Curriculum for

Food Engineering

Bachelor of Engineering Program

2023

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 Competency) 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 Member, PEC Governing Body / Prof. Emeritus /Advisor MUET	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 and Petrogas & 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

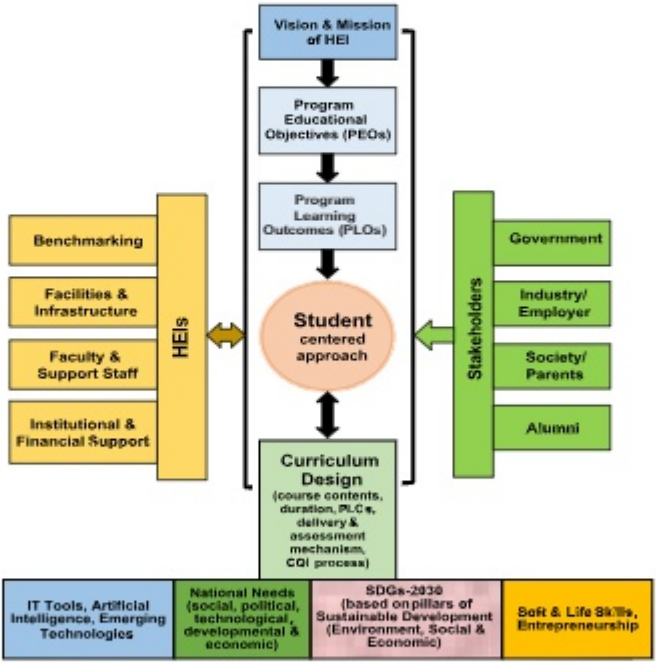
- The ECRDC is responsible to oversee the overall working of curriculum review and development for all engineering programs in terms of strategy, guidance & progress, and thereby submission to the relevant forum for adoption/ notification.

- 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 Chemical and Allied Engineering Disciplines

The PEC Engineering Curriculum Review and Development Committee (ECRDC) of Chemical and Allied Engineering Disciplines took up the task to review and update the curriculum for Food engineering program. The subject Committee had several meetings besides multiple sessions of Sub-Groups and the concluding meeting of ECRDC (Chemical Engineering) was conducted on 11-1-2024 at PEC Head Office Islamabad.

The Committee consisted of following members.

1. Engr. Dr. Naveed Ramzan — Convener
   Dean/ Professor, Department of Chemical Engineering
   University of Engineering & Technology, Lahore

2. Engr. Dr. Saeed Gul — Member
   Professor, Department of Chemical Engineering
   University of Engineering & Technology, Lahore

3. Engr. Dr. Sadiq Hussain — Member
   HoD/ Professor, Department of Chemical Engineering
   NFC-IET, Multan

4. Engr. Dr. Khadija Qureshi — Member
   Chairperson/ Professor, Department of Chemical Engineering
   Mehran University of Engineering & Technology
   Jamshoro

5. Engr. Dr. Tanveer Iqbal — Co-opted Member
   Chairman/ Campus Coordinator/ Professor
   Department of Chemical Engineering
   UET (New Campus), Lahore

6. Engr. Dr. Syed Kamran Sami — Co-opted Member
   Dean/ Professor, Faculty of Engineering & Architecture
   BUITEMS, Quetta

7. Engr. Dr. Muhammad Zafar Noon — Co-opted Member
   Former Professor, UET Lahore

8. Engr. Liaquat Mahmood — Co-opted Member
   Professor (Rtd.), Punjab University, Lahore

9. Engr. Muhammad Ramzan — Co-opted Member
   Plant Manager,
   Rafhan Maize, Faisalabad

10.	Engr. Mubashir Mahmood Butt Manager HSE&Q Fauji Fertilizer Corporation Company Sadiqabad, Rahim Yar Khan	Co-opted Member
11.	Engr. Ammar Abbas Process Manager, Pak Arab Refinery Company (PARCO), Kot Addu	Co-opted Member
12.	Engr. Habib ur Rehman Managing Director, Madina Glass Processing	Co-opted Member
13.	Engr. Imdad Hussain Brohi Former Process Engineer Saindak Metals Pvt Ltd, Ministry of Energy (Petroleum Division)	Co-opted Member
14.	Mr. Hidayatullah Kasi HEC Representative	Co-opted Member
15.	Engr. Niaz Ahmed Khaskheli Sr. Additional Registrar/ HoD-EAD	Secretary ECRDC
16.	Engr. Osaf Mahmood Malik Section Head (Curriculum & Development)	Additional Registrar-EAD
17.	Engr. Syed Haider Abbas Bokhari	Assistant Registrar-EAD
18.	Mr. Muhammad Irfan	Office Superintendent-EAD

The working on curriculum development of Food Engineering was initiated in 2022 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 Chemical and Allied Engineering Disciplines.

Sub-Group Food Engineering

1. Engr. Prof. Dr. Naveed Ramzan — Lead Sub-Group
   Dean, Faculty of Chemical Engineering,
   University of Engineering & Technology (UET), Lahore

2. Engr. Muhammad Ramzan — Co-Lead
   Plant Manager, Rafhan Maize, Faisalabad

3. Engr. Dr. Zahoor Ul Hussain Awan — Member
   Professor, Food Engineering, NED-UET, Karachi

4. Engr. Dr. Asim Laeeq Khan — Member
   Professor, Chemical Engineering,
   Comsats University, Islamabad (Lahore Campus)

5. Engr. Dr. Muhammad Younas — Member
   Professor, Chemical Engineering,
   University of Engineering & Technology, Peshawar

6. Engr. Dr. Saima Yasin — Member
   Professor, Chemical Engineering, UET Lahore

7. Engr. Dr. Sikandar Rafiq — Member
   Professor, Food Engineering, UET Lahore (New Campus)

8. Engr. Dr. Muhammad Amin — Member
   Associate Professor, Food Technology, BUITEMS, Quetta

9. Engr. Dr. Anjum Munir — Member
   Professor, Food Engineering, University of Agriculture, Faisalabad

10. Engr. Dr. Abdullah Durrani — Member
    Professor, Chemical Engineering, University of Punjab, Lahore

The ECRDC Chemical and Allied Engineering Disciplines appreciated the extra-ordinary efforts and contribution of Engr. Prof. Dr. Naveed Ramzan (Convener), Engr. Prof. Dr. Zahoor ul Hassan Awan (Member), Engr. Prof. Dr. Sikandar Rafiq (Member) & Engr. Osaf Mahmood Malik (Section Head Curriculum & Development) for compilation of course contents and proof reading of this curriculum booklet.

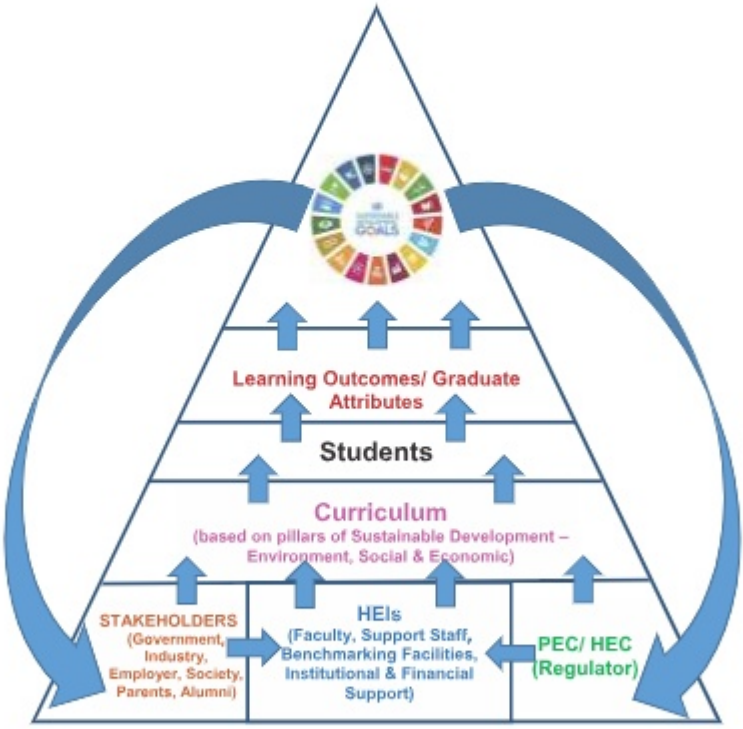
6. Agenda of ECRDC for Chemical and Allied Engineering Disciplines

- 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 policies/ HEC.
- 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. Dr. Naveed Ramzan 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 professors and experts from academia, industry and R&D institutions have provided a useful input and suggestions covering new developments to be incorporated in the curriculum. He also highlighted the importance of the field of Food Engineering for achieving sustainable developments while addressing socio-economic issues and challenges envisaged in Goal-4 of the Sustainable Development Goals-2030.

- 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 attitudes that 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 (WK-1-WK-4).

- **PLO-2 Problem Analysis:** Identify, formulate, conduct research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences (WK-1-WK-4).

- **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 the 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 theHEI'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. For mapping with 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.

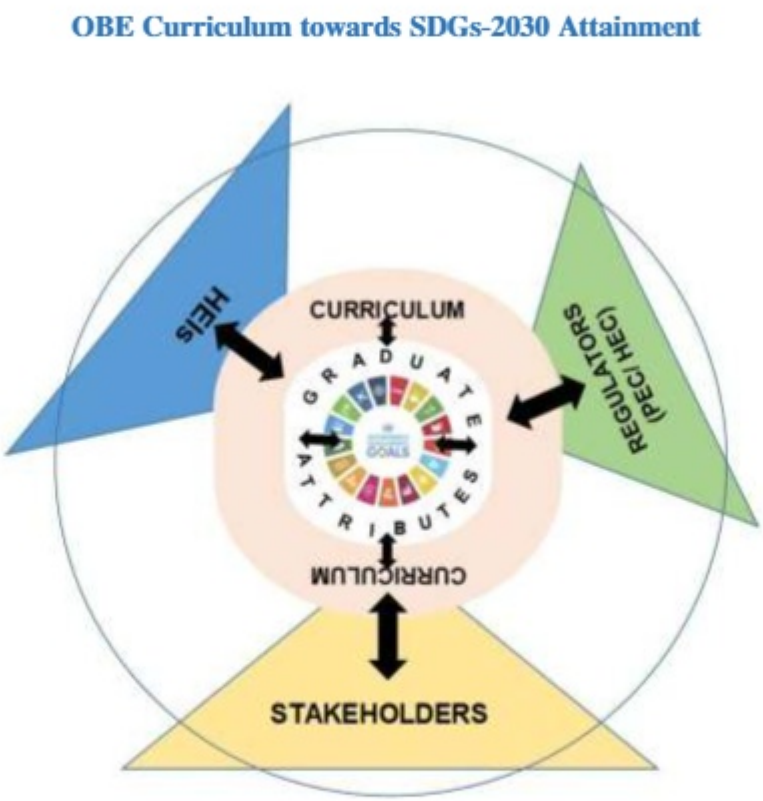


Figure 2: Consideration of UN SDGs in curriculum design

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

Ser	Description	UN SDGs																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	HEI vision and mission with focus on specific engineering program																	
2	Bachelor of Engineering Curriculum (Engg. & Non-Engg. Courses)																	
3	Final Year Design Project (FYDP)																	
4	Other pre-requisite activities (Internship, Community service, Survey camp, etc)																	
5	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** **Engineeringdesign and operations**	SDG-1, 2, 3, 6, 10, 11, 12, 13, 14 (relevance as per curriculum)

PLO-4 **Investigation:** Breadth and depth of investigation and experimentation	**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** **Engineeringdesign 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 inand 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 of activities 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 differing types of activity	**EC-9** **Manage engineering activities**	(WK-2 & WK-5) **WK-2** **Mathematics & computing** **& WK-5** **Engineering** **design and operations**	SDG-9
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-9, 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: Minimum 38 Credit Hours
    - o Engineering Domain (including computer courses, foundation, breadth, depth/major courses): Minimum 72 Credit Hours
    - o FYDP/ Capstone Project: 06 Credit Hours
    - o Multidisciplinary Engineering/Specialty Courses: Minimum 06 Credit Hours
    - o HEIs have flexibility of 8-14 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 Food 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 Science(s)	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 Occupational Health and Safety (Mandatory 01 credit hours)	6
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 Food 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 Food Engineering Curriculum

Knowledge Profile (WK-1 to WK-9)	Knowledge Area	Subject Area	Name of Course	Th	Lab	Cr Hrs	Total Credits
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	Ideology and Constitution of Pakistan **	2	0	2	6
			Islamic Studies/ Ethics**	2	0	2	
			Arts & Humanities Elective*	2	0	2	
		Social Sciences	Social Science Elective***	2	0	2	4
			Civics & Community Engagements **	2	0	2	
	Computer Sciences	Basic Computing	Applications of ICT **	2	1	3	3
	Management Sciences	Professional practice	Project Management ***	2	0	2	7
			Entrepreneurship **	2	0	2	
WK-1 WK-2	**Natural Sciences**	Chemistry	Applied Chemistry***	2	1	3	
		Mathematics	Quantitative Reasoning-I**	3	0	3	6
			Quantitative Reasoning-II**	3	0	3	
			Calculus & Analytical Geometry	3	0	3	9
			Linear Algebra & Differential Equations	3	0	3	
			Applied Physics***	2	1	3	
Total (General Education / Non-Engineering Domain)							**41**

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	Knowledge Area	Subject Area	Name of Course	Th	Lab	Cr Hrs	Total Credits
Engineering Domain							
WK-2 WK-4/ WK-5/ WK-6	Advanced Computer and Information Science(s)	ICT/AI/ Data Science/ Cyber Security	Computer Programming for Engineers	2	1	3	6
			Artificial Intelligence applications in Food Industry	2	1	3	
WK-2 WK-3	Engineering Foundation		Fluid Mechanics-I	2	1	3	22
			Engineering Materials	2	0	2	
			Engineering Thermodynamics	3	1	4	
			Heat & Mass Transfer	3	1	4	
			Engineering Properties of Food	2	1	3	
			Introduction to food Engineering	2	0	2	
			Material and Energy balance	3	0	3	
			Engineering Workshop	0	1	1	
WK-1 WK-2/ WK-4	Major Based Core (Breadth)		Fluid Mechanics-II	2	1	3	22
			Utility & Maintenance Management	2	0	2	
			Unit Operations in Food Engineering-I	3	1	4	
			Process Control & Instrumentations	2	1	3	
			Food Processing & Preservation	3	0	3	
			Machine Design for Food Industries	2	0	2	
			Food Process Engineering	2	0	2	
			Food Microbiology	2	1	3	
WK-5/ WK-6	Major Based Core (Depth)		Unit Operations in Food Engineering-II	3	1	4	22
			Food Plant Layout & Design	3	1	4	
			Food Packaging	2	1	3	
			Food Quality Control	2	0	2	
			Elective-I	3	0	3	
			Food Safety and Quality Management	3	0	3	
			Separation Processes	3	0	3	

WK-1 WK-2/ WK-3 WK-4/ WK-7	Multi-Disciplinary Engineering		Manufacturing Excellence	2	0	2	6
			Transport Phenomenon	3	0	3	
			Occupational Health and Safety	1	0	1	
WK-1/ WK-2/ WK-3/ WK-4/ WK-5/ WK-6/ WK-7	Flexible Engineering / Non-Engineering Courses		Food Bio-Chemistry	2	1	3	11
			Elective-II	2	0	2	
			Engineering Drawing & Graphics	1	1	2	
			Engineering Mechanics	2	0	2	
			Food Regulations & legislations	2	0	2	
WK-3/ WK-4/ WK-5/ WK-6 WK-7/ WK-8/ WK-9	Final Year Design Project (FYDP)		FYDP Part-I	0	3	3	6
			FYDP Part-II	0	3	3	
WK-6 WK-7/ WK-9	Industrial Training	6-8 weeks industrial training (Non-Credit)				**Mandatory & Qualifying**	
Total (Engineering Domain)						**95**	
Total (Credit Hours)						**136**	

