Michna, Total Quality Management, Latest Edition.
3. D. R. Kiran, Total Quality Management: Key Concepts and Case Studies, Latest Edition.

VIRTUAL REALITY

Credits: 3 Cr. Hrs.
Pre-Requisite: Nil

DESCRIPTION

To familiarize students with the principles and applications of virtual reality technology in industrial settings, enabling them to utilize VR tools for simulation, design, training, and analysis to improve efficiency, safety, and productivity

COURSE LEARNING OUTCOMES

1. To provide students with an overview of the basic principles of virtual reality (VR) and virtual environment technology (VET).
2. Apply the various input data to evaluate different VR systems
3. Analyze the working of VR systems including manufacturing systems, design to optimize Evaluate virtual environments for manufacturing decision support systems

COURSE CONTENT

Virtual reality applications in manufacturing systems design, manufacturing applications of networked virtual reality, virtual reality modelling of occupational safety engineering. Manufacturing systems design optimization using virtual environments, optimization of manufacturing decision support using virtual reality interfaces, analysis and evaluation of virtual environments.

PRACTICAL REQUIREMENTS (If Any)

1. The working of manufacturing and automation modeling using CAD/ CAM and computer-integrated manufacturing methods
2. Working of Virtual CIM Laboratory
3. Working of industrial robots in virtual environment
4. Working of highly automated manufacturing system/factory in virtual environment
5. Study the operation of automated manufacturing systems in virtual environment
6. Virtual reality modeling of occupational safety engineering

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Ong, S. K., Nee, A. Y. C., Virtual and Augmented Reality Applications in Manufacturing, Latest Edition.
2. Trucco, E., Verri, A., Introductory Techniques for 3D Computer Vision, Latest Edition.

SMART MANUFACTURING AND INDUSTRY 4.0

Credits: 3 Cr. Hrs.
Pre-Requisite: Nil

DESCRIPTION

The course aims to equip students with contemporary knowledge in smart manufacturing, enabling them to effectively apply the latest tools used in Industry 4.0 technologies and analyze the emerging trends shaping modern industries.

COURSE LEARNING OUTCOMES

1. Understand the concepts of Industry 4.0 and future of manufacturing as smart manufacturing systems.
2. Discuss the need for integration and flexibility in manufacturing
3. Understand basic technological aspects of Industrial Internet of things (IIoT), Cyber physical systems (CPS),Process modelling in digital enterprise, Industrial AI and predictive analytics for smart manufacturing.
4. Apply the industry 4.0 concepts for smart manufacturing systems
5. Analyse digital processes of enterprises
6. Evaluate processes with digital designs of the enterprises

COURSE CONTENT

Introduction to smart manufacturing, Systems engineering approach, Industry 4.0 enabling technologies, Industrial Internet of things (IIoT), Cyber physical systems (CPS),Process modelling in digital enterprise, Industrial AI and predictive analytics for smart manufacturing, Design principles in fourth industrial revolution and applications.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Masoud Soroush, Michael Baldea, Thomas Edgar, Smart Manufacturing Concepts and Methods, 1st Edition, Publisher: Elsevier, Year: 2019.
2. Schwab, Klaus. The Fourth Industrial Revolution, Publisher: Portfolio Penguin, Year: 2017.
3. Nof, S. Y. (Ed.). Springer Handbook of Automation, Publisher: Springer Science & Business Media, Year: 2009.
4. Ustundag, Alp, and Emre Cevikcan. Industry 4.0: Managing the Digital Transformation, Publisher: Springer, Year: 2017.
5. Gilchrist, Alasdair. Industry 4.0: The Industrial Internet of Things, Publisher: Apress, Year: 2016.

6. Li, W. D., Liang, Y., & Wang, S. (Eds.). Data Driven Smart Manufacturing Technologies and Applications, Publisher: Springer, Year: 2021.
7. Matt, D. T., Modrák, V., & Zsifkovits, H. Industry 4.0 for SMEs: Challenges, Opportunities and Requirements, Publisher: Springer Nature, Year: 2020.

FINITE ELEMENT ANALYSIS

Credits: 3 Cr. Hrs.
Pre-Requisite: Nil

DESCRIPTION

To provide students with a comprehensive understanding of the principles and methodologies of finite element analysis, enabling them to model, analyze, and solve complex engineering problems across various disciplines.

COURSE LEARNING OUTCOMES

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

- Solve various types of one-dimensional problems using Finite Element Methods (Direct method, Weighted Residual Methods, Variational Methods).
- Derive shape functions for linear, quadratic, and cubic elements.
- Analyze truss and beam problems using finite element methods.
- Use software tool(s) to perform relevant finite element analysis problems.

COURSE CONTENT

Introduction: Matrix forces methods, matrix stiffness method, interim period, variational principles and Finite Elements.

Variational Formulation and Approximation: Boundary and initial-Value problems, functional, variational symbol, variational formulation of boundary value problem, variational method of approximation, Ritz method, method of weighted residuals, time-dependent problems.

Finite Element Analysis of One-dimensional Problems: Modeling, discretization, connectivity of elements, imposition of boundary conditions, solutions &post processing, applications to heat transfer, fluid mechanics & solid mechanics problems

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Daryl L. Logan, A First Course in Finite Element Method, 4th Edition, Publisher: Nelson, Thomson, Location: Canada, Year: 2007.
2. David V. Hutton, Fundamentals of Finite Element Analysis, 1st Edition, Publisher: McGraw-Hill, Year: 2004.
3. Saeed Moaveni, Finite Element Analysis, 2nd Edition, Publisher: Prentice Hall, Year: 1999.

SUSTAINABLE MANUFACTURING

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

To educate students on environmentally responsible manufacturing practices, focusing on reducing waste, conserving resources, and promoting sustainability throughout the production process.

COURSE LEARNING OUTCOMES

1. Understand the basic concepts of sustainability
2. Apply the concepts of sustainability on material, processes, energy, resources for eco-design of systems
3. Analyze systems sustainability for circular economy, close loop concepts using life cycle assessment tools
4. Evaluate sustainable approach for sustainability in materials and processes, energy efficiency, resource management, life cycle assessment, Eco-design, circular economy, closed loop systems etc.

COURSE CONTENT

Sustainable materials and processes, energy efficiency, resource management, life cycle assessment, Eco-design, circular economy, closed loop systems, and green certifications and regulations.

PRACTICAL REQUIREMENTS (If Any)

Hands on experience using relevant computer software, equipment and simulation modules.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Günther Seliger, David O. Rosen, Sustainable Manufacturing: Shaping Global Value Creation.
2. Rainer Stark, Günther Seliger, Sustainable Manufacturing: Challenges, Solutions, and Implementation Perspectives.
3. Roger D. Hussey, Jeffrey W. Herrmann, Introduction to Sustainable Engineering.
4. 4.Kerop Janoyan, Catherine Mulligan, Sustainable Manufacturing: Understanding the Impact of Sustainability in the Manufacturing Environment.

RELIABILITY ANALYSIS

Credits: 3 Cr. Hrs.
Pre-Requisite: Nil

DESCRIPTION

The objective of the Reliability Analysis course is to equip students with the knowledge and techniques needed to assess and improve the reliability and performance of systems and components, ensuring their dependability and longevity in various engineering applications.

COURSE LEARNING OUTCOMES

1. Understand basics of reliability, its tools, and techniques
2. Apply reliability techniques to measure system reliability.
3. Evaluate the reliability of system to optimize the system

COURSE CONTENT

Definition, importance and objectives of reliability analysis, overview of reliability techniques and reliability metrics, statistical methods for reliability analysis, reliability block diagrams, fault tree, event trees, and Markov models, Failure Modes and Effect Analysis (FMEA), Fault Diagnosis and Prognosis. Catastrophic failure models and reliability functions, Failure distributions, Failure data analysis, System reliability evaluation techniques, Reliability optimization.

PRACTICAL REQUIREMENTS (If Any)

Hand on experience using relevant computer software

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. P.O. Connor, A. Kleyner, Practical Reliability Engineering, Latest Edition.
2. K.C. Kapur, L.R. Lamberson, Reliability in Engineering Design, Latest Edition.
3. C.E. Ebeling, An Introduction to Reliability & Maintainability Engineering, Latest Edition.
4. P.O. Connor, A. Kleyner, Practical Reliability Engineering, Latest Edition.
5. K.C. Kapur, L.R. Lamberson, Reliability in Engineering Design, Latest Edition.