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

12. Scheme of Studies for Bachelor of Food Engineering Curriculum

1st Year				
First Semester				
S. No.	**Course Title**	**(Credit Hours)**		**Total Cr. Hrs.**
		Theory	**Lab**	
1	Introduction to Food Engineering	2	0	2
2	Applications of ICT	2	1	3
3	Applied Chemistry	2	1	3
4	Functional English	3	0	3
5	Engineering Drawing & Graphics	1	1	2
6	Quantitative Reasoning-1	3	0	3
7	Ideology and Constitution of Pakistan	2	0	2
	Total	**15**	**3**	**18**
Second Semester				
S. No.	**Course Title**	**(Credit Hours)**		**Total Cr. Hrs.**
		Theory	**Lab**	
1	Food Bio-Chemistry	2	1	3
2	Food Microbiology	2	1	3
3	Expository Writing	2	1	3
4	Applied Physics	2	1	3
5	Engineering Materials	2	0	2
6	Quantitative Reasoning-II	3	0	3
7	Engineering Workshop	0	1	1
	Total	**13**	**5**	**18**

2nd Year				
Third Semester				
S. No.	**Course Title**	**(Credit Hours)**		**Total Cr. Hrs.**
		Theory	**Lab**	
1	Engineering Thermodynamics	3	1	4
2	Engineering Mechanics	2	0	2
3	Social Science Elective**	2	0	2
4	Engineering Properties of Foods	2	1	3
5	Fluid Mechanics-I	2	1	3
6	Unit Operations in Food Engineering-I	3	1	4
	Total	**14**	**4**	**18**
Fourth Semester				
S. No.	**Course Title**	**(Credit Hours)**		**Total Cr. Hrs.**
		Theory	**Lab**	
1	Food Process Engineering	2	0	2
2	Fluid Mechanics-II	2	1	3
3	Material and Energy Balance	3	0	3
4	Unit Operations in Food Engineering-II	3	1	4
5	Islamic Studies/ Ethics	2	0	2
6	Linear Algebra & Differential Equations	3	0	3
	Total	**15**	**2**	**17**

3rd Year				
Fifth Semester				
S. No.	**Course Title**	**(Credit Hours)**		**Total**
		Theory	**Lab**	**Cr. Hrs.**
1	Computer Programming for Engineers	2	1	3
2	Calculus & Analytical Geometry	3	0	3
3	Heat & Mass Transfer	3	1	4
4	Food Processing & Preservation	3	0	3
5	Elective-I***	3	0	3
6	Arts and Humanities Elective*	2	0	2
	Total	**16**	**2**	**18**
Sixth Semester				
S. No.	**Course Title**	**(Credit Hours)**		**Total**
		Theory	**Lab**	**Cr. Hrs.**
1	Machine Design for Food Industries	2	0	2
2	Transport Phenomenon	3	0	3
3	Artificial Intelligence applications in Food Industry	2	1	3
4	Project Management	2	0	2
5	Separation Processes	3	0	3
6	Occupational Health & Safety	1	0	1
7	Civics and Community Engagement	2	0	2
	Total	**15**	**1**	**16**

Final Year				
Seven Semester				
S. No.	**Course Title**	**(Credit Hours)**		**Total Cr. Hrs.**
		Theory	**Lab**	
1	Elective-II ****	2	0	2
2	Food Packaging	2	1	3
3	Food Safety and Quality Management	3	0	3
4	Process Control & Instrumentations	2	1	3
5	Food Plant Layout & Design	3	1	4
6	FYDP (Part-I)	0	3	3
	Total	**12**	**6**	**18**
Eight Semester				
S. No.	**Course Title**	**(Credit Hours)**		**Total Cr. Hrs.**
		Theory	**Lab**	
1	Food Regulations & Legislation	2	0	2
2	Entrepreneurship	2	0	2
3	Food Quality Control	2	0	2
4	Manufacturing Excellence	2	0	2
5	Utility & Maintenance Management	2	0	2
6	FYDP (Part-II)	0	3	3
	Total	**10**	**3**	**13**

* 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 phycology • Critical Thinking • Human Resource Management • Organizational Behavior • Engineering Law • Engineering Economics • Any other relevant course decided by the HEI as per requirement
***List of Electives-I for Food Engineering (3+0)	****List of Electives -II for Food Engineering (2+0)
• Fats and Oils Process Engineering • Dairy and Beverage Processing Engineering • Food Product Development • Meat Processing • Cereal Processing • Sugar Confectionery & Chocolates • Enzymes & Bioreaction Engineering • Nutrition Engineering • Post Harvest Processing • Food Plant Hygiene and Sanitation • Any other relevant course decided by the HEI as per requirement	• Renewable Energy Resources • Environmental Engineering • Waste 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;

- Computer Programming/ Programming Languages Lab
- Engineering Graphics & CAD Lab
- Artificial Intelligence application in food Industry Lab
- Fluid Mechanics Lab
- Materials & Metallurgy Lab
- Engineering Thermodynamics Lab
- Heat & Mass Transfer Lab
- Fluid Flow System Lab
- Process Control & Instrumentations Lab
- Engineering Properties of Foods Lab
- Unit Operations in Food Engineering Lab
- Food Microbiology
- Food Engineering Operations II / Unit Operations in Food Engineering II Lab
- Food Plant Layout & Design Lab
- Food Packaging Lab

- ***"Labs/ Practical: The course practical/ labs should be defined and synchronized with the course outline (Theory part)."***
- ***"All safety protocols, manuals and log books etc. should be maintained and complied by each lab."***

14. Courses 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.

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 Mid Term, 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: 03
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: 03
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 APLICATIONS 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

IDEOLOGY AND CONSTITUTION OF PAKISTAN

UGE Policy V1.1: General Education Course

Credits: 02
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.

ISLAMIC STUDIES

UGE Policy V1.1: General Education Course

Credits: 02
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 nay course of at least the same or more credits in subjects such as religious studies, ethics, theology, comparative religion, Christian ethics, etc.

*** List of Arts and Humanities 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

COMMUNICATION AND PRESENTATION SKILLS

Credits: 02
Pre-Requisite: Nil

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.

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 TEACHING AND ASSESSMENT 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 Engineering Project

ASSESSMENT:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

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: 02
Pre-Requisite: Nil

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 TEACHING AND ASSESSMENT METHODS

Lectures (audio,/video aids), Written Assignments/ Quizzes, Tutorials, Group discussion, Community Service, Report Writing, Social Impact Review

ASSESSMENT:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term
SUGGESTED INSTRUCTIONAL/ READING MATERIALS
1. Ele Actual A1 by Virgilio Boribio, Publisher: Editorial SM; ISBN: 978-84-675-4741-

ELEMENTARY ARABIC

Credits: 02
Pre-Requisite: Nil

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 TEACHING AND ASSESSMENT METHODS

Lectures (audio,/video aids), Written Assignments/ Quizzes, Tutorials, Group discussion, Community Service, Report Writing, Social Impact Review

ASSESSMENT:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

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: 02
Pre-Requisite: Nil

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 TEACHING AND ASSESSMENT METHODS

Lectures (audio,/video aids), Written Assignments/ Quizzes, Tutorials, Group discussion, Community Service, Report Writing, Social Impact Review

ASSESSMENT:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

SUGGESTED INSTRUCTIONAL/ READING MATERIALS
1. Débuts. Siskin, Williams-Gascon, Field. McGraw-Hill

ELEMENTARY CHINESE

Credits: 02
Pre-Requisite: Nil

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 Hànyǔ 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 TEACHING METHODS:

Lectures (audio,/video aids), Written Assignments/ Quizzes, Tutorials, Group discussion, Community Service, Report Writing, Social Impact Review

ASSESSMENT:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term
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: 02
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. Explain the epistemological nature of history, including its methods of knowledge production and the challenges it faces.
5. 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

ASSESSMENT:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

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.	Cohn, Bernard. An Anthropologist among Historians and Other Essay, Oxford University Press, 1988
5.	Collingwood, R. G. The Idea of History. Oxford: Oxford University Press, 1978.
6.	Daniels, Studying History: How and Why, New Jersey, 1981.
7.	Gertrude Himmalfarb. The New History and the Old, Cambridge: Harvard University Press, 1987
8.	Govranski. History Meaning and Methods, USA, 1969
9.	Hegel. Elements of the Philosophy of Right. Cambridge University Press, 1991

PHILOSOPHY

Credits: 02
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. Examine different perspectives on knowledge within epistemology, relating these perspectives to engineering practices and the development of technological solutions.
4. Analyze the concept of induction, exploring its role in reasoning and its applications in the engineering field.
5. Compare and contrast the philosophical perspectives of rationalism and empiricism, considering their implications for the understanding of engineering phenomena.

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

ASSESSMENT:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

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: 02
Pre-Requisite: Nil

COURSE LEARNING OUTCOME

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

1. Define key terms: profession, ethics, and their relation to law/morality.
2. Analyze ethical frameworks and their application in engineering. Identify desirable personality traits for ethical behaviour.
3. Explain ethical livelihood in engineering, including halal earning.
4. Describe professional ethics in engineering societies and codes of conduct.
5. Apply critical thinking and problem-solving in ethical situations.

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

ASSESSMENT:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

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

** List of Social Science Electives (2+0)
• Sociology for Engineers • Social phycology • Sociology • Critical Thinking • Human Resource Management • Organizational Behavior • Engineering Law • Engineering Economics • Any other relevant course decided by the HEI as per requirement

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.

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, Co mmunity 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 TEACHING 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

ASSESSMENT

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.
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

SOCIAL PSYCHOLOGY

Credits: 02
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 TEACHING METHODS:

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

ASSESSMENT

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

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,

SOCIOLOGY

Credits: 02
Pre-Requisite: Nil

COURSE LEARNING OUTCOMES

- To introduce the necessary subject knowledge and understanding required for the successful study of Sociology and related Social Science disciplines at undergraduate.
- To develop skills of application, analysis and evaluation in the context of the study of Social Science.
- To develop a knowledge and understanding of sociology both at a global and national level.
- To introduce the planning and organization skills necessary to develop as independent, autonomous learners.
- 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 TEACHING METHODS:

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

ASSESSMENT

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

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.

CRITICAL THINKING

Credits: 02
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. Explain the importance of asking questions, actively listening, and challenging assumptions.
4. Describe common creative thinking techniques like brainstorming, mind mapping, and De Bono's thinking hats. List and explain root cause analysis techniques like the 5 Whys and Ishikawa Diagram.
5. Describe strategies for effectively presenting recommendations to decision-makers and stakeholders.

COURSE CONTENT/COURSE OUTLINE

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

ASSESSMENT

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

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: 02
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).Compare and contrast global and local HRM practices.
2. Explain basic principles of HRM from Islamic and indigenous perspectives.
3. Apply job analysis techniques, including HR planning, job description, and specification.
4. Differentiate between compensation and benefit packages and their management.
5. Explain staffing strategies, covering recruitment techniques, sources, and selection tests.

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
- 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

ASSESSMENT

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

SUGGESTED INSTRUCTIONAL/READING MATERIALS

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

ORGANIZATIONAL BEHAVIOUR

Credits: 02
Pre-Requisite: Nil

COURSE LEARNING OUTCOMES

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

1. Explain the role of individual characteristics, abilities, and learning in organizational behavior.
2. Understand organizational behavior principles from Islamic and indigenous perspectives. Analyze human psychology through the lens of Quran and Sunnah.
3. Identify and classify different attitudes and behaviors in the workplace.
4. Recognize the importance of perception and its role in individual decision-making.
5. Apply motivation concepts, both content and process theories, and use them to design effective reward systems.

COURSE CONTENT/COURSE OUTLINE

- Foundations of Individual Behaviour:
- Biographical Characteristics, Ability, Learning
- Organizational behaviour from Islamic and indigenous perspective
- Understanding human psychology through the lenses of Quran and Sunnah
- Attitudes and Job Satisfaction
- Types of attitudes
- Types of behaviours
- Perception and Individual Decision Making
- Why perception is important
- Types of decision making
- Biases and errors in decision making
- Motivation concept
- Content theories of Motivational
- Process theories of motivation
- Motivation: from concept to application
- Applying motivation concepts for designing reward system

ASSESSMENT

Quizzes, Assignments, Mid Exam, Final Exam

SUGGESTED INSTRUCTIONAL/READING MATERIALS

1. Robbins, P. S., & Judge, T. A. (2009). Organizational Behaviour. 13th ed.

ENGINEERING LAW

Credits: 02
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.

ASSESSMENT

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

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

Credits: 02
Pre-Requisite: Nil

COURSE LEARNING OUTCOMES

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

- Apply economic principles to analyze engineering projects.
- Utilize cost analysis methods to evaluate project feasibility and make decisions.
- Manage risks and uncertainties in engineering economic assessments.
- Consider economic factors such as inflation and taxation in decision making.
- Integrate ethical and sustainable considerations into economic analyses.

COURSE CONTENT/COURSE OUTLINE

1. Introduction

- Engineering Costs
- Estimation Models & Cash Flow Diagram
- Life cycle cost

2. Time value of Money

- Time value of money, equivalence, use of spread sheet, simple and compound interest
- Uniform series & Arithmetic & geometric gradient
- Nominal & effective, continuous compounding Economic criteria,
- Present Worth, future worth and annuity

3. Rate of Return

- Minimum acceptable rate of return(MARR),
- Internal rate of return, External rate of return
- Choosing the best alternative
- Incremental Analysis

4. Benefits and Cost ratio and Payback period

- Benefit and cost ratio (B/C Ratio), discounted benefit and cost ratio
- Simple payback period, discounted payback period
- Sensitivity & breakeven analysis
- Principle of comparative advantage

5. Depreciation

- Depreciation
- Depreciation using Unit of Production

- Depreciation using straight line method
- Depreciation using Depletion

6. Taxes

- Income Taxes, After tax RoR
- Replacement analysis
- Design life, salvage value
- Up gradation Vs replacement

7. Risk and Uncertainty

- Estimation of future events
- Monte Carlo Simulation
- Bayes theorem

8. Concepts of Imports and Exports

- Basic concepts of import and export
- Dumping and anti-dumping and related laws

9. Teaching Methodology

- Lecturing
- Written Assignments
- Presentation

ASSESSMENT

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

SUGGESTED INSTRUCTIONAL/READING MATERIALS

1. William G. Sullivan and Elin M. Wicks, Estimation of future events
2. N. M. Fraser and E. M. Jewkes, Engineering Economics: Financial Decision Making for Engineers
3. D. G. Newnan, J. Whittaker, T. G. Eschenbach and J. P. Lavelle, Engineering Economic Analysis
4. J. Tarquin, L. T. Blank, Engineering Economy, McGraw Hill

CIVICS AND COMMUNITY ENGAGEMENT

UGE Policy V1.1: General Education Course

Credits: 02
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

PROJECT MANAGEMENT

Credits: 02
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 TEACHING & ASSESSMENT 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

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

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).

ENTREPRENEURSHIP

UGE Policy V1.1: General Education Course

Credits: 02
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.

APPLICATIONS OF ICT

UGE Policy V1.1: General Education Course

Credits: 2+1=3
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

APPLIED CHEMISTRY

Credit Hours: 2+1
Pre-Requisite: Nil

COURSE LEARNING OUTCOMES

1. To know Reaction mechanism and industrial applications of organic compounds and their reactions
2. To understand chemical process industry, Industrial Chemical Analysis and primary raw materials used in various industries
3. To infer the knowledge of synthesis and basic reactions of polymers
4. To learn Synthesis characterization and applications of Paints, pigments, dyes and coating

COURSE OUTLINE

- Industrial Aspects of Inorganic Chemistry, study of selected inorganic industries, Sulfur industry, Industry dealing with nitrogen, phosphorus, chloralkaline and titanium oxide.
- Reaction mechanism and industrial applications of organic reactions such as sulfonation, Nitration, Hydrogenation, Amination, Halogenation, oxidation, polymerization.
- An overview of chemical process industry and primary raw material, Industrial Pollution Prevention, Industrial Chemical Analysis, Chemical Explosives and propellants, Synthetic polymers, Polymeric materials, Corrosion, chemical analyses of materials, Improved Paints pigments and industrial coatings, Dye: Chemistry and Applications, Chemical manufacturing processes and production methods

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

SUGGESTED TEACHING & ASSESSMENT METHODS

Teaching Methodology (Proposed as applicable)

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

Group discussion,
Report Writing

Suggested Assessment Methods

Mid Term,
Report writing/ Presentation,
Assignments,
Project Report,
Quizzes,
Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Applied Chemistry and Chemical Engineering" A. K. Haghi, Devrim Balkose, Omari V.
   - Mukbaniani, Andrew G. Mercader, Apple Academic Press, 2018
2. Comprehensive Analytical Chemistry; Molecular Characterization and Analysis of
   - Polymer, John M. Chalmers, Robert J. Meier, Elsevier **(2008)**
3. Green Chemistry in industry Mark Anthony Benvenuto, Heinz Plaumann, De Gruyter,
   - Volume 3, 2018
4. Polymers, Polymer Blends, Polymer Composites and Filled Polymers, G. E. Zaikov,
5. Nova **(2006)**
6. Biodegradable Polymer Blends and Composites from Renewable Resources, Long Yu, Wiley **(2008)**
7. Sustainable Industrial Chemistry: Principles, Tools and Industrial Examples.
8. Fabrizio cavani, Gabriele Centi, Siglinda Perathoner , Wiley Publishshers, 2009
9. Pavia, Lampman, Introduction to Spectroscopy, 4th edition, Brooks/Cole, 2009
10. H. Kuhn, Principles of Physical Chemistry, 2nd edition, Wiley, 2009
11. G.D. Christian, Analytical Chemistry, 7th edition, 2014, Wiley
12. D. W. H. Rankin, Norbert Mitzel, Carole Morrison, Structural Methods in Molecular Inorganic chemistry, Wiley, (2013)
13. Gary Wulfsberg, Foundations of Inorganic Chemistry, University Science Books, 2017 David Klein, Organic Chemistry , Wiley, 2017

QUANTITATIVE REASONING (I)

UGE Policy V 1.1: General Education Course

Credits: 03
Pre-Requisite: Nil

DESCRIPTION

Quantitative Reasoning (I) is an introductory-level undergraduate course that focuses on the fundamentals related to the quantitative concepts and analysis. The course is designed to familiarize students with the basic concepts of mathematics and statistics and to develop students' abilities to analyze and interpret quantitative information. Through a combination of theoretical concepts and practical exercises, this course will also enable students cultivate their quantitative literacy and problem-solving skills while effectively expanding their academic horizon and breadth of knowledge of their specific major / field of study.

COURSE LEARNING OUTCOMES

By the end of this course, students shall have:

1. Fundamental numerical literacy to enable students work with numbers, understand their meaning and present data accurately;
2. Understanding of fundamental mathematical and statistical concepts;
3. Basic ability to interpret data presented in various formats including but not limited to tables, graphs, charts, and equations etc.

COURSE OUTLINE

1. **Numerical Literacy:**
   - Number system and basic arithmetic operations;
   - Units and their conversions, dimensions, area, perimeter and volume;
   - Rates, ratios, proportions and percentages;
   - Types and sources of data;
   - Measurement scales;
   - Tabular and graphical presentation of data;
   - Quantitative reasoning exercises using number knowledge.
2. **Fundamental Mathematical Concepts:**
   - Basics of geometry (lines, angles, circles, polygons etc.);
   - Sets and their operations;
   - Relations, functions, and their graphs;

- Exponents, factoring and simplifying algebraic expressions;
- Algebraic and graphical solutions of linear and quadratic equations and inequalities;
- Quantitative reasoning exercises using fundamental mathematical concepts.

3. **Fundamental Statistical Concepts**:
   - Population and sample;
   - Measures of central tendency, dispersion and data interpretation;
   - Rules of counting (multiplicative, permutation and combination);
   - Basic probability theory;
   - Introduction to random variables and their probability distributions;
   - Quantitative reasoning exercises using fundamental statistical concepts.

SUGGESTED INSTRUCTIONAL/READING MATERIALS

1. Quantitative Reasoning: Tools for Today's Informed Citizen" by Bernard L. Madison, Lynn and Arthur Steen.
2. "Quantitative Reasoning for the Information Age" by Bernard L. Madison and David M. Bressoud.
3. "Fundamentals of Mathematics" by Wade Ellis.
4. "Quantitative Reasoning: Thinking in Numbers" by Eric Zaslow.
5. "Thinking Clearly with Data: A Guide to Quantitative Reasoning and Analysis" by Ethan Bueno de Mesquita and Anthony Fowler.
6. "Using and Understanding Mathematics: A Quantitative Reasoning Approach" by Bennett, J. O., Briggs, W. L., & Badalamenti, A.
7. "Discrete Mathematics and its Applications" by Kenneth H. Rosen.
8. "Statistics for Technology: A Course in Applied Statistics" by Chatfield, C.
9. "Statistics: Unlocking the Power of Data" by Robin H. Lock, Patti Frazer Lock, Kari Lock Morgan, and Eric F. Lock.

QUANTITATIVE REASONING (II)

UGE Policy V1.1: General Education Course

Credits: 03
Pre-Requisite: Quantitative Reasoning (I)

DESCRIPTION

Quantitative Reasoning (II) is a sequential undergraduate course that focuses on logical reasoning supported with mathematical and statistical concepts and modeling / analysis techniques to equip students with analytical skills and critical thinking abilities necessary to navigate the complexities of the modern world. The course is designed to familiarize students with the quantitative concepts and techniques required to interpret and analyze numerical data and to inculcate an ability in students the logical reasoning to construct and evaluate arguments, identify fallacies, and think systematically. Keeping the pre-requisite course of Quantitative Reasoning (I) as its base, this course will enable students further their quantitative, logical and critical reasoning abilities to complement their specific major / field of study.

COURSE LEARNING OUTCOMES

By the end of this course, students shall have:

1. Understanding of logic and logical reasoning;
2. Understanding of basic quantitative modeling and analyses;
3. Logical reasoning skills and an ability to apply them to solve quantitative problems and evaluate arguments;
4. Ability to critically evaluate quantitative information to make evidence based decisions through appropriate computational tools.

COURSE OUTLINE

1. **Logic, Logical and Critical Reasoning:**
   - Introduction and importance of logic;
   - Inductive, deductive and abductive approaches of reasoning;
   - Propositions, arguments (valid; invalid), logical connectives, truth tables and propositional equivalences;
   - Logical fallacies;
   - Venn Diagrams;
   - Predicates and quantifiers;
   - Quantitative reasoning exercises using logical reasoning concepts and techniques.

2. Mathematical Modeling and Analyses

- Introduction to deterministic models;
- Use of linear function for modeling in real-world situations;
- Modeling with the system of linear equations and their solutions;
- Elementary introduction to derivatives in mathematical modeling;
- Linear and exponential growth and decay models;
- Quantitative reasoning exercises using mathematical modeling.

3. Statistical Modeling and Analyses

- Introduction to probabilistic models;
- Bivariate analysis, scatter plots;
- Simple linear regression model and correlation analysis;
- Basics of estimation and confidence interval;
- Testing of hypothesis (z-test; t-test);
- Statistical inference in decision making;
- Quantitative reasoning exercises using statistical modeling.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Using and Understanding Mathematics: A Quantitative Reasoning Approach" by Bennett, J. O., Briggs, W. L., & Badalamenti, A.
2. "Discrete Mathematics and its Applications" by Kenneth H. Rosen.
3. "Discrete Mathematics with Applications" by Susanna S. Epp.
4. "Applied Mathematics for Business, Economics and Social Sciences" by Frank S Budnick.
5. "Elementary Statistics: A Step by Step Approach" by Allan Bluman.
6. "Introductory Statistics" by Prem S. Mann.
7. "Applied Statistical Modeling" by Salvatore Babones.
8. "Barrons SAT" by Sharvon Weiner Green, M.A and Ira K.Wolf.

CALCULUS AND ANALYTICAL GEOMETRY

Credit Hours: 3+0=3
Pre-Requisites: Nil

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

1. **Analytical Geometry:**
   - Review of vectors, scalars and vector products.
   - Three dimensional coordinate system and equation of straight line and plane
2. **Functions Limit and Continuity**
   - Review of functions and graphs,
   - Limits & Continuity,
   - Techniques of Finding Limits,
   - Discontinuity,
   - Limits of Sine and Cosine and Exponential Functions
3. **Differentiation:**
   - Introduction to Derivatives
   - Examples of Derivatives
   - Derivative as Rate of Change
   - Derivative's Rules
   - Implicit Differentiation
   - Higher order derivative
   - Leibnitz Theorem
4. **Applications of Derivatives:**
   - Applications of Derivatives
   - Monotonic functions
   - Optimization problems
   - Relative and Absolute extrema
   - First and second derivative tests
   - Point of inflection
   - Concavity
   - Curvature
   - Indeterminate Forms and L' Hospital rule

- Differentials

5. Integration:

- Integrals and Properties of Integrals
- Techniques of Integration
- Integration by Parts
- Definite Integrals
- Integration of Trigonometric
- Exponential and Inverse Functions
- Integration by Partial Fractions
- Reduction Rules

6. Applications of Integration:

- Applications of Integration
- Area under the curve
- Area between curves
- Solids of Revolution
- Volume of Solids of revolution by disk
- washer, Cylindrical shell & Cross Section Methods
- Center of Pressure and Depth of Center of Pressure
- Center of mass
- Arc length

7. Improper Integrals:

- Improper Integral
- Integrals and Singularities
- Convergence of improper integrals

8. Infinite Sequence and Series:

- Sequence and Infinite Series
- Convergence and Divergence of sequences and series
- Positive Term Series
- Integral Test
- Basic Comparison Test
- Limit Comparison Test
- Ratio and Root tests
- Alternating series
- Absolute and Conditional Convergence

9. Power and Taylor Series:

- Power series
- Maclaurin and Taylor Series and its Applications

SUGGESTED TEACHING & ASSESSMENT METHODS

Lectures (audio/video aids),
Written Assignments/ Quizzes,

Tutorials,
Case Studies relevant to engineering disciplines,
Semester Project,
Guest Speaker,
Industrial/ Field Visits,
Group discussion,
Report Writing

Assessment

Mid Term,
Report writing/ Presentation,
Assignments,
Project Report,
Quizzes,
Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

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

LINEAR ALGEBRA AND DIFFERENTIAL EQUATIONS

Credit Hours: 3+0=3
Pre-Requisites: Nil

DESCRIPTION

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

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.
3. To define basic mathematical concepts related to differential equations
4. To describe different types of analytical methods for solution of differential equations
5. To formulate different engineering problems in the form of differential equations

COURSE OUTLINE

1. **System of Linear Equations and Applications**
   - Overview of linear system of equations, Cases of unique solution, No solution and infinite solutions,
   - Echelon form, Gauss elimination method, Inversion of matrix in the context of solution of system of equations, LU factorization, Row space and column space
   - Relevant engineering case studies such as Network analysis, Traffic Flows, Balancing chemical reaction, Leontief Input-output model, Finding max stress in compound cylinder, Applications of linear systems in force balancing of structures, Markov process
2. **Vector Spaces and Transformations**
   - Vector Spaces: Real vector spaces, Subspaces, Basis and dimension, Rank, Nullity
   - Gram-Schmidt process for finding orthonormal basis
   - Linear Transformation, Kernel of Transformation, Range of Transformation, Matrix of Transformation,
   - Applications: Cryptography, Coding and decoding, Breaking of

codes, Robotic Applications of linear transformations

3. **Eigenvalues and Eigen Vectors**
   - Eigenvalues, Eigenvectors, Similar matrices, Diagonalization,
   - Quadratic forms, Positive definite Matrices, Singular Value Decomposition, Inner product Spaces
   - Applications of linear Algebra: Constructing curves and surfaces, Computer graphics, Genetics
4. **Application of Linear Algebra in Dynamical Systems**
   - Numerical System of linear ODEs, Eigenvalue problems, Homogeneous and nonhomogeneous system of ODE.
   - Dynamical systems, Population dynamics, Prey-Predator models, Stability analysis
5. **Basic Concepts and Modelling**
   - Linear Differential equations, Non-Linear, Differential equations, Solutions of differential equations, General solutions, Particular solutions, Initial and boundary value problems, Degree and order of ODEs
   - Formulation of first-order ODEs: Case studies related to finding age of fossils, Mixing problems and free fall motion, Finding temperature of a building, RL, RC circuits, Airplane take-off problem, Population dynamics and logistic equations etc.
6. **Analytical Methods of Solution for First-order ODEs**
   - Variable separable method, Reduction to variable separable form, Homogeneous equations, Differential equations reducible to homogeneous form, Solution of the related ODE models by these methods
   - Exact equations, Integrating factors, Linear equations and related examples, Bernoulli's equations, Orthogonal trajectories and solution of the related ODE models by these methods
7. **Mathematical Models Based on Second-order ODEs**
   - Formulation of a single RLC circuit, Spring mass systems, Earthquake model of a single story building
   - Bungee Jumper model, Bridge collapse problem etc.
8. **Analytical Methods of Solution for Second-order ODEs**
   - Homogeneous linear ODEs, Method of reduction order , Wronskain determinant to check independence of the solution, and related examples
   - Cauchy-Euler equations and related examples, Non-homogeneous linear ODEs, Method of undetermined coefficients
   - Method of variation of parameters and related example
   - Analytical solution of the related ODE models by these methods
9. **Laplace Transform**
   - Laplace Transform, Derivation of Basic formulae, Inverse Laplace Transform, First shift theorem

- Laplace transform of integrals and derivative, Solution of second order ODEs by Laplace Transform, Unit step function and its Laplace transform, Second shift theorem, Convolution
- Application of Laplace transform to a system of ODEs and related applications

10. Partial Differential Equations

- Partial Differential Equations and their types, Applications of partial differential equations in Engineering
- Method of Separation of Variables Method (MSVM) and solution of wave equation by the MSVM
- Method of Separation of Variables Method (MSVM) and solution of heat equation by the MSVM

SUGGESTED TEACHING & ASSESSMENT METHODS

Lecturing
Laboratory Demonstration
Written Assignments
Guest Speaker
Project

Suggested Assessment Methods Theory

One hour test(s)/Mid-term
Quiz tests, Assignments, Project Reports/Term Paper/Presentations
Final Exam

Suggested Assessment Methods Practicals

Laboratory Participation
Laboratory Report/Manual
Laboratory Quiz /Viva Voce

RECOMMENDED TEXT AND REFERENCE BOOKS

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

APPLIED PHYSICS

Credit Hours: 2+1
Pre-Requisites: Nil

DESCRIPTION

An Applied Physics course covers fundamental topics such as vectors, mechanics, electrostatics, and magnetism, providing a strong foundation in classical physics. It then delves into specialized areas like semiconductor physics, exploring the behavior of materials crucial to modern electronics. Additionally, students study waves, oscillations, optics, and lasers, exploring into the principles behind light and its applications. The course may conclude with an overview of modern physics, offering insights into cutting-edge research and technologies.

COURSE OUTLINE

1. **Vectors:**
   - Review of vectors, Ordinary Differentiation of Vector, Gradient of Scaler field, Divergence and Curl of Vector Field, Line and Surface Integrals with applications.
2. **Mechanics:**
   - Newton Laws and their Applications(Simple Accelerometer, Banked Curve and Rotor), Frictional Forces and determination of Co-efficient of Friction, Work-Energy Theorem, applications of law of Conservation of Energy, Angular Momentum, Centre of Mass of two-particles, Many-particles and Solid Object, Rotational Inertia of Solid Bodies.
3. **Electrostatics And Magnetism:**
   - Electric field due to Discrete and Continuous Charge Distribution, Electrostatic Potential of discrete and Continuous charges, Applications of Gauss's Law, Lorentz Force and Hall effect, Ampere's Law, Magnetic Field due to Circular Current Loop and Solenoid, Magnetic dipole, Atomic and Nuclear Magnetism, Magnetization, Magnetic Materials.
4. **Semiconductor Physics:**
   - Energy levels in a Semiconductor, Hole concept, Intrinsic and Extrinsic regions, Law of Mass Action. P-N junction, Transistors.
5. **Waves And Oscillations:**
   - Simple Harmonic Oscillator, Damped Harmonic Oscillation, Forced Oscillation and Resonance, Types of Wave and Superposition Principle, Wave Speed on a stretched string. Wave equation, Energy & Power of a Wave.