METAL FORMING AND CUTTING ANALYSIS

Credits: 3 Cr. Hrs.
Pre-Requisite: Nil

DESCRIPTION

The course aims to enable the students to perform analysis of forming and machining processes. Students will learn economic and product design considerations in machining, micro-machining, and grinding. The effect of tool materials, tool geometry, and cutting fluids on tool life. Students will learn jigs and fixtures selection.

COURSE LEARNING OUTCOMES

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

1. Differentiation of the metal forming operations, machining processes and cutting tool types.
2. To be able to choose forming processes, cutting mechanisms, tool type, tool geometry and tool material, cutting fluids as per requirements. Also, able to interpret the results.
3. To be able to analyze machining economics and optimize metal forming, cutting, and grinding mechanisms. Also, able to select the appropriate jigs and fixtures as per the operation, and part geometry.

COURSE CONTENT

1. **Theory of machining**

- Cutting conditions
- Cutting models
- Chips formation and chip types
- Forces on metal cutting tools

2. Analysis of sheet metal working and bulk deformation processes:

- Shearing
- Bending
- Drawing
- Forming
- Other sheet metal operation (Stretch forming, Roll bending, Forming, Spinning, and High-energy-rate forming processes).

3. Jigs and fixtures:

- Types of drill jigs
- Types of fixtures
- Design considerations in drill jigs
- Material for jigs and fixtures

4. Grinding:
- Classification of grinding
- Abrasive materials
- Bonding materials
- Grinding wheels selection criteria
- Analysis of grinding process

5. Cutting Tools:
- Tool materials and properties
- Types of tools.
- Tools nomenclature.
- Cutting fluids
- Methods of cutting fluids application

6. Economic and product design considerations in machining
- Machinability
- Tolerances and Surface Finish
- Selection of Cutting Conditions
- Product Design Considerations in Machining

7. Micromachining
- Photolithography
- Etching
- LIGA
- Laser ablation
- Mechanical micro-machining

PRACTICAL REQUIREMENTS (If Any)

As part of overall learning requirements, the course will include:

1. Student will get hands-on practice on Turning operations (plain turning, taper turning), comparison of surface roughness for soft and hard materials, effect of rake angle.
2. Analysis of mold filling time and total solidification time, forging analysis, material removal rate analysis of lathe and milling operation.
3. Programming and operation of Lathe and Milling operation.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Hk09Kalpakjian, S., & Schmid, S. R. Manufacturing Engineering & Technology, 7th Edition, 2013.
2. Hosford, W. F., & Caddell, R. M. Metal Forming: Mechanics and Metallurgy, 4th Edition, 2014.
3. Knight, W. A., & Boothroyd, G. Fundamentals of Metal Machining and Machine Tools, 3rd Edition, 2005.
4. Beddoes, J., & Bibby, M. Principles of Metal Manufacturing Processes, 1st Edition, 1999.

COMPUTER INTEGRATED MANUFACTURING (CIM)

Credits: 3 Cr. Hrs.
Pre-Requisite: Nil

DESCRIPTION

To provide students with an understanding of how computer technology is used to control and automate manufacturing processes, enhancing efficiency, precision, and integration across production systems.

COURSE LEARNING OUTCOMES

1. KNOWLEDGE of Computer Integrated Manufacturing (CIM)/smart manufacturing, Components of CIM
2. UNDERSTAND CIM modeling through collaborative product design, Computer added process planning, CIM Justification, Computer Networks and Database Management
3. UNDERSTAND IDEF and PN Data flow diagrams
4. Apply IDEF and PN for CIM Modeling
5. Apply CIM measurement and Implementation guidelines for local SMEs and FMS.
6. Apply CIM principles to one's own work, as a member and/or leader in a team
7. Analyse justification of investment in CIM and its impact using Decision Support System (DSS) for CIM
8. Analyze CIM project in the broader context of innovation and technological developments.

COURSE CONTENT

Introduction to Computer Integrated Manufacturing, components of CIM system, CIM modelling, data flow diagrams and IDEF models, Integration of interconnected networks, computer network protocols, integrated approach to CIM justification and optimization, assessing the impact of investment in CIM, a decision support system for CIM investment, guidelines for implementing CIM, Application of CIM System in small & medium enterprises (SMEs).

PRACTICAL REQUIREMENTS (If Any)

1. Part programming on CNC machines
2. Part storage/retrieval programs and applications
3. Automated part identification
4. Part handling by robots and AGV
5. Use of CMM
6. Simulation of CIM
7. IDEF models development
8. Study of a decision support system

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Mikell Groover, Automation, Production Systems, and Computer Integrated Manufacturing, Latest Edition.
2. James A. Rehg and Henry Kraebber, Computer Integrated Manufacturing, Latest Edition.
3. Lin and Nagalingan, CIM Justification and Optimization, Latest Edition.

TOOL AND DIE DESIGN

Credits: 3 Cr. Hrs.
Pre-Requisite: Nil

DESCRIPTION

To equip students with the skills and knowledge necessary to design, develop, and manufacture precision tools and dies, essential for shaping and forming materials in various manufacturing processes.

COURSE LEARNING OUTCOMES

1. To develop comprehensive understanding of different types of tools, such as cutting tools, jigs, fixtures, molds, and dies, and their applications in manufacturing and assembly processes.
2. Be able to analyse and apply tool design principles for evaluating the performance of tools and dies to enhance the capability of tool designers.
3. Be able to evaluate the costs associated with tool design, production, and implementation against the potential benefits, such as improved efficiency, increased productivity, and reduced manufacturing costs.

COURSE CONTENT

Tool and die design, Tool materials, Work holding principles, Jigs and Fixtures design, Tools for inspection and gauging, Forming and drawing tools, Tool design for joining processes, Computers in tool design. Terminology for press working operations, Mechanical, hydraulic and pneumatic presses, Design of piercing, Blanking and shearing dies, Design of bending, forming and drawing dies, Design of Plastic injection dies, dies for pressure die casting.

PRACTICAL REQUIREMENTS (If Any)

To Study/survey different metals for making/manufacturing of tools

1. To study different clamping, locating and locking components for jigs fixtures
2. To Study the working of power/hydraulic press.
3. To design a blanking die for a typical part.
4. To study the function of compound dies
5. To Study of Progressive Dies
6. To study the function of different components of an injection mould and their working principles.
7. Designing of Plastic Injection Moulds using CAD software.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. J. Nee (Editor), Fundamentals of Tool Design, Society of Manufacturing Engineers, Latest Edition.
2. B. Boljanovic, Die Design Fundamentals, Latest Edition.
3. E. Hoffman, Jig and Fixture Design, 5th Edition, Latest Edition.
4. Prakash Hiralal, Jigs and Fixtures Design Manual, Latest Edition.

LOGISTIC MANAGEMENT

Credits: 3 Cr. Hrs.
Pre-Requisite: Nil

DESCRIPTION

To provide students with a thorough understanding of the principles and practices of efficient logistics and supply chain management, focusing on optimizing the flow of goods, information, and resources from origin to consumption

COURSE LEARNING OUTCOMES

1. Understanding of the basic concepts, procedures, requirements, techniques and systems involved in supply chain.
2. Applying the knowledge of material management, logistics management, warehouse management, strategic and time management, risk management, market channel management, sustainability for supply chain and logistics.
3. Studying and analyzing the parameters affecting the optimal strategies and management factors which contribute in the effectiveness of supply chain.
4. Evaluating different logistics networks, their related times and costs to optimize the supply chain network.
5. Create an optimal logistics network of supply chain design.

COURSE CONTENT

The logistical system of material management, developing a value-based Supply Chain, optimization of Supply Chain, Strategic relationships in logistics, process methodology, Issues concerning marketing channels functions, Determining the facilities requirement profile, Managing logistics facilities. Developing the logistics organization for effective supply chain management, Customer service and Customer retention.

PRACTICAL REQUIREMENTS (If Any)

Hand on experience using relevant computer software

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. J. L. Gattorna and D. W. Walters, Managing the Supply Chain: A Strategic Perspective, Latest Edition.
2. Martin Christopher, Logistic and Supply Chain Management, Latest Edition.
3. R. P. Mohanty, Supply Chain Management (Theories & Practices), Latest Edition.

ENTERPRISE RESOURCE PLANNING

Credits: 3 Cr. Hrs.
Pre-Requisite: Nil

DESCRIPTION

To equip students with the knowledge and skills to effectively implement and manage ERP systems, integrating various business processes and functions to enhance organizational efficiency and decision-making

COURSE LEARNING OUTCOMES

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

1. Understand the basic ERP system, its application and databases
2. Apply ERP concepts for project management, supply chain management, customer relationship, quality control, business intelligence and chain management with data security.

COURSE CONTENT

Fundamentals of ERP, business process integration, various ERP software applications, configuration, and customization, data management, and database concepts. ERP implementation, project management, modules for functional areas like finance, supply chain management, and customer relationship management. quality control and ERP, business intelligence and analytics, change management, and security within ERP systems

PRACTICAL REQUIREMENTS (If Any)

Hand on experience using relevant computer software

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Luvai Motiwalla and Jeffrey Thompson, Enterprise Systems for Management.
2. Thomas F. Wallace and Michael H. Kremzar, ERP: Making It Happen - The Implementers' Guide to Success with Enterprise Resource Planning.
3. S. N. Murthy, Enterprise Resource Planning: Concepts and Practice.
4. Mark von Rosing and Henrik von Scheel, The Complete Business Process Handbook: Body of Knowledge from Process Modeling to BPM.
5. Daryoush Daniel Vaziri, Bhuvan Unhelkar, and Gunasekaran Manogaran, Enterprise Information Systems: Contemporary Trends and Issues.

ADDITIVE MANUFACTURING

Credits: 3 Cr. Hrs.
Pre-Requisite: Nil

DESCRIPTION

To educate students on the principles, technologies, and applications of additive manufacturing, enabling them to design and produce complex and innovative products using 3D printing and other advanced manufacturing techniques.

COURSE LEARNING OUTCOMES

1. Understand additive manufacturing technology and processes
2. Apply various 3D printing techniques for various 3D printed objects
3. Analyze 3D printed objects using CAD software, design principles for optimizing 3D-printed objects, post-processing techniques, quality control and testing.
4. Evaluate 3D printing processes for real word application considering sustainability and legal considerations.

COURSE CONTENT

Introduction to the technology, in-depth exploration of various 3D printing processes and materials, hands-on experience with CAD software and 3D printers, design principles for optimizing 3D-printed objects, post-processing techniques, quality control and testing, real-world applications across industries, and discussions on sustainability, ethics, and legal considerations.

PRACTICAL REQUIREMENTS (If Any)

Hand on experience using relevant computer software

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Ian Gibson, David Rosen, and Brent Stucker, Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing.
2. Martin Leary, Design for Additive Manufacturing: Tools and Constraints.
3. Chee Kai Chua and Kah Fai Leong, Additive Manufacturing: Principles and Applications.
4. Ben Redwood and Filemon Schöffer, The 3D Printing Handbook: Technologies, Design, and Applications.
5. Steinar Westhrin, Avtar Singh, and Heng Li, Additive Manufacturing: Materials, Processes, Quantifications and Applications.
6. Francis N. Caddell and William F. Fornage, Additive Manufacturing for the Aerospace Industry

HUMAN ROBOT INTERACTION

Credits: 3 Cr. Hrs.
Pre-Requisite: Nil

DESCRIPTION

To explore the dynamics between humans and robots, studying design principles, communication modalities, and ethical considerations to develop effective and collaborative relationships between humans and robotic systems in various contexts.

COURSE LEARNING OUTCOMES

1. Understand human robot collaboration in various processes with basic principles and role of artificial intelligence and safety considerations
2. Apply principles of human psychology, ethical and social consideration for collaborative processes
3. Analyze user centered designs and robotic platforms through programming.

COURSE CONTENT

Design and development of robots for safe and effective collaboration with humans, the psychology of human-robot interaction, ethical and social considerations, and the practical implementation of HRI systems. an introduction to HRI principles, the study of user-centered design, the role of artificial intelligence in enabling natural communication with robots, safety and compliance standards, and hands-on experience in programming and experimenting with robotic platforms.

PRACTICAL REQUIREMENTS (If Any)

Hand on experience using relevant computer software

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Nikolaus Correll, Bradley Hayes, et al., Introduction to Autonomous Robots.
2. Ben Robins, Kerstin Dautenhahn, et al., Human-Robot Interaction.
3. Takayuki Kanda, Hiroshi Ishiguro, et al., HRI: Human-Robot Interaction.
4. Nancy M. Amato and Konstantinos E. Bekris, Human-Robot Interaction: A Survey.
5. Kerstin Dautenhahn and Joe Saunders, Social Robotics: An Interdisciplinary Approach.
6. Patrick Lin, George Bekey, and Keith Abney, Robot Ethics: The Ethical and Social Implications of Robotics.

7. Maja J. Mataric, The Robotics Primer.
8. Joseph L. Jones and Daniel Roth, Robot Programming: A Practical Guide to Behavior-Based Robotics.
9. Barbara Mirel, Interaction Design for Complex Problem Solving: Developing Useful and Usable Software.
10. Takayuki Kanda, Elin A. Topp, and Mohammad Obaid, Human-Robot Interaction in Social Robotics.

WAREHOUSE MANAGEMENT

Credits: 3 Cr. Hrs.
Pre-Requisite: Nil

DESCRIPTION

To provide students with a comprehensive understanding of warehouse operations, focusing on efficient storage, inventory management, and logistical processes to optimize the flow of goods and enhance overall warehouse productivity and performance.

COURSE LEARNING OUTCOMES

1. Describes how warehouse system can fully integrate all functions to manage warehouse effectively
2. Demonstrates capability to increase efficiency and profitability through effective management of Warehouses in organization

COURSE CONTENT

Warehouse design, inventory management, order picking, material handling equipment, and the implementation of warehouse technologies like Warehouse Management Systems (WMS). Quality control, safety, performance metrics, sustainability, and international logistics.

PRACTICAL REQUIREMENTS (If Any)

Hand on experience using relevant computer software

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Gwynne Richards and David Munden, Warehouse Management: A Complete Guide to Improving Efficiency and Minimizing Costs in the Modern Warehouse.
2. Donald J. Bowersox, David J. Closs, and M. Bixby Cooper, Warehouse Management and Inventory Control.
3. Kenneth B. Ackerman, Handbook of Warehousing.
4. Kevin Schofield, Introduction to Warehouse Management.
5. Gwynne Richards and David Munden, Warehouse Management: A Complete Guide to Improving Efficiency and Minimizing Costs in the Modern Warehouse.
6. B. Bhattacharyya, Warehouse Management and Inventory Control.

COMPUTER AIDED PROCESS PLANNING

Credits: 3 Cr. Hrs.
Pre-Requisite: Nil

DESCRIPTION

To familiarize students with the principles and tools of computer-aided process planning, enabling them to efficiently design and optimize manufacturing processes using software applications, thereby improving productivity, quality, and cost-effectiveness in production.

COURSE LEARNING OUTCOMES

1. Understand processes planning, CAPP and integration of geometric modeling tools
2. Apply CAPP tools for integrated process planning
3. Analyze various alternatives of CAPP based on utilization of resources, process sequences, tools selection, fixture designs, cost, quality and lean principles
4. Evaluate various CAPP to identify optimal CAPP of process.

COURSE CONTENT

Introduction to process planning and CAPP systems, integration of geometric modeling and CAD data, utilization of manufacturing resource data, process selection and sequencing, tool selection, CNC programming, fixture design, cost estimation, quality control, and lean manufacturing principles, manufacturing documentation and work instructions

PRACTICAL REQUIREMENTS (If Any)

Hand on experience using relevant computer software.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Paul Christ and Joseph Reisel, Computer-Aided Process Planning.
2. Carlos A. Smith and Armando B. Corripio, Automated Continuous Process Control.
3. S. Kant Vajpayee, Principles of Computer Integrated Manufacturing.
4. K. G. Swift and J. D. Booker, Manufacturing Process Selection Handbook.
5. James V. Valentino and Joseph Goldenberg, Introduction to Computer Numerical Control.

APPLICATIONS OF AI IN MANUFACTURING AND SERVICES SECTOR

Credits: 3 Cr. Hrs.
Pre-Requisite: Nil

DESCRIPTION

The course aims to demonstrate the real-world applications of artificial intelligence in both manufacturing and service industries, showcasing how AI can improve efficiency, quality control, predictive maintenance, supply chain management, customer service, and decision-making processes, ultimately fostering innovation and competitiveness.