6. **Optics And Lasers:**
   - Huygens Principle, Two-slit interference, Single-Slit Diffraction, Resolving power of Optical Instruments. Principles for Laser action, Types of Laser, Applications of Laser.
7. **Modern Physics:**
   - Planck's explanations of Black Body Radiation Photoelectric Effect, Compton Effect, De-Broglie Hypothesis, Electron Microscope, Atomic structure, X-rays and Moseley's Law, Atomic Nucleus and Properties of Nucleus, Radioactive Decay and Radioactive Dating, Radiation Detection Instruments, Nuclear Reactions. Radiation Detection Instruments, Nuclear Reactions.

PRACTICAL REQUIREMENTS

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

SUGGESTED TEACHING & ASSESSMENT METHODS

Lectures (audio/video aids),

Written Assignments/ Quizzes,

Tutorials,

Case Studies relevant to engineering disciplines,

Semester Project,

Guest Speaker, Industrial/ Field Visits,

Group discussion,

Report Writing

Suggested Assessment Methods

Assessment

Mid Term,

Report writing/ Presentation,

Assignments,

Project Report,

Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Physics, By: Halliday, Resnick & Krane, Edition: 10th Edition.
2. University Physics, BY: Hugh D. Young and R.A. Freedman, EDITION: 12 Physics for Scientist & Engineers, BY: Serway, Jewett, (latest edition)

14.2 Engineering Domain

COMPUTER PROGRAMMING FOR ENGINEERS

Credit Hours: 2+1=3

Pre-Requisites: Nil

DESCRIPTION

This course is designed to introduce students to programming concepts and their practical applications. It covers introduction to computational thinking emphasizing problem-solving methodologies, fundamental programming concepts, including various programming paradigms, structures, and the steps involved in program development.

COURSE LEARNING OUTCOMES

1. Describe fundamentals and semantics of computer programming.
2. Apply basic programming language structures.
3. Practice computer programming using constructs of a high level language (Lab work only).

COURSE OUTLINE

1. **History Introduction to Computational Thinking**
   - Computational Thinking Concept
   - Applications to Computer Science
2. **Introduction to Programming Concepts and Programming Languages**
   - Paradigms of Programming
   - Main Programming Structures
   - Steps to Develop a Program
   - Categories of Programming Languages
3. **Introduction to C Language and Building Blocks**
   - Basic C Concepts and Structure of a C Program,
   - Input and Output Operations,
   - Data Types in C,
   - Data Type Modifiers, Constants and Variables in C, Backslash Constantsin C, Working with Operators and Expressions
4. **Structured Programming Loops**
   - Repetition / Iteration Control Structures

- Decision Loops (while, do-while Loop)
- Counter- controlled Loops (for Loop)
- Nesting of Iteration and Decision Control Structures

5. Data Structures, Arrays and Pointers.

- Arrays Initialization, Bounds Checking, Multidimensional Arrays, Processing Arrays
- Creating and manipulating Strings
- Standard Library String Functions
- Understanding Pointers, Performing Operations on Pointers, Pointers, and Strings,
- Sorting Algorithms (Quick Sort, Bubble Sort, Merge Sort)

6. Functions

- Motivation and benefits of Functions
- Functions and Variables
- Parameter Passing Mechanisms, Recursion and its Applications.
- Passing Arrays to Functions
- Preprocessor Directives

7. Structures and File Processing

- Declaring a Structure
- Accessing Structure Elements
- Array of Structures,
- File Operations Reading and writing to a File.
- Database Management

8. Object Oriented Programming with C++

- Introduction to Classes, Objects, Operator Overloading, Inheritance and Polymorphism.

SUGGESTED TEACHING & ASSESSMENT METHODS

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

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes,
Final Term

Suggested Assessment Methods Practical

Laboratory Participation
Laboratory Report/Manual
Laboratory Quiz /Viva Voce

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Paul J. Deitel, C How to Program, 2016
2. Yashavant Kanetkar, Let Us C, 2017
3. Simon Monk, Programming Arduino, 2016

ARTIFICIAL INTELLIGENCE APPLICATIONS IN FOOD INDUSTRY

Credit Hours: 2+1=3
Pre-Requisites: Nil

DESCRIPTION

This course delves into the integration of AI technologies within food-related systems. The history of AI and its pivotal role in biological systems, emphasizing its impact on food, water, and energy sectors. The course includes supervised, unsupervised, and reinforcement learning along with various machine learning algorithms like support vector machines and decision trees. The focus expands to artificial neural networks, deep learning, and convolutional neural networks), emphasizing their applications in object detection and segmentation within food systems.

COURSE LEARNING OUTCOMES

1. Understand the mechanism of AI for food processing
2. Development and applications of machine learning & AI for food processing

COURSE OUTLINE

1. **Introduction to Artificial Intelligence (AI)**
   - History of Artificial Intelligence
   - Role of AI for biological systems, Role of AI for food, water, and energy nexus
2. **Types of learning:**
   - Supervised learning,
   - Unsupervised learning
   - Reinforcement learning
   - Machine learning,
   - Applications of machine learning
3. **Types of machine learning algorithms:**
   - Support vector machine, decision trees, discriminant analysis, naive bayes classifier, nearest neighbor's classifier and ensemble classifier; features, features extractions.
4. **Artificial neural networks (ANN):**
   - Applications of ANNs;
   - General architecture of ANNs and basic terminologies
   - Deep learning
5. **Convolutional neural networks (CNN):**

- General architectures of CNNs and basic terminologies;
- Types of CNN; classifications; object detection; semantic segmentation; types of classification, object detection, and semantic segmentation networks and frameworks; types of datasets; creating a dataset; training strategies; transfer learning;

6. **Hyperparameters:**
   - Performance evaluation metrics for classification; object detection; and semanticsegmentation tasks.

SUGGESTED TEACHING & ASSESSMENT METHODS

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

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes,
Final Term

Suggested Assessment Methods Practical

Laboratory Participation
Laboratory Report/Manual
Laboratory Quiz /Viva Voce

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Tomar, P., & Kaur, G. (Eds.). (2021). Artificial Intelligence and IoT-based Technologies for Sustainable Farming and Smart Agriculture. IGI Global.
2. Galanakis, C. M. (Ed.). (2021). Innovation strategies in the food industry: Tools for implementation. Academic Press.
3. Shukla, A. K. (Ed.). (2020). Spectroscopic Techniques & Artificial Intelligence for Food and Beverage Analysis. Springer.
4. Chatterjee, J. M., Kumar, A., Rathore, P. S., & Jain, V. (Eds.). (2021). Internet of Things and Machine Learning in Agriculture: Technological Impacts and Challenges (Vol. 8). Walter de Gruyter GmbH & Co KG.

FLUID MECHANICS-I

Credit Hours: 2+1=3
Pre-Requisites: Nil

DESCRIPTION

This course provides fundamental knowledge about fluid behavior and its applications in food processing and handling. The course may cover topics like viscosity, fluid pressure, Bernoulli's equation, flow measurement, fluid forces, and the behavior of fluids in different environments.

COURSE LEARNING OUTCOMES

1. Discuss fluid mechanics properties and characteristics of different types of flow.
2. Solve static and dynamic systems with fluid as the working medium using fundamental principles and relations of fluid mechanics
3. Apply dimensional analysis that helps in scale-up and scale-down of fluid flow systems.
4. Use resources to solve the case of a food industry fluid system.
5. Imitate and practice the fluid properties by various measuring devices.

COURSE OUTLINE

1. **Fluid Properties**
   - Definition of fluid, Classification of fluids
   - Concept of continuum, Viscosity, Vapor pressure, Surface tension
   - Variation of fluid properties with temperature
2. **Fluid Statics**
   - Concept of pressure and basic equation for compressible and incompressible
   - Pressure measurements and devices, Hydrostatic forces on plane and curved surfaces
   - Buoyancy and stability , Pressure variation in fluid with rigid body motion
3. **Fluid Kinematics**
   - Flow characterization, Description of velocity and acceleration field (Streamlines, streak-lines and path-lines)
   - Control volume and control mass, Deriving Reynold transport theorem (RTT)

4. Fluid Dynamics

- Application of Newton's 2nd law in fluids
- Total, stagnation and dynamic pressures.
- Deriving Bernoulli equation and its applications

5. Integral Analysis of Fluid Flow

- Deriving continuity
- Linear momentum and moment of momentum equations using RTT
- Solving problems related to continuity.
- linear and angular momentum

6. Flow in Pipes

- Characteristics of pipe flow laminar and turbulent.
- Calculating friction factor and wall shear stresses
- Solving pipe flow network problems

SUGGESTED TEACHING & ASSESSMENT METHODS

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

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes,
Final Term

Suggested Assessment Methods Practical

Laboratory Participation
Laboratory Report/Manual
Laboratory Quiz /Viva Voce

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Fundamentals of Fluid Mechanics; Bruce R Munson,7th edition, 2012, Juhn Wiley & Sons.
2. Durst, F., & Arnold, I. (2008). Fluid mechanics: an introduction to the theory of fluidflows (Vol. 1). Berlin: Springer.
3. Finnemore, E. J., & Franzini, J. B. (2002). Fluid mechanics with engineering applications.McGraw-Hill Education

ENGINEERING MATERIALS

Credit Hours: 2+0=2
Pre-Requisites: Nil

DESCRIPTION

The course explores various materials such as metals, polymers, ceramics, and composites, focusing on their properties, behaviors, and applications in food-related machinery, packaging, and processing.

COURSE LEARNING OUTCOMES

1. Calculate internal loads, based on different support reaction.
2. Correlate the internal stresses with different external loading conditions.
3. Operate under supervision different equipments and techniques to determine mechanical properties.

COURSE OUTLINE

1. Introduction to Materials Engineering

- Types of materials, Source of materials and their extraction,
- Crystalline and amorphous materials
- Application and selection of materials (basic criteria for different environments).

2. Metallic Materials

- Pure metals and alloys, Nature and properties of metals and alloys, Major properties of metal and alloys
- Single crystal and polycrystalline metals, Crystal defects and the mechanism of deformation and fracture, Plastic flow in polycrystalline materials
- Structure property relationship, Macro and micro examination, Structural aspect of solidification and solid phase transformation in binary systems
- Ferrous and non-ferrous metals
- Steel making processes, Heat treatments, TTT diagram, Surface hardening coatings, Powder metallurgy, Non-destructive testing.

3. Ceramics, Glasses and Refractory Materials

- Compositions, Properties, Structures of various non-metallic materials

- Application of ceramics, Glasses, refractory materials, Methods of manufacture.

4. Polymers and Rubbers

- Polymerization,
- Structural feature of polymers
- Thermoplastic polymers, Thermosetting polymers, Additives
- Major mechanical properties, Rubber (Elastomers), Synthesis of rubber

5. Composites

- Introduction to composite materials, Types of composite material
- Method of fabrication of composite materials, Property averaging
- Major mechanical properties

6. Environmental Degradation

- Metal degradation by atmosphere
- Aqueous and galvanic corrosion,
- Stress corrosion cracking, Methods of corrosion prevention, Behavior of metal at elevated temperature pyrometer, Oxidation, Scaling and creep.
- Chemical degradation of ceramic and polymers,
- Radiation damage of surface, Improvement against degradation

SUGGESTED TEACHING & ASSESSMENT METHODS

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

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes
Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Materials Science and Engineering: An Introduction, William D Callister, 8th edition, 2010.

ENGINEERING THERMODYNAMICS

Credit Hours: 3+1=4
Pre-Requisites: Nil

DESCRIPTION

This course would focus on the fundamental concepts of thermodynamics and their application to food processing and preservation. Students learn about energy, heat transfer, and the laws of thermodynamics as they apply to food systems.

COURSE LEARNING OUTCOMES

1. Explain basic concepts, fundamental laws of thermodynamics
2. Apply concepts of thermodynamics laws to engineering applications.
3. Describe phase equilibria for single and multicomponent systems.

COURSE OUTLINE

1. **Thermodynamics**
   - Thermodynamics and energy
   - Dimensions and units
   - Systems and control volume; properties.
2. **Energy and Energy Transfer**
   - Forms of energy
   - energy transfer by heat and work
   - mechanical work
   - First law of thermodynamics.
   - Pure substances and phases of pure substance, property diagrams and tables
   - Ideal gas equations, compressibility factor
   - Mass and energy analysis for closed systems and control volumes; examples
3. **Second Law of Thermodynamics & Entropy**
   - Second law concepts
   - Reversible and irreversible process
   - Carnot cycle, entropy, isentropic processes, increase of entropy principle.
   - Power and Refrigeration cycles, Essential equipment.

4. Thermodynamics Properties for Mixture

- Maxwell relations, Clapeyron equation, Joule Thomson Coefficient
- Gibbs free energy and fugacity for pure substance
- Criteria for phase equilibria in multi-component system
- Vapor-liquid equilibrium, control

5. Chemical & Phase Equilibria

- Chemical equilibrium in single phase system, chemical reactions,
- Combined chemical and phase equilibrium.
- PH as criteria for ionization of biochemical.

SUGGESTED TEACHING & ASSESSMENT METHODS

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

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Assessment Methods Practical

Laboratory Participation
Laboratory Report/Manual
Laboratory Quiz /Viva Voce

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Thermodynamics – An Engineering Approach; Cengel& Boles, 5th ed. 2006, Tata McGraw.
2. Chemical, Biochemical and Engineering Thermodynamic; Stanley L. Sandler, 4th ed. 2006,John Wiley & Sons, Inc.

HEAT & MASS TRANSFER

Credit Hours: 3+1=4
Pre-Requisites: Nil

DESCRIPTION

This course covers the fundamental concepts and mechanisms of heat transfer through conduction, convection, and radiation. Additionally, it explores mass transfer modes and principles, including diffusion and convective transport. It includes topics such as thermal conductivity, heat exchangers and the design considerations for efficient heat and mass transfer.

COURSE LEARNING OUTCOMES

1. Discuss the concept of heat and mass transfer in food engineering applications.
2. Apply different types of mathematical relations to solve the heat and mass transfer problems.
3. Describe working procedures of different types of heat exchanging equipment.
4. Practice experiments to analyze heat transfer characteristics of different materials.

COURSE OUTLINE

1. Basic Concepts of heat transfer

- Difference between thermodynamics and heat transfer
- Basic laws governing heat transfer.

2. Modes of heat transfer

- Heat transfer by conduction
- Fourier's law of heat conduction
- Thermal conductivity of materials and thermal resistance
- Heat transfer by convection
- Heat transfer by radiation
- Conduction-Steady state one dimension: heat conduction through plane wall, heat conduction through composite wall, overall heat transfer coefficient

3. Blocks Heat Conduction through hollow and composite cylinders

- Introduction to hydrodynamics
- Ideal and real fluids viscosity
- Continuity equation in Cartesiancoordinates
- Equation of continuity in polar coordinates
- Velocity potential and stream function
- laminar and turbulent

4. Forced convection.

- laminar flow
- laminar flow over plate
- energy equation of thermal boundary layer over a flat plat
- integral energy equation

5. Turbulent flow

- Turbulent boundary layer
- Turbulent flow over a flat plat, in tube, over cylinder and over spheres
- Liquid metal heat transfer

6. Free convection

- Parameters in free convection, momentum, and energy equation for laminar flow
- Integral equation for momentum and energy on a flat plate
- Transition and turbulence in free convection
- Empirical correlation for free convection
- Simplified free convection relations for air, combined free and forced convection.