COURSE LEARNING OUTCOMES

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

1. Understand the fundamental concepts of AI, machine learning, and deep learning.
2. Apply AI techniques to optimize industrial and manufacturing processes.
3. Identify opportunities and challenges in implementing AI in industrial settings.
4. Analyse real-world case studies of AI applications in industry.

COURSE CONTENT

AI and robotics in manufacturing, predictive maintenance, quality control, production optimization, and supply chain management, customer service chatbots, personalized marketing, recommendation systems, and data-driven decision-making, Natural language processing and sentiment analysis, fraud detection, AI in healthcare services, HR and recruitment, and ethical and legal considerations.

PRACTICAL REQUIREMENTS (If Any)

Hand on experience using relevant computer software.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach.
2. Kevin P. Murphy, Machine Learning: A Probabilistic Perspective.
3. Srinivas Kollipara, Predictive Maintenance: Tools and Techniques.
4. Ric Messier, Introduction to Artificial Intelligence for Security Professionals.
5. Foster Provost and Tom Fawcett, Data Science for Business.

ADVANCED MANUFACTURING PROCESSES

Credits: 3 Cr. Hrs.
Pre-Requisite: Nil

DESCRIPTION

The course delves into advanced manufacturing processes such as additive manufacturing, advanced machining, composite materials processing, and nanotechnology. Its goal is to equip students with the expertise to maximize productivity, improve product quality, and drive innovation in contemporary manufacturing sectors.

COURSE LEARNING OUTCOMES

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

1. Recall the basic knowledge of workshop practice and learn manufacturing processes via shaping, forming, joining, machining, additive manufacturing in more depth and extent.
2. Identification of the known and unknown parameters in Manufacturing Processes and making efficient use of boundary conditions to solve problems.
3. Redesign and develop products by selecting/Applying appropriate manufacturing processes and analyzing the conditions.

COURSE CONTENT

Introduction to Advanced Manufacturing, non-traditional machining processes, abrasive machining, advanced metal forming, additive manufacturing (3D printing), materials processing, nano and micro manufacturing, precision engineering, computer-aided manufacturing, and sustainability.

PRACTICAL REQUIREMENTS (If Any)

Hand of Experience.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Hassan El-Hofy, Advanced Machining Processes.
2. Gary F. Benedict, Nontraditional Manufacturing Processes.
3. Shigeyuki Somiya, Handbook of Advanced Ceramics.
4. Ian Gibson, David Rosen, and Brent Stucker, Additive Manufacturing Technologies.
5. Yi Qin and Marc Madou, Micromanufacturing Engineering and Technology.
6. V.C. Venkatesh, Precision Engineering.
7. Warren S. Seames, Computer Numerical Control: Concepts & Programming.
8. J. Paulo Davim, Sustainable Manufacturing.

CYBERSECURITY FOR INDUSTRIAL CONTROL SYSTEMS

Credits: 3 Cr. Hrs.
Pre-Requisite: Nil

DESCRIPTION

To provide a focused understanding of safeguarding industrial control systems from cyber threats. Participants will gain specialized skills to assess, mitigate, and respond to cybersecurity risks, ensuring the reliability and safety of critical infrastructure operations

COURSE LEARNING OUTCOMES

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

1. To understand cyber security, its issues, data security, threats to industrial control systems
2. To apply knowledge of cyber security to identify the risks and vulnerability, and apply risk assessment techniques.
3. To analyze cyber security risks on industrial control systems

COURSE CONTENT

Industrial Control System architecture and protocols, risk assessment, network and endpoint security, incident response, and secure design principles. SCADA systems and the security challenges posed by the Internet of Things (IoT) and Industrial Internet of Things (IIoT)

PRACTICAL REQUIREMENTS (If Any)

The course practical/labs should be defined and synchronized with the course outline"

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Eric D. Knapp and Joel Langill, Industrial Network Security: Securing Critical Infrastructure Networks for Smart Grid, SCADA, and Other Industrial Control Systems.
2. Clint Bodungen, Bryan Singer, and Aaron Shbeeb, Hacking Exposed Industrial Control Systems: ICS and SCADA Security Secrets & Solutions.
3. Tyson Macaulay and Bryan L. Singer, Cybersecurity for Industrial Control Systems: SCADA, DCS, PLC, HMI, and SIS.
4. Joseph Weiss, Protecting Industrial Control Systems from Electronic Threats.
5. Steve Winterfeld and Jason Andress, The Basics of Cyber Warfare: Understanding the Fundamentals of Cyber Warfare in Theory and Practice.

DATA ANALYTICS FOR INDUSTRIAL ENGINEERS

Credits: 3 Cr. Hrs.
Pre-Requisite: Nil

DESCRIPTION

The course aims to empower industrial engineers with practical skills in data analytics. Through hands-on experience, students will learn to extract valuable insights from large datasets, enabling them to make data-driven decisions that optimize processes, boost efficiency, and enhance productivity in industrial settings.

COURSE LEARNING OUTCOMES

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

1. Apply data analytics methods to solve practical business problems.
2. To extract meaningful insights from real datasets and make data-driven decisions.
3. Develop the ability to communicate findings effectively to both technical and non-technical audiences through reports, dashboards, and presentations.
4. Develop practical skills in programming languages like Python or R, as well as tools like Excel, SQL, and data visualization platforms.

COURSE CONTENT

Introduction to Data Analytics (Introduction to essential tools and technologies like Python/R, Excel), Data Manipulation and Preprocessing, Statistical Analysis for Data Analytics, Data Visualization and Interpretation (Creating impactful visualizations using tools like Tableau/Power BI), Machine Learning Basics, Advanced Machine Learning Techniques, Big Data and Data Warehousing, Ethical Considerations in Data Analytics, Applying data analytics techniques to solve a real-world problem, Preparing and delivering findings effectively to a diverse audience.

PRACTICAL REQUIREMENTS (If Any)

Labs/ Practical: The course practical/labs should be defined and synchronized with the course outline

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Pedro M. Saraiva, Industrial Engineering: Theory, Practice and Application.
2. Paul Newbold, William L. Carlson, and Betty Thorne, Statistics for Business and Economics.
3. Andreas C. Müller and Sarah Guido, Introduction to Machine Learning with Python: A Guide for Data Scientists.

4. Foster Provost and Tom Fawcett, Data Science for Business: What You Need to Know about Data Mining and Data-Analytic Thinking.
5. Thomas P. Ryan, Statistical Methods for Quality Improvement.
6. Averill M. Law and W. David Kelton, Simulation Modeling and Analysis.
7. “Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph” by David Loshin.
8. “Python for Data Analysis” by Wes McKinney (2nd Edition, 2017, Wiley)
9. “Business Analytics: Data Science for Business Problems” by Walter R. Paczkowski (Springer 2022).
10. Practical Statistics for Data Scientists” by Andrew Bruce and Peter Bruce (2017, Wiley)

ADVANCED ENGINEERING OPTIMIZATION

Credits: 3 Cr. Hrs.
Pre-Requisite: Nil

DESCRIPTION

To equip students with advanced optimization techniques for engineering applications. Through theoretical concepts and practical exercises, students will learn to optimize designs and processes, utilizing algorithms, mathematical modeling, and simulation tools to enhance performance and reduce costs effectively

COURSE LEARNING OUTCOMES

1. Understand linear programming, goal programming, integer programming, gem theory, Markov chain, single objective and multi objective optimization
2. Apply various programming techniques to solve optimization problems
3. Analyze optimization problems based on single and multiple objectives through various optimization techniques.
4. Evaluate the optimal solution of a given problem through various optimization techniques based on single and multiple objectives.

COURSE CONTENT

Advanced Linear Programming, Goal Programming, Integer Programming, Game Theory, Markov Chains, Multi objective Programming

PRACTICAL REQUIREMENTS (If Any)

Hand on experience using relevant computer software.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. H. A. Taha, Operations Research.
2. Wayne L. Winston, Operations Research: Applications and Algorithms.
3. Hillier, Liberman, Introduction to Operations Research.

INTRODUCTION TO THERMOS-FLUID

Credits: 3 Cr. Hrs.
Pre-Requisite: Nil

DESCRIPTION

The course introduces students to basic thermofluid principles. Through theory and practical examples, students learn thermodynamics, fluid mechanics, and heat transfer, preparing them to analyze fluid behavior and heat transfer in engineering contexts.

COURSE LEARNING OUTCOMES

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

1. Be conversant with the concepts and definitions used in fluid mechanics and thermodynamics;
2. Understand and be able to apply fundamental concepts and equations to practical problems;
3. Have a good understanding of basic thermodynamics and its importance in thermal systems;
4. Have a good understanding of basic gas laws and phase change processes;
5. Have a deep understanding of the different forms of energy, its transfer and the laws that controls this transfer;
6. Have a good understanding of basic ideal thermal cycles and their application to daily life;
7. Be equipped with the knowledge of environmentally responsible and current best practice for the design of efficient thermal system and cycles;
8. Have developed analytical cognitive skills and problem solving skills in thermodynamics and fluid mechanics

COURSE CONTENT

An introduction to mechanical engineering thermodynamics dealing with the application of the first and second laws of thermodynamics to the thermodynamic design and performance analysis of typical thermo-mechanical plant using condensable vapours and gases as the working fluid. Basic fluid mechanics including: kinematics and dynamics of fluid flows; conservation laws applied to fluid flow; Euler, Bernoulli, Navier-Stokes equations; dimensional analysis; differential and integral flow analysis; flow visualization. energy and entropy balance for closed and open systems In Fluid Mechanics students are introduced to basic fluid mechanics including: kinematics and dynamics of fluid flows; conservation laws applied to fluid flow; Euler, Bernoulli, Navier-Stokes equations; dimensional analysis; differential and integral flow analysis; fl

ow visualization and other experimental techniques.

Modern Tool Usage:

- Flow simulator
- Sim Scale

PRACTICAL REQUIREMENTS (If Any)

The course practical/labs should be defined and synchronized with the course outline"

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Moran, M.J., Shapiro, H.N., D. D. Boettner & Bailey, M. B., Principles of Engineering Thermodynamics, John Wiley and Sons Inc, 8th Edition, 2015.
2. Moran, M.J., Shapiro, H.N., D. D. Boettner & Bailey, M. B., Fundamentals of Engineering Thermodynamics, John Wiley and Sons Inc, 7th Edition, 2011.
3. T. D. Eastop and M.C. Conkey, Applied Thermodynamics for Engineering Technologists.
4. Sanford Klein and Gregory Nellis, Thermodynamics.

SOFT COMPUTING AND DATA MINING

Credits: 3 Cr. Hrs.
Pre-Requisite: Data Analytics, Probability and Statistics, Introduction to Computing, Optimization Techniques

DESCRIPTION

The course introduces students to soft computing and data mining. Through theory and practical applications, students learn methods like neural networks and fuzzy logic to analyze data efficiently, extract insights, and make informed decisions from large datasets.

COURSE LEARNING OUTCOMES

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

1. Understand basic principles data, its structure, clustering, classification and data analysis.
2. Apply data mining techniques to predict the variables
3. Analyze data and compute near optimal solutions
4. Evaluate data through soft computing techniques to predict the information

COURSE CONTENT

Data Mining, decision trees, association rule mining, incremental mining, distributed data mining, sequential mining, clustering, classification, discrimination, deviation mining, evolutionary mining, prediction, web mining, text mining, data warehouse, model overfitting, soft computing, genetic algorithms, neural networks, support vector analysis, fuzzy logic, rough sets, data mining applications, self-adaptive genetic algorithms, characteristics amplifications based algorithms, dynamic association rule mining algorithms, evolutionary approach for XML data mining, soft computing based CBIR systems, Fuzzy based algorithms, classification techniques.

Modern Tools:

- R language,
- Python
- Matlab

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Pang-Ning Tan, Michael Steinbach, Anuj Karpatne, Vipin Kumar, Introduction to Data Mining (Second Edition), Pearson, January 4, 2018.
2. K.R. Venugopal, K.G. Srinivasa, L.M. Patnaik, Soft Computing for Data Mining Applications, Springer.

LEAN SIX SIGMA

Credits: 3 Cr. Hrs.
Pre-Requisite: Nil

DESCRIPTION

The course aims to teach students Lean Six Sigma methodologies and tools to enhance process efficiency and quality. Through practical training and real-world examples, participants learn to identify inefficiencies, streamline operations, and achieve sustainable performance improvements across industries.

COURSE LEARNING OUTCOMES

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

1. Understand the principles, concepts, and methodologies of Lean and Six Sigma.
2. Apply Lean tools and techniques to identify and eliminate waste in manufacturing and service processes.
3. Apply Six Sigma tools and techniques to reduce variation and improve process performance.
4. Implement DMAIC methodology to systematically solve problems and improve processes.
5. Analyze process data using statistical methods to identify root causes of defects and inefficiencies.
6. Design and execute Lean Six Sigma projects to achieve measurable improvements in quality, cost, and delivery.
7. Collaborate effectively with cross-functional teams to drive continuous improvement initiatives.
8. Evaluate the benefits and limitations of Lean Six Sigma in different organizational contexts.
9. Prepare for Lean Six Sigma certification exams and professional development opportunities.
10. Demonstrate critical thinking and problem-solving skills in real-world Lean Six Sigma projects.

COURSE CONTENT

Introduction to Lean Six Sigma: History and Evolution of Lean and Six Sigma Methodologies, Principles of Lean Manufacturing, Principles of Six Sigma Quality Management, DMAIC Methodology (Define, Measure, Analyze, Improve, Control).

Lean Tools and Techniques: Value Stream Mapping5S (Sort, Set in Order, Shine, Standardize, Sustain), Kanban System, Poka-Yoke (Error Proofing), Just-in-Time (JIT) Production, Kaizen (Continuous Improvement).

Six Sigma Tools and Techniques: Statistical Process Control (SPC), Design of Experiments (DOE), Root Cause Analysis, Failure Mode and Effects Analysis (FMEA), Regression Analysis, Integration of Lean and Six Sigma, Lean Six Sigma Case Studies and Applications, Lean Six Sigma Project Management, Lean Six Sigma Certification and Training Programs

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. John Morgan and Martin Brenig-Jones, Lean Six Sigma For Dummies.
2. Michael L. George, John Maxey, David Rowlands, and Malcolm Upton, The Lean Six Sigma Pocket Toolbook: A Quick Reference Guide to 100 Tools for Improving Quality and Speed.
3. Michael L. George, Lean Six Sigma: Combining Six Sigma Quality with Lean Production Speed.

MECHANICS OF MACHINES

Credits: 3 Cr. Hrs.
Pre-Requisite: Nil

DESCRIPTION

To teach students the principles behind analyzing machine components and systems. Through theory and practice, students learn to assess motion, forces, and energy transfer within machines, preparing them to design and optimize mechanical systems for diverse engineering tasks.

COURSE LEARNING OUTCOMES

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

1. To understand basic concepts of kinematics and motion
2. To apply knowledge of mechanics on various applications including cam, gears, belts, chains, screw
3. To analyze static and dynamic loading of various engineering components of engineering machines including cams, gears, belts, screws etc

COURSE CONTENT

Introduction to Mechanisms and Kinematics, Building Computer Models of Mechanisms Using Working Model, Vectors, Position and Displacement Analysis, Mechanism Design, Velocity Analysis, Acceleration Analysis, Computer-Aided Mechanism Analysis, Cams: Design and Kinematic Analysis, Gears: Kinematic Analysis and Selection, Belt and Chain Drives, Screw Mechanisms, Static Force Analysis, Dynamic Force Analysis

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. David H. Myszka, Machines & Mechanisms: Applied Kinematic Analysis, 4th edition, Pearson.
2. Mahmoud A. Mostafa, Mechanics of Machinery, CRC Press, April 21, 2017.

COMPUTER AIDED MANUFACTURING

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

The course aims to teach students how to use computer-aided design models to generate manufacturing instructions for numerically controlled machines, and to provide them with basic knowledge of additive manufacturing principles for designing parts using computational tools and process understanding.

COURSE LEARNING OUTCOMES

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

1. The Identify and recognize the fundamental theory and concepts of CAM, NC machining, group technologies. Design for Manufacture (Comprehension)
2. Develop the concepts of NC programming of parts and underlying theory of its integration with hardware. Illustration of group technologies and its application in the design on cellular manufacturing in systems application. Apply design for manufacturing concepts (Application)
3. Design parts for AM by combining process knowledge, computational design tools and application requirements. Enable the students to assess the value of an AM part based on its production cost and performance (Application)

COURSE CONTENT

The contents of the course include: Conventional NC control, NC part programming, Computer control in NC, Group technology & process planning, PLCs, Design for Manufacturing (Dfx), and Additive Manufacturing.