7. Heat exchangers

- Types of heat exchangers and heat exchanger analysis
- logarithmic Mean Temperature Difference (LMTD)
- heat exchanger effectiveness number of transfer units (NTU) evaporators.
- Design of heat exchanger

8. Heat transfer by radiation

- Surface emission properties, absorptivity, reflectivity and transmissivity

- Concept of black body, the Steafan-Boltzman law, Kirchoff's law, Planck's law, Wien Displacement law, intensity of radiation and Lambert's Cosine law

9. Mass Transfer

- Modes of mass transfer, concentration, velocities and fluxes,
- Fick's law
- General Mass Diffusion Equation in Stationery Media
- Steady state diffusion in common geometries
- Steady state diffusion in liquids, Mass transfer coefficient, correlations for connective mass transfer
- Reynolds and Colburn Analogies for mass transfer-combined heat and mass transfer

SUGGESTED TEACHING & ASSESSMENT METHODS

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

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes,
Final Term

Suggested Assessment Methods Practical

Laboratory Participation
Laboratory Report/Manual
Laboratory Quiz /Viva Voce

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Fundamentals of heat and mass transfer. 2011. Bergman, T.L., Incropera, F.P., DeWitt, D.P. and Lavine, A.S. John Wiley & Sons.
2. Heat and mass transfer: fundamentals and applications 2014. Cengel, Y. McGraw-Hill Higher Education.
3. Fundamentals of heat and mass transfer. 2011. Bergman, T.L., Incropera, F.P., DeWitt, D.P. and Lavine, A.S.. John Wiley & Sons.

4. Fundamentals of heat and mass transfer. 2009. Thirumaleshwar, M. Pearson Education India.
5. Fundamentals of heat and mass transfer. 2010. Venkanna, B.K. PHI Learning Pvt. Ltd

ENGINEERING PROPERTIES OF FOODS

Credit Hours: 2+1=3
Pre-Requisites: Nil

DESCRIPTION

This course focuses on the physical, chemical, and mechanical properties of food materials. It explores how these properties influence food processing, preservation, and quality. various characteristics of food materials such as texture, viscosity, density, thermal properties, rheology, moisture content, and compositional aspects are also included.

COURSE LEARNING OUTCOMES

1. Acquire the knowledge of engineering properties of food materials
2. Explain the relationship between food composition and physical properties

COURSE OUTLINE

1. **Introduction to fundamental properties**
   - Physical attributes,
   - Size and size distribution, Shape,volume, density, porosity
2. **Rheological properties**
   - Flow of materials
   - Newton's law of viscosity, Viscous fluids, Plastic fluids, Measurement of viscosity
3. **Deformation of materials**
   - Viscoelastic behavior, Stress relaxation test, Creep test, Dynamicoscillatory test
4. **Textural properties**
   - Texture profile analysis,
   - Compression, snapping-bending, Cutting shear, puncture, penetration
5. **Water activity and sorption properties**
   - Prediction and measurement of water activity Effect of temperature and pressure on water, Activity, preparation of sorption isotherms

SUGGESTED TEACHING & ASSESSMENT METHODS

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

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes,
Final Term

Suggested Assessment Methods Practical

Laboratory Participation
Laboratory Report/Manual
Laboratory Quiz /Viva Voce

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Rao, M.A., Rizvi, S.S., Datta, A.K. and Ahmed, J., 2014. Engineering properties of foods. CRC press. USA
2. Barbosa-Canovas, G.V., Juliano, P. and Peleg, M., 2009. Engineering properties of foods. In Food engineering: Encyclopedia of life support systems (pp. 39-70). EOLSS Oxford. UK

INTRODUCTION TO FOOD ENGINEERING

Credit Hours: 2+0=2
Pre-Requisites: Nil

DESCRIPTION

This course provides an overview of the principles, techniques, and technologies involved in the production, processing, and preservation of food.

COURSE LEARNING OUTCOMES

By the end of this course, students shall have:

1. Identify the major and minor constituents of food and the chemical reactions in which they participate. Define the principles involved in the processing of the major types of food products.
2. Apply the principles of mass and energy balance to food processing systems
3. Explain the mechanism and working of various thermal and preservation techniques in food and related processing methods

COURSE OUTLINE

1. **Historical Background of Food Engineering**
   - Food engineering and its scope
   - Importance of chemistry and biological science in food engineering
2. **Food Processing**
   - Baked and snack foods
   - Honey, syrups
   - Confectionery
   - Beverages
   - Milk and fish
3. **Thermal Techniques in Food Processing**
   - Heat processing of food
   - Freezing and cold storage
   - Microwave heating
4. **Food process and plant design**
   - Personal cleanliness
   - Buildings and facilities
   - Plant layout
   - Food process design

5. **Preservation Techniques in Food Processing**
   - Food processing from harvest to preservation, packaging and distribution

SUGGESTED TEACHING & ASSESSMENT METHODS

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

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes,
Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Introduction to Food Engineering; R.Paul Singh & Dennis R Heldman; Fourth Edition, AP & Elsevier
2. Case-studies in Food Processing; J.Peter Clark, Ed 2009, Springer.

MATERIAL & ENERGY BALANCE

Credit Hours: 3+0=3
Pre-Requisites: Nil

DESCRIPTION

This course covers the principles of conservation of mass and energy for applying these principles to analyze and design food processing operations. It covers topics such as mass balances, energy balances, process flow sheets, and calculations involving material and energy transformations. This course is vital for understanding and optimizing various processes involved in food production and processing.

COURSE LEARNING OUTCOMES

1. Write material and energy balance or unit operations and processes involved in food industry
2. Solve energy and material processes calculation by computing tools.

COURSE OUTLINE

1. **Fundamentals**
   - Basic concepts regarding energy balance, units and conversions, stoichiometric calculations
2. **Mass Balance**
   - Mass balances for items of plant; choice of basis/datum for balances, overall and component balances, balances for systems with recycle, purge and by-pass streams, mass balancesfor reactive processes, mass balances for unit operations, tie components, balances for batch & continuous plant.
3. **Mass Balance on various applications**
   - Ideal and real gas relationships, Vapor pressure, Saturation, Partial saturation, Humidity, Balances for condensing systems, Humidification, Dynamic balances
4. **Energy Balance**
   - Energy balance; concepts and units, forms of energy, the first law of thermodynamics, calculation of enthalpy changes, applications of the general energy balance without reactions occurring. Balances with reaction; mass and energy balances for reacting systems and balances for combustion processes

5. Case Studies on Energy Balance

- Case studies on balances for a selection of important industrial processes, Efficiency and Conversion, Simultaneous mass, and energy balances; temperature andpressure dependence

SUGGESTED TEACHING & ASSESSMENT METHODS

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

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes,
Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Richard, F.M, Ronald, R.W., and Lisa G.B., Elementary Principles of Chemical Processes. 4th ed. New Jersey: John Willey & Sons, 2015.
2. Nayef, G., and Redhouane, H., Principles of Chemical Engineering Processes: Material and Energy Balances, 2nd ed. CRC Press, 2014.
3. Himmelblau, D.M., Basic Principles and Calculations in Chemical Engineering. 8th ed. Prentice Hall PTR, 2013.
4. Chopy and Hicks, Handbook of Chemical Engineering Calculations, 4th ed. New York N.Y: McGraw-Hill Professional Publishing, 2012.
5. Reklaitis, G.V. and Schneider, D.R., Introduction to Material and Energy Balances. New Jersey: John Wiley & Sons, 2002

ENGINEERING WORKSHOP

Credit Hours: 0+1=1
Pre-Requisites: Nil

DESCRIPTION

Engineering workshop serves as a practical space where students gain hands-on experience with various tools, machinery, and techniques used in the food industry. It's a place where theoretical knowledge meets practical application.

COURSE LEARNING OUTCOMES

1. Acquire laboratory safety guidelines and define experimental goals of workshop practice
2. Follow experimental procedures of workshop practice
3. Perform and reproduce experiments individually and efficiently in teams
4. Report and summarize the experiment data in manual

COURSE OUTLINE

1. **Workshop Safety**
   - Lecture and movie on workshop safety and practical demonstration of safety equipment,tools, and safety gear
2. **Measurement Section**
   - Measurement of different dimensions of a given specimen using Vernier calipers
   - Micrometer and thread pitch gauge, etc.
   - Preparation of report
3. **Bench Fitting Shop**
   - Introduction of different bench fitting tools and equipment and preparation of a report.
   - Fabrication of a wall-hanger base plate as per drawing using operations like, measuring, marking, sawing, filing, drilling, counter sinking and threading
   - Fabrication of wall-hanger hooks as per drawing using operations like, measuring marking,sawing, filing, taping, fitting and assembly of the complete wall hanger
4. **Welding Shop**
   - Preparation of metal work pieces of required dimensions and joining in

- Preparation of metal work pieces of required dimensions and joining in lap, butt and T joints using gas welding
- Joining of metal work pieces in lap, butt and T-joints using TIG welding
- Joining of metal work piece in lap, butt and T-joints using MIG welding

5. Machine Shop

- Introduction of a lathe machine, its parts and accessories, and different operations which can be performed on a lathe machine.
- Manufacturing of a pen holder top on lathe machine using operations like facing, center drilling, turning, taper turning and parting

SUGGESTED TEACHING & ASSESSMENT METHODS

Suggested Assessment Methods Practical

Laboratory Participation

Laboratory Report/Manual

Laboratory Quiz /Viva Voce

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Umesh Rathore and Naresh Kumar Sharma, "A Textbook of Electrical Workshop Practices", S.K. Kataria & Sons, 1st Ed. 2019
2. S. K. Choudhury, "Elements of Workshop Technology", Vol. 1, Media Promoters & Publishers.
3. Chapman, "Workshop Technology", Part-I, II, III,CBS

FLUID MECHANICS-II

Credit Hours: 2+1=3
Pre-Requisites: Fluid Mechanics-I

DESCRIPTION

Fluid Mechanics-II" typically delves deeper into advanced topics and applications of fluid dynamics beyond the introductory level. This course cover more complex aspects of fluid behavior and its applications in various food industries. Topics such as turbulent flow, boundary layer analysis, flow in pipes and channels, computational fluid dynamics (CFD), and other advanced fluid flow phenomena are included.

COURSE LEARNING OUTCOMES

1. Apply differential fluid mechanics for theoretical solution of various fluid flow systems
2. Describe the characteristics of flow over immersed bodies, Compressible and open channel flow
3. Apply principles of fluid mechanics to the operation, design, and selection of fluid machinery such as pumps, blowers, fans, and compressors
4. Use resources to solve simple fluid flow problems using available CFD code.
5. Practice fundamental concepts of fluid through laboratory experiments.

COURSE OUTLINE

1. **Differential Analysis of Fluid Flow**
   - Deriving continuity equation by applying principle of conservation of mass
   - Calculating velocityand acceleration field using material derivative.
   - Deriving Navier
   - Stokes equation
   - Solving Navier Stokes equation for simple geometries

2. **Potential Flow Theory**
   - Concept of Vorticity
   - Circulation, Inviscid and Irrotational flow fields
   - Basic velocity potential, functions, and their superposition
   - Prediction of Lift and Drag using potential flow theory.

3. **Flow Over Immersed Bodies**
   - Boundary layer theory and its thicknesses,
   - Concept of local and average drag coefficient
   - Calculating drag and lift forces due to pressure and velocity field

4. **Turbo machinery**
   - Classification of fluid Machines, Fans, Pumps, turbines and other flow devices
   - Deriving Euler's equation of Turbo machine
   - Solving turbo-machine problems using velocity triangle.
   - Turbo machine performance characteristic curves,
   - Series and Parallel combination of pumps, affinity laws

5. **Introduction to Compressible Flows**
   - Mach number and speed of sound
   - Isentropic flow of an ideal gas
   - Convergent and divergent nozzle

6. **Introduction to Open Channel Flow**
   - Steady, 1 dimensional open channel flow analysis,
   - Froude Number,
   - Uniform flow channels and critical depth

7. **Introduction to Computational Fluid Dynamics**
   - Finite difference formulations
   - Concept of discretization
   - Solving simple fluid flow problems using available CFD code

SUGGESTED TEACHING & ASSESSMENT METHODS

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

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes,
Final Term

Suggested Assessment Methods Practical

Laboratory Participation
Laboratory Report/Manual
Laboratory Quiz /Viva Voce

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Fundamentals of Fluid Mechanics; Bruce R Munson,7th edition, 2012, Juhn Wiley & Sons.
2. Jog, C. S. (2015). Fluid Mechanics (Vol. 2). Cambridge University Press

UTILITY & MAINTENANCE MANAGEMENT

Credit Hours: 2+0=2
Pre-Requisites: Nil

DESCRIPTION

This course covers the maintenance types including scheduling, safety protocols, government regulations, hazard assessments, and firefighting equipment usage, ensuring plant safety and minimizing risks for personnel at various workplace.

COURSE LEARNING OUTCOMES

1. Explain the type of maintenance, application and risk management
2. Apply the knowledge acquired of food plant maintenance and safety to hazard and risk assessment.
3. Analyze design consideration and overall safety of plants and personals in view of accidents and government regulations

COURSE OUTLINE

1. Types of maintenance

- Preventive, predictive, breakdown and total productive maintenance.
- Individual versus group replacement. Internal versus external maintenance

2. Scheduling of maintenance

- Computerized Maintenance, Organization of maintenance force.
- Design considerations; Layout and construction maintenance of rotary and stationary equipment, inspection techniques.
- Non-destructive testing techniques, basic of rigging and lifting.
- Lubrication and lubricants. Importance of safety with increased productivity

3. Overall safety of plant and personnel

- Accidents and loss statistics. Accident analysis and prevention. Types of accidents in the chemical industry.
- Govt. regulations for industrial safety. Difference between accident and incident. Accident rate calculations and economics of accident prevention.
- Safety management. Hazard and risk assessment. Accident investigation and case history. Fires and explosions. Fire triangles. Flammability characteristics.

- Safety equipment, firefighting equipment, and their uses.
- Occupational diseases related to the chemical industry.

SUGGESTED TEACHING & ASSESSMENT METHODS

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

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes,
Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Maiti, J., and Ray, P.K., Industrial Safety Management: 21st Century Perspectives of Asia, Springer, 2017.
2. Davis M.L. and Cornwell D.A. Introduction to Environmental Engineering. 5th ed. McGraw Hill Inc., 2012.
3. Crowl, D.A. and Louver, J.F. Chemical Process Safety Fundamentals with Application. 3rd ed. Prentice Hall, 2011.
4. Mobley, R.K. et al. Maintenance Engineering Handbook. 7th ed. McGraw Hill, 2008.
5. Masters, G.M. and Ela, W.P. Introduction to Environmental Engineering and Science. 3rd ed. Prentice Hall, 2007.
6. Mishra R.C. and Pathak K. Maintenance Engineering and Management. Prentice-Hall of India, 2002

UNIT OPERATIONS IN FOOD ENGINEERING-I

Credit Hours: 3+1=4
Pre-Requisites: Nil

DESCRIPTION

This course focuses on the fundamental processes involved in food manufacturing and processing. It covers various operations and techniques used in the initial stages of food production including the principles and application of unit operations such as heating, cooling, drying, size reduction, mixing, and separation.

COURSE LEARNING OUTCOMES

1. Describe the engineering principles required to design preliminary preparative operations and material handling in food processing.
2. Design of unit operations involved in food industry.
3. Compare the performance of preliminary processes and material handling equipment used in food industries.
4. Practice engineering principles of each unit operation.

COURSE OUTLINE

1. **Preliminary preparative operation**
   - Cleaning
   - Sorting
   - Grading methods
2. **Size reduction**
   - Particle size distribution
   - Classification, Screening and sieving
   - Mechanism of size reduction, Machinery for crushing and grinding
   - Disintegration of fibrous materials
   - Energy requirements for communication of solids
3. **Pneumatic and Hydraulic Conveying Systems:**
   - Types of conveyers, types of elevator
4. **Fluidization, mixing and agitation**
   - Flow pattern and baffles, rate of mixing and power consumption
   - Centrifugation theory and applications

5. Agglomeration Phenomena and its application

- Granulation, palletization
- Tableting process and storage

6. Filtration

- Mechanism of filtration, filter media, flow through filter cake or cloth
- Cake resistance and relation between thickness of cake and volume of filtrate

SUGGESTED TEACHING & ASSESSMENT METHODS

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

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes,
Final Term

Suggested Assessment Methods Practical

Laboratory Participation
Laboratory Report/Manual
Laboratory Quiz /Viva Voce

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Singh, R.P. and Heldman, D.R., 2008. Introduction to food engineering. Gulf Professional Publishing.
2. Barbosa-Canovas, G.V. and Ibarz, A., 2014. Unit operations in food engineering. Crc Press.
3. Irudayaraj, J.M. and Jun, S., 2015. Food processing operations modeling: design and analysis. CRC press

PROCESS CONTROL & INSTRUMENTATION

Credit Hours: 2+1=3
Pre-Requisites: Nil

DESCRIPTION

This course covers the measurement principles for temperature, pressure, flow, and more, covering sensors, transmitters, and controllers. It explores calibration methodologies, safety protocols, and control practices using P & I diagrams, servo operations, and control strategies like Ziegler-Nichols formulae. Additionally, it includes modeling techniques, control theory using Laplace transforms, and case studies.