PRACTICAL REQUIREMENTS (If Any)

The course practical/labs should be defined and synchronized with the course outline"

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. T. C. Cheng, Richard A. Wysk, H. P. Weng, Computer-Aided Manufacturing, 3rd Edition, 2005.
2. Kunwoo Lee, Principles of CAD/CAM/CAE Systems, 1999.
3. Ibrahim Zeid, CAD/CAM Theory and Practice, 2nd Edition, 2009.
4. I. Gibson, D. W. Rosen, B. Stucker, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Publisher: Springer, 2010.

HEALTH SAFETY & ENVIRONMENT

Credits: 2+0
Pre-Requisite: Nil

DESCRIPTION

The course "Health, Safety, and Environment" aims to provide students with a comprehensive understanding of the principles and practices related to maintaining health, safety, and environmental standards in industrial settings. By exploring various aspects of safety management, environmental protection, and regulatory frameworks, students will be equipped to contribute effectively to maintaining a secure and sustainable workplace

COURSE LEARNING OUTCOMES

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

1. Understand the significance of health and safety in industrial contexts
2. Illustrate the importance of maintaining a clean environment wrt environmental pollution, and explain the key provisions of environmental and health and safety acts
3. Comprehends ISO standards to regulatory compliance, risk reduction, and sustainable industry practices.

COURSE CONTENT

1. Introduction of Health and Safety: Industrial Safety: introduction objectives of Safety, Importance of Safety in an industry, Industrial accidents, Effects of accidents, Types of accidents incidence of fire. Fire prevention and control.
2. Techniques of Safety Management: Principles of accident prevention, hazard analysis. Legal, humanitarian, and economic reason for action. Safety inspection procedures. Safety training, First aid and emergency procedures
3. Environment and Health: Introduction: importance of clean environment, Scale of Environmental Pollution. Environmental Act. Health and Safety Act.
4. Atmospheric Pollution: Types of Atmospheric pollution, Their Causes and Effects on Human Health, Available Technologies for Controlling Pollution.
5. Industrial Waste: Solid Waste, Industrial Effluents and Waste Gases, waste treatment plants.
6. Noise Pollution: Measurement of Noise level, Effect of excessive noise on human health. Remedial Measures
7. ISO Standards for Safety and Health and Environment
8. ISO 45001: 2018 (OH&S) management system — Requirements with guidance

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. J. Ridley, J. Channing, Safety at Work, Publisher: Routledge.
2. K. G. Lockyer, Factory & Production Management, Publisher: Pitman Publishing.

NUMERICAL ANALYSIS & COMPUTER APPLICATIONS

Credit Hours: 2+1
Pre-Requisites: Nil

DESCRIPTION

To provide students with a comprehensive understanding of numerical methods and their applications in solving engineering problems, along with proficiency in utilizing computer software to analyze and optimize industrial processes, enhancing their ability to make informed decisions and solve real-world engineering challenges efficiently.

COURSE LEARNING OUTCOMES

The knowledge units in this area collectively encompass the following:

1. To comprehend different numerical techniques such as: error propagation, interpolation, differentiation, integration, eigenvalues and solution of algebraic and differential equations
2. To apply the numerical techniques to different linear and nonlinear engineering problems.

COURSE OUTLINE

- **Error Analysis and Interpolation**

a. Error analysis, Types of error, Sources of error, Norms of vectors and matrices, Computer arithmetic, Condition number of a matrix, Significant digits and loss of significant digits, Floating point arithmetic, Binary and decimal representation, Single and double precision

b. Interpolation: Newton forward and backward difference formula for interpolation, Central difference interpolation formulae, Lagrange's interpolation, Error in interpolation, Linear least square approximation, Interpolation versus least square approximation, Relevant engineering case studies

- **Numerical Differentiation and Integration**

a. Derivation of numerical differentiation of first order and second order derivatives using two points, three points, and five points formulas along with its application in engineering, Relevant case studies

b. Numerical integration: Trapezoidal rule, Simpson's rules, Composite Trapezoidal Simpson Rules and Romberg integration, Applications of numerical in engineering, Relevant case studies

- **Methods of solution a system of Linear Equations**

a. Solution of system of linear algebraic equations, Gauss elimination method

b. LU factorization, Tridiagonal solver

c. Applications of these methods in engineering disciplines, Relevant case studies

- **Iterative Methods for Linear and Nonlinear Equations**

a. Numerical Solution of nonlinear equations: Bisection method, Newton's method, Secant method, Convergence analysis of these methods
b. Newton's method for system of nonlinear equations
c. Solution of system of linear equations by Jacobi, Gauss Seidel and SOR methods, Applications of these methods in engineering disciplines, Relevant case studies

- **Numerical Methods for IVPs and BVPs**

a. Euler's method and its variations, Taylor's higher order methods, Error analysis, Consistency, stability and convergence
b. Runge-Kutta methods of order 2, 3, and 4, Stiff ODEs, Consistency, stability and convergence
c. Linear multistep methods, Numerical solution of system of ODEs
d. Numerical solution of BVPs by Finite Difference Method
e. Applications in engineering: Some relevant case studies

- **Numerical Methods for Computing Eigenvalues**

a. Eigenvalues and Eigenvectors of matrix: power method,
b. Inverse power method, Shifted inverse power method.
c. Applications of eigenvalues in engineering disciplines.

- **Numerical Optimization**

a. Unconstrained Optimization,
b. Golden search ratio, Lagrange Multipliers,
c. Method of steepest descent
d. Applications of optimization in engineering disciplines

COURSE OUTLINE (PRACTICALS)

The course practical/labs should be defined and synchronized with the course outline.

SUGGESTED INSTRUCTIONAL/ 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.

BASIC ELECTRONICS

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

To introduce students to core principles and concepts in electronics, covering electronic components, circuits, PCBs, microcontrollers, and industry applications. It aims to develop essential skills in analyzing, designing, and troubleshooting electronic circuits.

COURSE LEARNING OUTCOMES

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

1. Demonstrate understanding of industrial electronics components including electronics components, power supplies, semiconductors, switching devices and microcontrollers.
2. Apply knowledge of industrial electronics components for drawing circuit for real time applications.
3. Apply knowledge of industrial electronics components for PCB printing.

COURSE CONTENT

Fundamentals of Electricity, Voltage and Current, Power Supplies, Monitoring signals (multimeter, oscilloscope etc), Resistor Circuits and Ohms Law, Resistor Networks, Capacitor Circuits, Inductor Circuits, diodes, transistors, switching devices (SCR, MOSFET, IGBT, GTO.), non-isolated and isolated DC-DC switched-mode converters, diode and thyristor bridges, voltage-sourced converters (inverters and rectifiers), Operational amplifier, microcontrollers, practical Electronic Circuits, prototyping , PCB printing, industry applications of electronics.

Modern Tools which can used:

- Simulink
- Altium

PRACTICAL REQUIREMENTS (If Any)

Diode, Transistors, Switches, Transducers, Digital Systems, Microprocessors

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Mitchel E. Schultz, Grob's Basic Electronics, 13th Edition, McGraw Hill, 2021, New York

2. N. Mohan, T.M. Undeland, W.P. Robbins, Power Electronics -- Converters, Applications, and Design, 3rd Edition, John Wiley & Sons, 2003, ISBN: 978-0-471-22693-2.
3. R.W. Erickson, D. Maksimovic, Fundamentals of Power Electronics, Second Edition, Springer Science+Business Media Inc.
4. Daniel J. Shanefield, Industrial Electronics for Engineers, Chemists, and Technicians, Noyes Publications, 2001

ENVIRONMENT AND SUSTAINABILITY

Credits: 2+0
Pre-Requisite: Nil

DESCRIPTION

The course aims to provide students with an understanding of environmental science and sustainability, covering topics such as climate change, biodiversity, sustainable development, environmental policy, water resources, renewable energy, sustainable agriculture, waste management, and pollution control. It aims to foster awareness of environmental issues and promote sustainable practices for a better future.

COURSE LEARNING OUTCOMES

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

1. Explain environmental standards, obligations, and sustainable development.
2. Analyze different environmental challenges considering sustainability and solutions.
3. Propose solutions for different environmental challenges considering sustainability and sustainable solutions.

COURSE CONTENT

Introduction to Environmental Science, Climate Change, Biodiversity and Conservation, Diversity of life on earth, Threats to biodiversity, Sustainable Development and its applications, Environmental policy and governance, national and international environmental laws, Environmental monitoring and assessment, Water resources, Conservation of water resources, water scarcity, Renewable energy sources, Sustainable agriculture and foods systems, Waste management and Pollution Control, ISO 14000, ISO 14040.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Richard T. Wright, Dorothy F. Boorse, Environmental Science: Toward a Sustainable Future, Latest Edition.
2. Tom Theis, Jonathan Tomkin, Sustainability: A Comprehensive Foundation, Latest Edition.

****** List of Proposed Electives for Management Sciences Course (2+0)**
• Managerial Accounting • Total Quality Management • Management of Technical Organization • Supply Chain Management

MANAGERIAL ACCOUNTING

Credits: 2+0
Pre-Requisite: Nil

DESCRIPTION

The course aims to equip students with practical accounting skills for managerial decision-making. Through theory and practice, students learn to analyze financial data, interpret reports, and make informed decisions to enhance organizational performance.

COURSE LEARNING OUTCOMES

1. Understand various concepts of managerial accounting, money measurement, financial accounting, balance sheets, financial statements, book keeping, debit, credit, Assets and their types, liabilities and owners' equity, cost accounting and control, basic frame work of budgeting.
2. Apply the concepts of managerial accounting on various applications of investments
3. Analyze investments through cash flows, rate on investment, economic life, rate of return, investment turnover, profit margin etc.
4. Evaluate best investment plan through various methods of cash flows.

COURSE CONTENT

Managerial accounting, Money measurement concept, Financial accounting and managerial accounting, Balance sheet, Financial statement, Income Statement, Book keeping, Debit & Credit, Applications to investment decisions, Return on investment, Cash in-flow, Economic life, Rate of return, Investment turnover and profit margin, Tests of investment utilization, Assets and their types, liabilities and owners' equity, cost accounting and control, basic frame work of budgeting.

PRACTICAL REQUIREMENTS (If Any)

Hand on experience using relevant computer software

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Ray H. Garrison, Eric W. Noreen, Peter Brewer, Managerial Accounting, Latest Edition.
2. Jack L. Smith, Robert M. Keith, William L. Stephens, Managerial Accounting, Latest Edition.
3. Stacy Whitecotton, Robert Libby, Managerial Accounting, Latest Edition.

TOTAL QUALITY MANAGEMENT

Credits: 2+0
Placement: Nil

DESCRIPTION

To equip students with skills to implement quality management principles. Through theory and practice, students learn to analyze processes, improve quality, and enhance customer satisfaction, fostering continuous improvement in organizations.

COURSE LEARNING OUTCOMES

1. To demonstrate proficiency in utilizing advanced statistical tools and techniques for data analysis, hypothesis testing, and process optimization, enabling data-driven decision-making and problem-solving
2. To apply advanced quality improvement methodologies, such as Lean Six Sigma and Design for Six Sigma (DFSS), to identify opportunities for process optimization and achieve significant performance enhancements.
3. To conduct advanced research projects in the field of Total Quality Management, contributing to the development of innovative quality management approaches and solutions and furthering the knowledge in the field.

Learning Domains and Levels:

Maximum Level of Cognitive Domain	Maximum Level of Affective Domain	Maximum Level of Psychomotor Domain
C3	A4	

COURSE CONTENT

Advanced Quality Concepts, Advanced Quality Improvement Methods, Quality Management Systems (QMS), Advanced Statistical Tools, Advanced Process Management, Strategic Quality Management, Advanced Quality Culture and Leadership, Advanced Quality Measurement and Metrics, Advanced Case Studies and Applications, Research in TQM, Global Perspectives in TQM, Legal and Ethical Considerations

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Joseph M. Juran, Juran's Quality Handbook, McGraw-Hill.
2. Joseph A. Defeo, David L. Goetsch, Quality Management for Organizational Excellence, Publisher: Pearson.
3. William Edwards Deming, Quality, Productivity, and Competitive Position, Massachusetts Institute of Technology, Center for Advanced Engineering Study, 1982.

SUPPLY CHAIN MANAGEMENT

Credits: 2+0
Pre-Requisite: Nil

DESCRIPTION

To teach students how to efficiently manage the flow of goods and services from suppliers to consumers. Through theory and practice, students learn to optimize operations, reduce costs, and enhance customer satisfaction.

COURSE LEARNING OUTCOMES

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

1. To classify the types of supply chain management, measures the issues/ risks, and discuss the strategy of logistics and supply chain management of the organization (Comprehension)
2. To apply the techniques and tools in modelling and optimization of the logistics and supply chain management (Application)
3. To evaluate and assess the performance, efficiency, and resilience of the logistics system and its impact on supply chain management from customer perspective (Evaluation)

COURSE CONTENT

- The era of physical distribution
- Introduction to logistics and supply chain management
- The logistical system of material management
- Strategic relationships in logistics
- Process methodology of logistics & SCM
- Issues concerning marketing channels functions
- Developing a value based supply chain
- Optimization of Supply chain management
- Determining the facilities requirement profile
- Managing logistics facilities.
- Developing the logistics organization for effective supply chain management
- Customer service and customer retention.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Martin Christopher, Logistics & Supply Chain Management, 4th Edition.
2. Business Logistics and Supply Chain Management.

MANAGEMENT OF TECHNICAL ORGANIZATION

Credits: 2+0= 2
Pre-Requisite: Nil

DESCRIPTION

To equip students with the skills to manage technical organizations effectively, focusing on leadership, contemporary challenges, diverse management cultures, and legal and strategic principles.

COURSE LEARNING OUTCOMES

- 1. To understand and distinguish between management and leadership roles, and apply effective strategies in technical organizations.
- 2. To identify and analyze current trends, challenges, legal issues, and partner ecosystems in technical management.
- 3. To develop skills to manage diverse cultural environments and apply strategic principles to enhance organizational performance

COURSE CONTENT

- Management vs leadership, challenges in managing technical organizations, trends in management, management cultures, leadership lessons, legal issues in management, Modern challenges in partner ecosystem, management challenges across culture

SUGGESTED INSTRUCTIONAL/READING MATERIALS

1. Good to Great: Why Some Companies Make the Leap and Others Don't by Jim Collins, HarperCollins Publishers
2. Winning by Jack Welch, HarperCollins Publishers
3. When Cultures Collide: Leading Across Cultures by Richard D. Lewis, Third Edition, 2006

Annexure A

NON-EXHAUSTIVE LIST OF CONSIDERED KEY PHRASES IN UN SDGs FOR MAPPING WITH BACHELORS OF ENGINEERING PROGRAM

SDG-1 (1.5 …… reduce their exposure and vulnerability to climate-related extreme events …..)

SDG-2 (2.4 ……. implement resilient agricultural practices …… adaptation to climate change, extreme weather, drought, flooding and other disasters ….)

SDG-3 (3.6 …… halve the number of global deaths and injuries from road traffic accidents)

SDG-3 (3.9 …….. air, water and soil pollution and contamination)

SDG-4 (4.3 …….. ensure equal access for all women and men …, including university ……..)

SDG-4 (4.4 ……. increase the number of youth and adults ……., for employment, decent jobs and entrepreneurship)

SDG-4 (4.5 …….. eliminate gender disparities in education ……..)

SDG-4 (4.7 ……. all learners acquire the knowledge and skills needed to promote sustainable development……..)

SDG-4 (4.c …….. substantially increase the supply of qualified teachers……)

SDG-5 (5.1 End all forms of discrimination against all women and girls everywhere)

SDG-5 (5.5 …… Ensure women's full and effective participation …….. at all levels……..)

SDG-6 (6.1 … access to safe and affordable drinking water for all)

SDG-6 (6.2 … adequate and equitable sanitation and hygiene for all and end open defecation ..)

SDG-6 (6.3 …….. improve water quality by reducing pollution……)

SDG-6 (6.4 …… increase water-use efficiency across all sectors ……)

SDG-6 (6.5 …… implement integrated water resources management at all levels……..)

SDG-6 (6.a ..... water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies.....)

SDG-6 (6.b ..... improving water and sanitation management.....)

SDG-7 (7.b ... expand infrastructure.....)

SDG-8 (8.3 ..... decent job creation, entrepreneurship.....)

SDG-8 (8.6 ..... reduce the proportion of youth not in employment, education or training....)

SDG-8 (8.8 ..... promote safe and secure working environments for all workers.....)

SDG-9 (9.4 ..... greater adoption of clean and environmentally sound technologies and industrial processes.....)

SDG-9 (9.5 ..... encouraging innovation and substantially increasing the number of research and development workers.....)