COURSE LEARNING OUTCOMES

1. Describe the fundamental principles of process control apply in food processing.
2. Use resources to solve process control problems by applying mathematical model.
3. Apply the knowledge of mathematics [Linearization, Laplace Transforms and Frequency Response] to solve it describing dynamics of Food processing.

COURSE OUTLINE

1. **Instrumentation**
   - Principles of measurement of temperature, pressure, level, flow, weight, power, speed, position, etc. Study of common sensors, transmitters, controllers, actuators, recorders, switches, etc.
2. **Calibration**
   - Methodology for calibration. Fail-safe modes of operation, alarm, trip, and interlocksystem. Emergency shut-down systems. Fire and gas detection. Pressure relief & venting systems
3. **Control Practice**
   - Terminology signal types and standard ranges, interpretation of P & I diagrams; servo and regulator operations. Bias and offset auto/manual optimum settings. Ziegler and Nicholsformulae
4. **Control strategy**
   - Formulation P & I diagram. Control loop elements, Block diagrams. Control objectives. Industrial Applications. Use of feedback,

cascade, ratio, fee forward. Use of analyzer and chromatographs

5. **Modeling**
   - Lumped parameter models to plant, e.g., jacked vessel.
6. **Control theory**
   - Use of Laplace transforms. Mathematical modeling of simple lumped parametersystems and their Laplace transforms. Response of First & Second order systems. Study of a typical feedback control loop, open and closed loop response to simple inputs
7. **Case Studies**

SUGGESTED TEACHING & ASSESSMENT METHODS

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

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes,
Final Term

Suggested Assessment Methods Practical

Laboratory Participation
Laboratory Report/Manual
Laboratory Quiz /Viva Voce

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Weedon, T.A., Kirk, P., Kirk, F.W., Instrumentation and Process Control, 7th ed., American Technical Publisher, 2019.
2. Dunn, W.C., Fundamentals of Industrial Instrumentation and Process Control, 2nd ed., McGraw-Hill Education, 2018.

3. Seborg, D.E. et al. Process Dynamics and Control, 3rd ed. John Wiley and Sons. 2010.
4. Bequette, B.W. Process Control: Modeling, Design and Simulation, New Delhi: Prentice Hall. 2003.
5. Stephanopoulos, G. Chemical Process Control: An Introduction to Theory and Practice. New Delhi: Prentice Hall. 2003.
6. Marlin, T.E. Process Control: Designing Processes and Control Systems for Dynamic Performance, 2nd ed. McGraw-Hill. 2000.
7. Luyben, W.L. Process Modeling Simulation and Control for Chemical Engineers, 2nd ed. McGraw Hill, 1990.

FOOD PROCESSING & PRESERVATION

Credit Hours: 3+0=3
Pre-Requisites: Nil

DESCRIPTION

This course covers fundamental concepts of food safety, constituents, and preservation techniques. It explores spoilage factors, preparatory operations, and preservation techniques, packaging materials for food preservation and safety measures in diverse environments.

COURSE LEARNING OUTCOMES

1. Describe the basics of food processing and preservation techniques.
2. Demonstrate the construction and operations of food processing equipment and their impact on food quality.
3. Demonstrate emerging trends related to food processing, packaging and preservation, along with their environmental impacts.

COURSE OUTLINE

1. **Introduction**
   - Food processing and preservation
2. **Food safety and security**
   - Food sources and global food situation
3. **Food constituents and their functions**
   - Water, carbohydrates, lipids, proteins, vitamins andminerals
4. **Food classification based on perishability and pH**
   - Spoilage agents in food: Enzymes,microorganisms, insects, rodents, birds and physical factors
5. **Principles of food preservation**
   - Preparatory operations in food processing
6. **Preparatory operations in food processing**
   - Cleaning, sorting and grading, peeling, removal ofinedible constituents, size reduction, mixing, filtration and prevention of enzymatic browning-applications
7. **Heat exchangers**
   - types of heat exchangers, heat exchanger analysis, logarithmic Mean Temperature Difference (LMTD), heat exchanger effectiveness number of transfer units (NTU), evaporators. Design of heat exchanger

8. **Preservation by high temperature**
   - Canning - unit operations and their significance
9. **Preservation by low temperature**
   - Distinction between refrigeration and freezing. Cold storage:Factors affecting. Freezing and frozen storage: unit operations, effect on food and microorganisms
10. **Preservation by removal of moisture**
   - Sun drying, dehydration - equipment, procedures,precautions. Defects in dried foods, Types of dehydrators, Still air and forced draft.
11. **Food additives:**
   - Chemical additives, contaminants and adulterants - differentiation. Uses of foodadditives: Non preservative, preservative
12. **Fermentation techniques**
   - alcoholic, acetic and lactic fermentations – applications, procedures
13. **Irradiation technology**
   - Applications in food preservation. Merits and demerits
14. **Food Packaging**
   - Packaging materials, protective packaging in tropical environment, Asepticpackaging

SUGGESTED TEACHING & ASSESSMENT METHODS

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

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes,
Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Awan, J.A. 2018. Food Processing and Preservation. Unitech Communications, Faisalabad, Pakistan.
2. Awan, J.A. 2018. Food Science and Technology. Unitech Communications, Faisalabad, Pakistan.
3. Khetarpaul, N. 2005. Food Processing and Preservation. Daya Publishing House, New Delhi, India.
4. Rehman, M.S. 2007. Handbook of Food Preservation. CRC Press Taylor & Francis Group, Boca Raton, FL, USA.
5. Zahoor, T., M. S. Butt. 2017. Handbook of Food Science and Technology. ISBN 978-969-8237- 97-4: © University of Agriculture, Faisalabad, Pakistan.
6. Awan, J.A. 2005. Food science and technology. Unitech Communications, Faisalabad, Pakistan.
7. Awan, J.A. 2005. Food processing and preservation. Unitech Communications, Faisalabad.
8. Potter, N.N. and J.H. Hotchkiss. 1995. Food science (5th Ed). The AVI Pub Co Inc, Westport, Connecticut, USA

MACHINE DESIGN FOR FOOD INDUSTRIES

Credit Hours: 2+0=2
Pre-Requisites: Nil

DESCRIPTION

This course focuses on designing machinery tailored specifically for food processing applications. It covers systematic approach of conceptualizing, designing, and optimizing machinery within the context of food and agricultural production. It includes tolerance design, stress analysis, and the design of essential components such as shafts, bearings, gears, and power transmission elements, considering their crucial role in food processing machinery.

COURSE LEARNING OUTCOMES

1. Discuss machine dynamics and the basic knowledge, tools and resources involved in designing food machinery elements.
2. Calculate the stress under static and variable loading and identify failure modes for machine elements.
3. Design the simple machine elements of food machinery.
4. Present the design aspects effectively through oral presentation.

COURSE OUTLINE

1. **Philosophy of Design**
   - Formulating of procedure
   - the importance of machine design in Food & Agricultural Machinery
   - Reliability
   - Engineering Standards and User economics
2. **Tolerance Design and Statistics**
   - Tolerance and allowances
   - Application of statistics to manufacturing.
3. **Stresses**
   - Stress failure theory
   - Designing for deflection
   - Strain determinations
   - Stresses caused by impact.

4. Design of Simple Machine Components

- Design of shafts
- Torsion of circular shafts, horsepowertransmitted by the shafts
- Design of clutches, bearings, gears, flange couplings, pulleys and connecting rod

5. Elements of Rotary Power Transmission

- Belts, Stresses in belts
- Chain and sprocket drives
- Gears drives
- Flexible shafts
- Bearing

6. Hydraulic Power System

- Hydrostatic drives and hydraulic pumps
- Pump performance and rating
- Hydraulic motors performance and rating
- Control valves
- Hoses and fitting
- Cylinders

7. Design of Fasteners and Connections

- Different types of fasteners.
- Thread standards and definitions
- Mechanics of power screws.
- Bolts strength and selection of units
- Bolt preload, torque requirement
- Bolted, riveted and welded joints loaded in shear, Keys pins, and retainers
- Design of pressure vessels

SUGGESTED TEACHING & ASSESSMENT METHODS

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

Report Writing.

Suggested Assessment Methods Theory

Mid-term

Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Krutz, G., L. Thompson and P. Claar. (1984). Design of Agricultural Machinery. John Wiley and Sons Inc. USA.
2. Bernacki, H. J. Haman, C. Kanafojski, Agricultural Machines, Theory and Construction, Vol. I , U.S. Department of Commerce.
3. Shigley, J.E. and C. R. Mischhe, (2000). Mechanical Engineering Design. Fifth Edition. McGraw Hill Publications Inc. US

FOOD PROCESS ENGINEERING

Credit Hours: 2+0=2
Pre-Requisites: Nil

DESCRIPTION

The course focuses on the principles and application of engineering techniques to design, analyze, and optimize food processing operations. The curriculum often covers topics like process design, material and energy balance, processing, energy efficiency, and food quality preservation.

COURSE LEARNING OUTCOMES

1. Describe the basic of food processing
2. Demonstrate the construction and operations of food processing equipments and their impact on food quality

COURSE OUTLINE

1. **Overview**
   - Unit conversion,
   - Material and energy balance
   - Fluid flow properties
   - Engineering properties offood
2. **Food processing**
   - Types of conveyers, types of elevators
3. **Drying and dehydration process**
   - Flow pattern and baffles
   - Rate of mixing and powerconsumption
   - Centrifugation theory and applications
   - Thermal processing and non-thermal processing
4. **Low temperature processing**
   - Granulation, palletization
   - Tableting processand storage
5. **Evaporator**
   - Introduction
   - Types of evaporators

- Membrane separation
- Emulsification process
- Filtration Minimal processing
- Electrostatic coating
- Design of coatings

6. Case Studies

SUGGESTED TEACHING & ASSESSMENT METHODS

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

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes,
Final Term

Suggested Assessment Methods Practical

Laboratory Participation
Laboratory Report/Manual
Laboratory Quiz /Viva Voce

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Brennan, J.G. and Grandison, A.S. eds., 2012. Food processing handbook. John Wiley & Sons.
2. Dunne, C.P., 2008. High pressure processing of foods (Vol. 12). John Wiley & Sons.
3. Gaonkar, A.G. ed., 1995. Food processing: recent developments. Elsevier. Science
4. Smith, J.S. and Hui, Y.H. eds., 2008. Food processing: principles and applications. John Wiley & Sons.

FOOD MICROBIOLOGY

Credit Hours: 2+1=3
Pre-Requisites: Nil

DESCRIPTION

A course in "Food Microbiology" delves into the study of microorganisms in the context of food production, preservation, and safety.

COURSE LEARNING OUTCOMES

1. Describe the basics of microbiology with emphasis on characteristics, sources, and growth requirements of food associated micro-organisms.
2. Demonstrate procedures/ methods/ principles for microbial enumeration.
3. Demonstrate the advantages and disadvantages of microbial association with food and their control measures.
4. Express HACCP plan for different food products
5. Practice identification or enumeration of different micro-organisms.

COURSE OUTLINE

1. **History**
   - The scope and development of food microbiology
   - microorganisms in food, food spoilage/preservation
   - foodspoilage/preservation
   - food safety
   - micro-organism in atmosphere, soil, air, water, equipment, plants and animal, raw meat, raw and pasteurized milk, vegetables fruits and nuts, canned foods, sugars and confectionaries, soft drinks etc.
2. **Metabolism**
   - Microbial metabolism of food components
   - Metabolism of food carbohydrates, fermentation, anaerobic aerobic respiration, metabolism of food proteins, metabolism of food lipids.
   - Factors affecting the growth and survival of micro-organism; intrinsic factors: pH, moisture contents, oxidation reduction potential, nutrient content, extrinsic factors: temperature of storage, concentration of gases, humidity.

3. Food Examination

- Microbial spoilage and examination of food; spoilage, spoilage of various foods, causes of spoilage, types of spoilage, examination; sampling, microbial test procedures, indicator organisms, food poisoning organisms, food spoilage organisms.
- Bacterial and non- bacterial agents of food borne illness; aeromonashy drophilia, bacillus cereus and other species, brucella, compylobecter, clostridium botulinum, clostridium perfringens, listeria monocy togenesis, mycobacterium species, plesiomonas Shigelloids, samonella, Shigella, vibrio, yersinia, enterocolitica, scombrotoric fish poisoning, helminths and nematodes, protozoa, toxigenic algae and fungi,
- Food borne viruses, spongiform encephalopathies.

4. Microbes in Food

- Beneficial activities of microbes in food; fermented and microbial food, yeast,lactic acid bacteria, fermented milks, cheese, fermented vegetable, and meats.
- Controlling the microbiological quality of food; food preservation, microbial control.

SUGGESTED TEACHING & ASSESSMENT METHODS

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

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes,
Final Term

Suggested Assessment Methods Practical

Laboratory Participation
Laboratory Report/Manual
Laboratory Quiz /Viva Voce

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Doyle, M.P., Gonzalez, F.D., and Hill, C., 2019. Food microbiology: fundamentals and frontiers. 5th ed. Wiley.
2. Robinson, R.K., 2014. Encyclopedia of food microbiology. Academic press.
3. Doyle, M.P. and Buchanan, R.L. eds., 2012. Food microbiology: fundamentals and frontiers. American Society for Microbiology Press.
4. Ray, B. and Bhunia, A., 2007. Fundamental food microbiology. CRC press.
5. Montville, T.J., and Matthews, K.R., 2007. Food microbiology: an introduction (No. Ed. 2). ASM Press.

UNIT OPERATIONS IN FOOD ENGINEERING-II

Credit Hours: 3+1=4
Pre-Requisites: Unit operations in food engineering-I

DESCRIPTION

This course may cover advanced topics related to food engineering processes, such as drying processes, heat exchangers, thermal processing methods (such as pasteurization, sterilization, and ultra-high temperature treatment), filtration mechanisms, extrusion techniques, distillation principles, adsorption technology, liquid-liquid extraction, and absorption processes.

COURSE LEARNING OUTCOMES

1. Describe the engineering principles required to design unit operations used in food processing.
2. Design of unit operations involved in food industry where mass transfer and simultaneous heat and mass transfer are applied.
3. Discuss the application of unit operations used in food engineering.
4. Practice engineering principles of each unit operation.

COURSE OUTLINE

1. **Process of drying**
   - Working principal, Equipment, Types
2. **Heat exchangers**
   - Principles, Types and applications, parameters of heat exchangers, **Thermal processing**: Pasteurization, Sterilization, Thermization, UHT
3. **Filtration processing**
   - Mechanism of filtration, Filter media, Flow through filter cake or cloth, Cake resistance and relation between thickness of cake and volume of filtrate, UHT
4. **Extrusion**
   - Introduction and importance,
   - Working Principle
   - Single screw extruders, Twin screw extruders Applications
   - Advantages and disadvantages,
   - Textured vegetables proteins, breakfast cereals etc.

5. Distillation

- Rectifying and stripping sections, material balances. Constant molal overflow.
- Adsorption Technique
- The nature of adsorbents, adsorption equilibria
- Adsorption equipment and regeneration of spent adsorbents.

6. Liquid-Liquid Extraction

- Introduction
- Extraction Processes, Extraction equipment Absorption
- Extension of design techniques and Wetted wall columns method
- determination of transfer coefficients, Equipment for gas absorption

SUGGESTED TEACHING & ASSESSMENT METHODS

Lecturing (audio/video aids)

Written Assignments/ Quizzes

Tutorials

Case Studies relevant to engineering disciplines.

Semester Project

Guest Speaker

Industrial/ Field Visits

Group discussion

Report Writing.