SDG-9 (9.b Support domestic technology development, research and innovation in developing countries.....)

SDG-9 (9.c significantly increase access to information and communications technology.....)

SDG-10 (10.2 ..... empower and promote the social, economic ..... inclusion of all.....)

SDG-11 (11.2 ..... access to safe, affordable, accessible and sustainable transport systems for all.....)

SDG-11 (11.5 ..... reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses ..... by disasters, including water-related disasters.....

SDG-11 (11.6 ..... special attention to air quality and municipal and other waste management.....)

SDG-11 (11.a ..... positive economic, social and environmental links between urban, peri-urban and rural areas.....)

SDG-11 (11.c ..... resilient buildings utilizing local materials)

SDG-12 (12.2 ..... achieve the sustainable management and efficient use of natural resources)

SDG-12 (12.4 ..... achieve the environmentally sound management of chemicals and all wastes throughout their life cycle.....)

SDG-12 (12.5 ..... substantially reduce waste generation through prevention,

reduction, recycling and reuse)

SDG-12 (12.7 Promote public procurement practices that are sustainable……)

SDG-12 (12.8 …… relevant information and awareness for sustainable development……)

SDG-12 (12.a …… more sustainable patterns of consumption and production)

SDG-13 (13.1 Strengthen resilience and adaptive capacity to climate related hazards and natural disasters……)

SDG-13 (13.2 Integrate climate change measures……)

SDG-13 (13.3 Improve education, awareness-raising …… on climate change mitigation, adaptation, impact reduction and early warning……)

SDG-13 (13.b … effective climate change-related planning and management……)

SDG-14 (14.1 …… reduce marine pollution of all kinds……)

SDG-14 (14.3 …… impacts of ocean acidification……)

SDG-15 (15.3 …… land affected by desertification, drought and floods……)

SDG-16 (16.3 …… rule of law at the national and international levels……)

SDG-16 (16.5 …… reduce corruption and bribery in all their forms)

SDG-16 (16.6 …… effective, accountable and transparent institutions at all levels……)

SDG-17 (17.1 Strengthen domestic resource mobilization……)

SDG-17 (17.13 …… macroeconomic stability……)

SDG-17 (17.17 …… effective public, public private and civil society partnerships……)

Annexure B

MAPPING GUIDE OF SELECTED COURSE WITH SDGs

SOCIOLOGY FOR ENGINEERS

Credits: 02
Pre-Requisite: Nil

DESCRIPTION

This course is meant to provide engineering students, with an opportunity to view the discipline of sociology from the engineering perspective and will highlight its application to engineering profession. This will also enable the engineers to fit their technical ideas into a socially acceptable product /project in a more successful manner, with emphasis on UN SDGs.

Mapped SDGs:

DG-13 Climate Change	13.2 Integrate climate change measures……

COURSE LEARNING OUTCOMES

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

1. Introduce to the methods and philosophy of the social science to help their understanding of the socio-cultural dimension of human existence as a fundamental reality in engineering projects etc.
2. To provide opportunity for students to begin the process of considering social problems/ issues while designing engineering products.
3. To allow engineers to play a pro-active role in critical discussions of social issues specifically.
4. To demonstrate comprehension of roles and functions of various social institutions, state organizations, Professional bodies and relationships for analyzing their social impact Assessment.

COURSE OUTLINE

1. Fundamental Concepts and Importance of Sociology for Engineers

- What is sociology? Nature, Scope, and Importance of Sociology, Sociological Perspectives and Theories, Social Interactions, Social Groups/ Social Institutions & heir interface with Engineering Project/services,

Sociology & Impact of Technology & Engineering Products/Projects on Society.

2. Cultural Impacts of Engineering Projects on Society

- Definition of Culture, Types of Culture & Elements of Culture, Culture & Power, Authority, Dominance Socialization and Personality, Role of Engineering Projects on Culture, social norms and values of Society, Cultural Infusion of Engineers in Society.

3. Theoretical Perspective of Sociology: Diffusion and Innovation; Adoption and Adaptation; Social development; Community Development

- Community Development & Social consequences of Industrialization, Development Processes of Societal Development, Cooperation and Conflict in Community Development in Engineering Context.

4. Understanding of Societal & Ethical Norms and Values for Engineers

- Engineering Ethics, Engineering product/services for Less privileged, Role of Engg & Technology in addressing Social inequality, Core Social Values/Norms affecting Engg Performance

5. Organizational Social Responsibility (OSR) of Engineers

- Extent to which development intends to sensitize societal and under-privileged needs
- Gender inclusiveness and balance
- Special and Disadvantaged Community of the Area
- Planning for community inclusiveness
- Societal Obligation of Engineers

6. Engineers, Society and Sustainability

- Social System and Concept of Sustainable Development Technology and Development, Population Dynamics in Pakistan, Causes and Consequences of Unplanned Urbanization, Community Development, Programs in Pakistan, Community Organization & Engineering Projects, Population, Technological & Industrial expansion and Development with focus on social/human/ethical dimensions, UN SDGs.

7. Industrial & Organizational Psychology

- Interpersonal Relations, Interpersonal Behavior, Formation of Personal Attitudes,Language and Communication, Motivations and Emotions, Impact of Technology on human feelings and level of Sensitivity

8. Climate Change and Ecological Friendliness from Engineering Perspective 173

- Ecological Processes, Ecosystem and Energy, Impact of Engineering Projects on Eco System & Human Ecology, Industrial & Environmental

impact on Population & General Masses, Technological Intervention, Ecosystem and Physical Environment, Social Impact of Technology & Engineering Products & Services (Solid Waste Disposal, Pollution control etc)

9. Social Approaches and Methodologies for Development Administration & Stakeholders Analysis

- All Phases of the Project (pre, post and execution) Structured, Focused Group, Stakeholder Consultative Dialogues etc. Dynamics of Social Change, Sociology of Change and Industrial Development, Social Change due to Technology Driven Economic Growth.

10. SIA (Social Impact Assessment)

- Base line and need-assessment, evaluation and impact assessment surveys of the development projects. Role of Engg & Technology for Creating Social Cohesiveness & Societal Integration. Technology Based change in Collective

  Behavior, Social Audit of Engineering Projects.

11. Engineering Intervention for Social Stratification

- Factors of Social Stratification, Engineering Interventions for addressing Social Stratification, Social Mobilization through Technological Innovation.

12. Case Studies of Different Development Projects in Social Context

SUGGESTED TEACHING & ASSESSMENT METHODS

Suggested Teaching Methods

Lectures (audio/video aids) Written Assignments/ Quizzes, Tutorials
Case Studies relevant to engineering disciplines, Semester Project
Guest Speaker
Project/Field Visits Group discussion
Community Service Report Writing
Social Impact Review and Social Audit of Engg Project

Suggested Assessment Methods Theory

Mid Term,
Report writing/ Presentation Assignments
Project Report Quizzes
Final Term

SUGGESTED INSTRUCTIONAL/READING MATERIALS

1. Godhade, J. B., and S.T. Hunderkari. 2018. Social Responsibility of Engineers.

International Journal of Academic Research and Development. Vol. 03; Special Issue. March, 2018.174

2. Nichols,S.P.andWeldon,W.F.2017. Professional Responsibility: The Role of Engineering in Society Center for Electro-mechanics, The University of Texas at Austin, USA.

3. Aslaksen,E.W.2016. The Relationship between Engineers and Society: is it currently fulfilling its potential? Journal and Proceedings of the Royal Society of New SouthWales,Vol.148.Nos.455-456. Gumbooya Pty Lte, Allambie Heights, Australia.

4. Bell, S. Engineers, Society and Sustainability. Synthesis Lectures on Engineers, Technology, and Society. Edited by Caroline Baillie, University of Western Australia. Morgan and Claypool Publishers.

5. Jamison,A.,Christensen,S.H.,andLars,B.2011.A Hybrid Imagination: Science and
Technology in cultural perspective

6. Vermaas,P.,Kroes,P.,Poet,1.,andHoukes,W.2011.APhilosophyof Technology: FromTechnical Artefacts to Socio technical systems.

7. Mitcham,C.,andMunoz,D.2010.HumanitarianEngineering. Morganand Claypool Publishers. Riley,D.2008.Engineering and Social Justice. Morgan and Claypool Publishers.

8. Bugliarello,G.1991.TheSocial Functions of Engineering: A Current Assessment, A Chapter in“ Engineering as A Social Enterprise. Sociology

Available at:
http://www.pec.org.pk