Suggested Assessment Methods Theory

Mid-term

Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Assessment Methods Practical

Laboratory Participation

Laboratory Report/Manual

Laboratory Quiz /Viva Voce

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Singh, R.P. and Heldman, D.R., 2008. Introduction to food engineering. Gulf Professional Publishing.
2. Barbosa-Canovas, G.V. and Ibarz, A., 2014. Unit operations in food engineering. Crc Press.
3. Irudayaraj, J.M. and Jun, S., 2015. Food processing operations modeling: design and analysis. CRC press

FOOD PLANT LAYOUT & DESIGN

Credit Hours: 3+1=4
Pre-Requisites: Nil

DESCRIPTION

This course covers the objectives and financial aspects of plant design, location, equipment layout, material selection, product selection through market surveys, incorporating material & energy balances. Further it focuses on computer-aided design for layout planning, environmental impact, material handling, and process flow charts to efficiently design.

COURSE LEARNING OUTCOMES

1. Describe the strategic importance of a plant layout and its Location selection
2. Demonstrate the major elements of plant design and its cost estimation.
3. Develop the flow sheet synthesis and process equipment design concepts with the principles of engineering.
4. Demonstrate related software that help in food process design, analysis and flow sheeting.

COURSE OUTLINE

1. **Plant design and layout**
   - Objectives and functions, financial requirements,
   - Plant location, site selection, space requirement,building design and construction, floors, drains, walls, doors, windows, ceiling, ventilation,lighting, auxiliary facilities.
   - Food plant equipment, layout of equipment, requirements, design, construction, choice of material
2. **Selection of products from Food Industry**
   - Selection of novel products from food industry through market survey, food product development.Selection of the local preparation of the plant layout
   - Material and energy balances
   - Design of the major units and sizing, auxiliary equipment including services, health and safety considerations,plant and product cost estimation

3. Use of computer for layout Design

- Use of computer for layout, environmental impact, material handling and equipment process flowchart.

SUGGESTED TEACHING & ASSESSMENT METHODS

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

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes,
Final Term

Suggested Assessment Methods Practical

Laboratory Participation
Laboratory Report/Manual
Laboratory Quiz /Viva Voce

RECOMMENDED TEXT AND REFERENCE BOOKS

1. James, M.More., Plant Layout and Design, MacMillian Publishing Co., New York,1976.
2. Antonio López Gómez, Gustavo V. Barbosa-Cánovas. Food plant design. Taylor & Francis inc., 2007.
3. Max S. Peters, Klaus D. Timmerhaus, Plant Design And Economics For Chemical Engineers,5TH Edition 2003,McGrawhill

FOOD PACKAGING

Credit Hours: 2+1=3
Pre-Requisites: Nil

DESCRIPTION

The course covers recent trends such as active and biodegradable packaging, alongside equipment like vacuum sealers and aseptic systems, crucial for preserving food quality and safety. It includes industrially preferred manufacturing processes such as injection molding, extrusion, and lamination, focusing on fresh and frozen food packaging systems for diverse products.

COURSE LEARNING OUTCOMES

1. Evaluate different packaging materials, their properties and processing steps as used for the safety, quality and shelf life of various types of food products
2. Use resources to identify problems associated with different processing steps used in food packaging industries.
3. Apply modern food packaging guidelines in accordance with sustainability and eco-friendly environment

COURSE OUTLINE

1. **Fundamentals of Food Packaging**
    - Introduction to conventional and modern food packaging, importance and functions of packaging, elements of successful packaging
2. **Packaging materials and their processing**
    - Introduction to packaging materials: polymers (plastics), paper, glass and metals.
    - Selection criteriaof packaging materials for different food products, processing of packaging materials for food applications
    - Industrially preferred manufacturing processes of food packaging products such as injection moulding, extrusion, blow moulding, sheet and film extrusion, paper and paperboard calendaring, lamination, steel drawn cans processes.
    - Fresh and frozen food packaging systems (meat, poultry, sea food, fruits and vegetables, dairy products).

3. **Recent trends in Food Packaging**
    - Active, Controlled atmosphere (CA), Modified atmosphere (MA), Anti-microbial, Edible,Aseptic and biodegradable packaging
4. **Packaging equipment and machinery**
    - Vacuum, Seal and shrink packaging machine. Form & fill sealing machine, Aseptic packaging systems, Retort pouches, Bottling machines, Carton making machines, Package printing machines

SUGGESTED TEACHING & ASSESSMENT METHODS

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

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Assessment Methods Practical

Laboratory Participation
Laboratory Report/Manual
Laboratory Quiz /Viva Voce

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Rui M. S. da Cruz. Food Packaging, Innovations and Shelf Life.CRC Press, 1st Edition 2019.
2. Alexandru Grumezescu. Food Packaging. Elseveir, Academic press, 1st Edition, 2016
3. Sina Ebnesajjad. Plastic Films in Food Packaging: Materials, Technology and Applications (Plastics Design Library) 1st Edition.2018.
4. Ruben Hernandez, Susan E. MSelke, John Culter, John D. Culter, Plastics Packaging: Properties, Processing, Applications, and Regulations, 2000

FOOD QUALITY CONTROL

Credit Hours: 2+0=2
Pre-Requisites: Nil

DESCRIPTION

This course covers the quality concepts' evolution and Total Quality Management principles, emphasizing ISO-9000 standards and the Quality Assurance Department's role.

COURSE LEARNING OUTCOMES

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

1. Describe the basics of Quality and control techniques applied in food industries.
2. Apply Food quality management standard in food manufacturing unit
3. Demonstrate an effective HACCP system implementation in food production area.

COURSE OUTLINE

1. **Definition of Quality**
   - Quality assurance, total quality concepts; evolution of quality activities in the history

2. **Principles of total Quality Management**
   - Quality Management System and ISO-9000 standards; functions of Quality Assurance Department and its relations with other departments

3. **Description of Critical Control Points**
   - HACCP, GMP systems; classification of food quality attributes; definition and objective evaluation of sensory food attributes, sensory test techniques.

4. **Nutritional Quality Control**
   - Approximate analysis of foods; statistical quality control tools

SUGGESTED TEACHING & ASSESSMENT METHODS

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

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Food Analysis: Theory and Practices. Pomeranz, Y and Melcoan C.E. 2002. 3rd Ed., Kluwer.
2. Mark Clute, Food Industry Quality Control System,2009CRC Press Taylor & Francis Group
3. J. Andres Vasconcellos, Quality Assurance for The Food Industry, 2004, CRC Press Taylor & Francis Group.
4. Imtiaz Ali, Food Quality Assurance Principles and Practices, 2003CRC Press Taylor & Francis Group

***List of Electives-I for Food Engineering
• Fats and Oils Process Engineering • Dairy and Beverage Processing Engineering • Food Product Development • Meat Processing • Cereal Processing • Sugar Confectionery & Chocolates • Enzymes & Bioreaction Engineering • Nutrition Engineering • Post Harvest Processing • Food Plant Hygiene and Sanitation • Any other relevant course decided by the HEI as per requirement

Electives-I

FATS & OILS PROCESS ENGINEERING

Credit Hours: 3+0=3
Pre-Requisites: Nil

DESCRIPTION

This course covers various examination types including physical and chemical traits of oils and fats, their sources, production, and various characteristics.

COURSE LEARNING OUTCOMES

1. Illustrate the process of extraction and refining of edible oils and fats from different natural sources
2. Demonstrate the processing techniques and technology used to produce a range of edible fats and oils products and their quality assessment.
3. Use resources to identify problems associated with oil processing.
4. Imitate experiments to characterize different oil seed and edible oil samples

COURSE OUTLINE

1. **Physical and Chemical Characteristics**
   - Oils and fats: importance, sources, production, uses; Characteristics of oils and fats. Oil bearing materials: pre-treatment, storage
2. **Extraction Methods**
   - Rendering, expression, solvent extraction; Processing: degumming, refining, bleaching, deodorization, fractionation, winterization, hydrogenation, interesterification, esterification, emulsification, stabilization; Spoilage: oxidative and hydrolytic rancidity – chemistry, prevention use of antioxidants;
   - Manufacture of frying oils, margarine, mayonnaise; Byproducts of fats and oils industry and their uses.
   - Industrial oil & fat products and their analysis

SUGGESTED TEACHING & ASSESSMENT METHODS

Lecturing (audio/video aids)
Written Assignments/ Quizzes
Tutorials

Case Studies relevant to engineering disciplines.
Semester Project
Guest Speaker
Industrial/ Field Visits
Group discussion
Report Writing.

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes,
Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Food Technology, Composition, Properties and Uses, Second Edition, Edited by Frank D. Gunstone.
2. Fats and Oils: Formulating and Processing for Applications, Third Edition By Richard D. O'Brien,2003
3. Edible Oil Processing, edited by Wolf Hamm, Richard J. Hamilton, Gijs Calliauw,2013 Bailays industrial oil & products

DAIRY & BEVERAGE PROCESSING ENGINEERING

Credit Hours: 3+0=3
Pre-Requisites: Nil

DESCRIPTION

This course explores milk production, quality factors, and handling techniques. It covers unit operations in milk processing, technology behind various dairy products and regulations in Pakistan.

COURSE LEARNING OUTCOMES

1. Define the basic working principles of key dairy process operations
2. Understand the basics of carbonated and non carbonated beverages
3. Formulate and prepare different kind of beverages

COURSE OUTLINE

1. **Milk**
   - Production statistics, importance, standards, major constituents; Factors influencing raw milk quality. Milk Handling: Manual and machine milking, farm cooling, collection, reception,analyses at different levels, transportation
2. **Unit Operations in Milk Processing**
   - Cream separation, bactofugation, filtration, thermization, standardization, homogenization, pasteurization, sterilization, UHT, aseptic packaging, storage, distribution, effect on milk constituents
3. **Technology**
   - Chemistry, microbiology of industrial products and quality control: evaporated, condensed and powder milks, butter, yogurt, cheese, ice cream, khoa, gulabjamun, burfi, rabri, paneer, dahi, lassi,kheer, desi ghee; Milk by-products: dried whey, casein
4. **Beverage industry in Pakistan**
   - Beverages: classification – still, carbonated, alcoholic; Beverage ingredients: water, fruit components, sweeteners, flavorings, colorings, preservatives; Manufacture of soft drinks and fruitjuices: mixing, pasteurization, homogenization, filling, packing and storage

5. Carbonation

- History, CO2, gas volume; Soft drinks and fruit juices: ingredient specifications, manufacturing problems, changes in color, appearance, flavor

6. Packaging Types

- Interactions
- Shelf life Issues: microbiological problems; Bottled water: legislation
- Water treatment, filling, quality issues.
- Fermented beverages: introduction, types, role of microorganisms. Regulations and Standards: Statuary requirement: labeling, nutrition claims.

SUGGESTED TEACHING & ASSESSMENT METHODS

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

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes,
Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Technology, Chemistry and Microbiology by Alan H. Varnam and Jane P. Sutherland Chapman& Hall, 1999, ISBN: 0412457202

FOOD PRODUCT DEVELOPMENT

Credit Hours: 3+0=3
Pre-Requisites: Nil

DESCRIPTION

This course covers the stages of new product development from idea generation to feasibility testing and market life cycles.

COURSE LEARNING OUTCOMES

1. Illustrate the steps in food product development cycle
2. Demonstrate the processing techniques and technology used for food product development
3. Use resources to identify problems/ risks associated with product development
4. Imitate experiments to develop food products

COURSE OUTLINE

1. **Introduction**
   - Keys to new product success and failure, Idea generation, screening, feasibility, test marketing, product life cycles.
   - Key requirements for successful product development: Developing an innovation strategy, Sensory evaluation in food product development, Food additives, Formulationand the product process development,
   - The knowledge base for product development, The consumer in product development. Managing and improving product development: Managing theproduct development process
2. **Case studies**
   - Product development in the food system, Improving the product development process
3. **Packaging and Labeling**
   - Levels of packaging, Packaging materials. Innovative packaging of new products. Parts of a food label. Shelf life: water activity, preservatives, ingredient effects and new processing technologies

4. **Health and Safety Concerns**
    - Physical and microbial contamination, HACCP Principles & Application. Regulatory Considerations: International and local perspectives
5. **Economic Feasibility**
    - Economic analysis based upon market competitiveness. Essentials of Marketing Food Products: Organizing marketing functions, Consumption, Participants in the marketing process, Test marketing

SUGGESTED TEACHING & ASSESSMENT METHODS

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

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes,
Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Fuller, G.W., New Food Product Development: From Concept to Marketplace, 3rd ed, CRC Press, 2016.
2. Fadi Aramouni, Kathryn Deschenes. "Methods for Developing New Food Products: An Instructional Guide", 2014. DEStech Publications.
3. Mary Earle, Richard Earle. "Case Studies in Food Product Development", 2008. Woodhead Publishing Limited.
4. Mobley, R.K. An Introduction to Predictive Maintenance. 2nd ed. Butterworth-Heinemann, 2002.
5. Mary Earle, Richard Earle, Allan Anderson. "Food Product Development: Maximizing Success", 2001. Woodhead Publishing Limited and CRC Press LLC

MEAT PROCESSING

Credit Hours: 3+0=3
Pre-Requisites: Nil

DESCRIPTION

The course explores poultry processing methods, factors affecting quality, nutritive value, and the utilization of industry byproducts.

COURSE LEARNING OUTCOMES

1. Demonstrate critical thinking skills in meat processing by understating of animal biology
2. Describe proper sanitation of work equipment techniques and explaining proper meat cutting techniques

COURSE OUTLINE

1. **Meat Processing**
    - Factors affecting post-mortem changes, properties, and shelf-life of meat. Meat tenderization and Meat quality evaluation. Modern abattoirs, slaughterhouse, and its features
2. **Preservation of meat**
    - Aging, pickling, smoking. Dried and Cured meat. Canned meat, Frozen meat, Cooked and Refrigerated meat, Sausages.
    - Poultry Processing: -types, factors affecting quality, chemical composition and nutritive value of poultry meat, methods of stunning, slaughter, scalding & dressing. Tenderness of poultry, problem factors in poultry meat.
    - Utilization of poultry industry byproducts

SUGGESTED TEACHING & ASSESSMENT METHODS

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

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes,
Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Toldra, F., and Nollet, L.M.L., Advanced Technologies for Meat Processing, 2017. CRC Press.
2. Y. H. Hui. "Handbook of Meat and Meat Processing", 2012. CRC Press.
3. G.C. Mead. "Poultry Meat Processing and Quality", 2004. Woodhead Publishing, England.
4. Joseph P. Kerry, John F. Kerry, David Ledward. "Meat Processing", 2002. Woodhead Publishing Limited, England (CRC Press).

CEREAL PROCESSING

Credit Hours: 3+0=3
Pre-Requisites: Nil

DESCRIPTION

This course in Food Engineering studies various aspects of cereal production and its processing technologies. It covers the types and uses of cereals, milling processes, and the technological aspects of wheat, rice, and corn processing.

COURSE LEARNING OUTCOMES

1. Illustrate the cereal processing
2. Demonstrate the processing techniques and technology used to produce a range of cereal products
3. Use resources to identify problems associated with cereal processing.
4. Imitate experiments to characterize cereal products

COURSE OUTLINE

1. **Cereal Production and its Characteristics**
   - Types and uses of cereals, Baked cereal foods, Fermented cereal foods, extruded cereal foods, Cereal breeding
   - Aspects of economic production, preservation of grain quality. Cereal production methods. Technologies for Improving the Nutritional
2. **Quality of Cereals**
   - Extrusion cooking, high pressure processing, Microwave processing, Milling, Germination, Fermentation, Enzymatic processing. Milling Process: Wheat, corn and coarse grains milling,
   - Reception and cleaning of grains, Conditioning and milling
3. **Wheat Technology**
   - Composition of grain and environmental effects on its processing quality
   - Enzymes of wheat and their role in the manufacture of wheat products; principles of wheat milling and its effect on composition of flour, aging of flour, byproducts, chemical improvers bleaching and maturing. agents, property of dough and its rheology,

- Manufacture of wheat products bread, biscuits etc.;formulation of premixes for bakery products; pasta goods and processed cereal foods for infants

4. Rice Technology

- Composition, type of proteins, starch content, amylose and amylopectin fractions, presence and effect of lipases; distribution of vitamins; minerals, and proteins in rice grain and its relation to milling,
- Rice milling operations and its effect on nutritive value; cooking quality; byproducts of rice milling and their utilization; processed and prepared mixes based on rice.

5. Corn Technology

- Composition, processing of corn for manufacture of corn grits, meal and flour; manufacture of corn flakes, corn syrup, cornstarch, corn steep liquor, corn oil and canned corn. Composition andprocessing of millets like barley, sorghum, oats etc. Breakfast Cereals.

6. Malting

- Malting process, malting technology; steeping vessels, germination vessels and kilning vessels, Functional properties of malted barley.
- Transportation and Storage of Cereals: Types of storage, Cereal drying (low temperature, high temperature and aeration).
- Biotic and biotic factors for grainsconservation. Dust explosion in grain storage, Quality of whole grains

SUGGESTED TEACHING & ASSESSMENT METHODS

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

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Raquel de Pinho Ferreira Guine, Paula Maria dos Reis Correia, "Engineering Aspects of Cereals and Cereal-Based Products", 2016. CRC Press, Taylor & Francis Group, LLC.
2. Gavin Owens. "Cereal Processing Technology". 2001. Woodhead Publishing Ltd.
3. Jing Wang, Baoguo Sun, Cao, Tsao Rong. "Bioactive Factors and Processing Technology for Cereal Foods", 2019. Springer International Publishing.

SUGAR CONFECTIONERY & CHOCOLATES

Credit Hours: 3+0=3
Pre-Requisites: Nil

DESCRIPTION

This course delves into sugar confections, chocolate processing, and their properties. Topics cover include crystallization, hydrocolloids, and chocolate science, emphasizing ingredient properties and their applications.

COURSE LEARNING OUTCOMES

1. Discuss processing of sugar and its properties
2. Describe processing of confectionery products.
3. Use resources to identify problems associated with confectionery products.
4. Imitate experiments to understand confectionery processing

COURSE OUTLINE

1. **Sugar Confections**
   - Overview of sugar and corn syrup chemistry and phase transitions, Physical and chemical properties of sweeteners, Principles of crystallization,
   - Applications including hard candies, fondants, creams, tablets, lozenges, caramel, fudge, and toffee., Factors impacting quality and shelf-life of sugar confections. Stabilized Confections: Introduction to hydrocolloid chemistry, Role of stabilizers
2. **Principles of processing**
   - Applications including chewing and bubble gum, gummies and jellies, aerated candy, and sugar panning,
   - Relationship between hydrocolloids and both texture and quality of stabilized confections.
3. **Chocolates**
   - Introduction to fats, oils, and emulsifiers, Physical and chemical properties of lipids, Chocolate and chocolate coatings,
   - Principles of processing chocolates, the science of chocolates, particle size and flavor, viscosity, fats, and tempering, and panning, Troubleshooting chocolates

SUGGESTED TEACHING & ASSESSMENT METHODS

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

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Hartel, Richard W., von Elbe, Joachim H., Hofberger, Randy. "Confectionery Science and Technology". 2018. Springer International Publishing AG.L
2. W. P. Edwards. "The Science of Sugar Confectionery", 2002. The Royal Society of Chemistry.
3. R. Lees. "Sugar Confectionery and Chocolate Manufacture", 1992. Springer International Publishing.

ENZYMES & BIOREACTION ENGINEERING

Credit Hours: 3+0=3
Pre-Requisites: Nil

DESCRIPTION

The course explores he significance of enzymes in food processing, their activity factors, kinetics, and immobilization techniques. It covers enzyme inhibition, kinetics analysis, and practical applications.

COURSE LEARNING OUTCOMES

1. Distinguish the fundamental of enzymes properties, nomenclature, characterizes and mechanism
2. Apply biochemical calculation for enzyme kinetics
3. Compare methods for production, purification, characterization and immobilization of enzymes

COURSE OUTLINE

1. **Cereal Production and its Characteristics Introduction**
   - Significance & nature of enzymes, enzyme activity and their role in food, enzymedependency, enzyme in post-harvest
2. **Factors & Enzyme activity**
   - Temperature pH, radiation, pressure & moisture
3. **Enzyme inhibition and activation**
   - Enzyme inhibition & activation, kinetics of inhibition & activation
4. **Enzyme kinetics**
   - Reaction order, michaelis–menten mechanism, product inhibition, specificity
5. **Estimation of Kinetic Constants**
   - Data analysis, effect of experimental error on kinetic analysis,least-squares fit to the michaelis–menten equation
6. **Immobilization**
   - Enzyme localization, compartmentalization, and significance to food quality/Need of immobilization, types and techniques of immobilization

7. **Bioreactors**
    - Types of Bioreactors, kinetic in bioreactors, Design and applications of bioreactors
8. **Enzyme alternates**
    - Sources & applications, regulations; enzyme synthesis, posttranslational modification, genetic engineering, halal Issues
9. **Practical**
    - Enzyme extraction & their application in foods
    - Bioreactors
    - Case studies on enzyme kinetics
    - Immobilization
    - Enzyme alternative extraction & efficiency analysis
    - Enzyme alternates in dairy, meat, and baking industries

SUGGESTED TEACHING & ASSESSMENT METHODS

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

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Ye, I.Q, J. Bao, J.J. Zhong. 2016. Bioreactor Engineering Research and Industrial Applications. Springer, Inc.
2. Najafpour, G.D. 2015. Biochemical engineering and biotechnology. Ed. 2nd Springer.
3. Kudus, M. 2019. Enzyme in food Biotechnology, production, application, and future prospects. Elsevier, NL.

4. Tawfik, D. 2020. Enzyme engineering and evolution: general methods. Elsevier, NL.
5. Yoo, Y.J. 2017. Fundamentals of enzyme engineering. Springer, Inc.

NUTRITION ENGINEERING

Credit Hours: 3+0=3
Pre-Requisites: Nil

DESCRIPTION

The "Nutrition Engineering" course delves into human nutrition fundamentals, exploring macronutrients (water, carbohydrates, fats, proteins), micronutrients (vitamins, minerals), and their digestion and metabolism.

COURSE LEARNING OUTCOMES

1. Interpret and apply nutritional concepts to evaluate and improve the nutritional health of communities
2. Integrate knowledge and skills in food and nutrition with professional issues affecting the nutrition and/or dietetics fields

COURSE OUTLINE

1. **Fundamentals of human nutrition**
    - Introduction: Food, nutrients, nutrition, malnutrition, Diet, balanced diet, foundations of healthydiet, Food groups and meal planning
2. **Macronutrients**
    - Water: Functions, regulation in body, dietary requirements, electrolytes and acid-base balance Carbohydrates:
    - Types, role in body, dietary fiber, bulk and alternative sweeteners, recommended intake and energy value, Fats and oils: types, functions, recommendations concerning fat intake,fat substitutes Proteins: Amino acids, protein synthesis and degradation, classification, functions,quality of proteins, dietary requirements
3. **Micronutrients**
    - Vitamins: Classification, types, sources, role in body & Mineral elements: Types, requirements,sources, role in body
4. **Digestion and metabolism of nutrients**
    - Alimentary tract, digestive juices, secretions, Absorption and metabolism of nutrients: Carbohydrates, protein, lipids, Nutrient and dietary deficiency disorders; special nutrient requirements

5. **Engineered foods for nutrition, health and well being**
    - Development of engineered foods with improved nutritional value, Delivery of functionality through encapsulation and colloidal systems, Designing functional foods with targeted health benefits
6. **Role of engineered foods in gastrointestinal behavior and absorption**
    - Oral processing and food structures, Gastric processing and food structures and Modelling of digestion

SUGGESTED TEACHING & ASSESSMENT METHODS

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

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Cerqueira, M. and L.P. Castro., 2022. Food structure engineering and design for improvednutrition, health and well-being. Elsevier.
2. Galanakis, C.M. 2020. Food structure and functionality. Elsevier
3. Awan, J.A. 2011. Elements of Food and Nutrition. Unitech Communications, Faisalabad,Pakistan.
4. Geissler, C. and H. Powers. 2011. Human Nutrition. 12th Ed. Churchill Livingstone, London,UK and Applications, pp.52-96. USA

POST HARVEST PROCESSING

Credit Hours: 3+0=3
Pre-Requisites: Nil

DESCRIPTION

This subject covers the fundamentals of handling fruits, vegetables, and cereals after harvesting. It explores fruit ripening, the ripening process, and various postharvest treatments affecting quality and storage.

COURSE LEARNING OUTCOMES

1. Illustrate the post harvest processing of fruits and vegetables
2. Demonstrate the use of storage techniques for post harvest processing
3. Use resources to identify problems associated with post harvest processing
4. Imitate experiments to characterize post harvest processing steps

COURSE OUTLINE

1. **Introduction**
   - Production, losses, causes, trade
2. **Fruit Ripening**
   - Changes during ripening, recommended conditions, commercial practices, water loss, respirationactivity; Harvesting and handling methods; Maturity assessment of different fruits and vegetables
3. **Ripening Process**
   - Respiration, climacteric and non-climacteric patterns, pectic substances, ripening conditions;Postharvest physiology of fruits and vegetables
   - Postharvest treatments: coatings, curing, vaporheat treatment, hot water treatment, degreening; Storage: refrigerated, CA, hypobaric, MAS
4. **Packaging**
   - Types, design, modified atmospheric packaging, recycling
5. **Cold Chain**
   - Packing house operations, transportation; Safety and quality of fruits and vegetables

6. Postharvest Technology of Cereals

- Harvesting, threshing, drying, storage and handling; New developments in postharvest technology

SUGGESTED TEACHING & ASSESSMENT METHODS

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

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Brennan, J.G. and Grandison, A.S. eds., 2012. Food processing handbook. John Wiley & Sons.
2. Jongen, W. ed., 2002. Fruit and vegetable processing: Improving quality. Elsevier.
3. Kumari, A. 2013. Post-harvest management of fruits & vegetables, Enkay Pub. House, New Delhi, India.
4. Nirala, V.K. 2011. Harvest technology of the horticultural crops. Vista International Pub. House, Delhi, India.
5. Sahay, K.M. and Singh, K.K., 1996. Unit operations of agricultural processing. Vikas Publishing House Pvt. Ltd.
6. Singh, D.K. 2012. Post harvesting engineering, Oxford Book Co., UK

FOOD PLANT HYGIENE & SANITATION

Credit Hours: 3+0=3
Pre-Requisites: Nil

DESCRIPTION

This course covers the essential aspects of maintaining cleanliness and safety in food processing facilities. It focuses on sanitation standards, regulatory inspections, and facility design to meet sanitation requirements.

COURSE LEARNING OUTCOMES

1. Illustrate the standards used for hygiene improvement
2. Demonstrate the procedures used for hygiene improvement in food industries
3. Use resources to identify issues in hygiene and sanitation
4. Imitate experiments to improve hygiene and sanitation in food processing

COURSE OUTLINE

1. **Food Plant Sanitation and its Requirements**
   - Food Plant Sanitation, Importance of Food Plant Sanitation, Sanitation Standard Operating,Procedures, Sanitation Performance Standards (SPSs)
2. **Regulatory Inspection and Control Action**
   - Inspection, Regulatory Control Action, Recall
3. **Sanitary Facility Design**
   - Principles of Sanitary Facility Design, Other Considerations for Sanitary Equipment Design
4. **Sanitation Best Practices**
   - Responsibilities of Sanitation, Cleaning Process, Sanitizing
5. **Verification of Sanitation**
   - Verification of sanitation, Validation
6. **Employee Good Manufacturing Practices**
   - Rationale for Good Manufacturing Practices (GMPs), Good Manufacturing Practices

7. Pest Control, Sanitation, and Hazard Control

- Pest of Concern to Food Plants, Pest Controls Measures, Chemical and Physical Hazard Control

SUGGESTED TEACHING & ASSESSMENT METHODS

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

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes,
Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Principles of Food Sanitation, 4th ed., Norman G. Marriott, 1999.
2. Sanitation in Food Processing, John A. Troller, 1993. Academic Press

FOOD SAFETY & QUALITY MANAGEMENT

Credit Hours: 3+0=3
Pre-Requisites: Nil

DESCRIPTION

This course covers the scope of food safety, focusing on hazards caused by organisms like bacteria, protozoans, and various toxins from microbial, plant, animal sources. Adulterants such as additives, packaging materials, and toxicants that arise during food processing.

COURSE LEARNING OUTCOMES

1. Describe the basics of food safety & Quality.
2. Apply Food quality management standard in food manufacturing unit
3. Demonstrate an effective HACCP system implementation in food production area.

COURSE OUTLINE

1. History and Overview
   - History and overview of food safety and quality management, Definitions, Scope, Types of foodsafety hazards
2. Food Safety
   - Different types of organisms responsible for food safety issues in food processing: Bacteria and protozoans, Food born toxins, Microbial toxins, Plant and animal toxins, Residual toxins
3. Adulterants
   - Food additives, Packaging materials, Toxicants induced during food processing, Toxicantsinduced from industrial waste

SUGGESTED TEACHING & ASSESSMENT METHODS

Lecturing (audio/video aids)
Written Assignments/ Quizzes
Tutorials
Case Studies relevant to engineering disciplines.
Semester Project
Guest Speaker
Industrial/ Field Visits

Group discussion
Report Writing.

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Shibamoto, Takayuki, and Leonard F. Bjeldanes. Introduction to food toxicology, 2009.
2. Luning, P.A., and W.J. Marcelis. Food quality management: Technological and managerial principles and practices. Wageningen Academic Publishers, 2020.
3. Knechtges, P. Food safety: Theory and practice. Jones & Bartlett Learning, 2012

SEPARATION PROCESSES

Credit Hours: 3+0=3
Pre-Requisites: Nil

DESCRIPTION

This course equips students with critical skills to optimize separation techniques vital in food processing. Covering stages, flow patterns, and phase equilibria, students learn material balance calculations for cascades and absorption effects. Distillation principles including feed location, reflux ratios, and efficiency calculations are extensively covered. It also includes ternary systems using triangular diagrams for solvent extraction, emphasizing mass balances and graphical solutions for stage-to-stage analyses.

COURSE LEARNING OUTCOMES

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

1. Explain the fundamental principles of various separations processes techniques for food industry
2. Analyze multistage separation system for absorption, extraction, distillation, leaching etc.

COURSE OUTLINE

1. **Descriptions of separation processes**
   - Stages, cascades, co- and countercurrent flows
2. **Phase equilibrium**
   - Gas-liquid, liquid-vapour etc. vapour pressures and relative **volatility**
3. **Material balance calculations on separation cascades**
   - Mole fraction and mole ratio coordinates, graphical representation, the operating line
4. **Effect of L/V ratio in absorption**
   - Minimum L/V ratio. Stripping and minimum V/L
5. **Distillation**
   - rectifying and stripping sections: material balances. Constant molal overflow, Balances over top plate/condenser and bottom plate/reboiler,
   - Feed plate location and the q-line. McCabe-Thiele construction.

- Minimum reflux ratio and minimum number of stages: Fenske equation,
- Partial condensers: multiple feed/product streams
- Stage efficiencies and design of plate columns

6. Use of triangular diagrams for ternary systems

- Phase boundaries and tie-lines. Solvent extraction

7. Overall mass balance and sum point

- Stage-to-stage mass balance and difference point. Stagewise graphical solution. Minimum solvent:feed ratio

SUGGESTED TEACHING & ASSESSMENT METHODS

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

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes,
Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Andre B. de Haan, Industrial Separation Processes: Fundamentals, de Gruyter, 2020.
2. Valgfri Geankoplis, Transport processes Separation Process Principles, Pearson, 4. utg, 2014.
3. Gordon Aylward of Tristan Findlay: SI Chemical data, Wiley 7. utg, 2014

MANUFACTURING EXCELLENCE

Credit Hours: 2+0=2
Pre-Requisites: Nil

DESCRIPTION

This course explores operational excellence frameworks, continuous improvement methodologies, and cost reduction strategies.

COURSE LEARNING OUTCOMES

1. Describe how to apply total quality management approach to derive quality excellence
2. Analyze manufacturing systems against best practices
3. Explain various concepts and techniques required for problem solving and process improvement on the shop floor

COURSE OUTLINE

1. **Manufacturing excellence perspectives & strategic approach**
   - The OPEX Framework, Principles, Benefits. Practices & methodologies for operational excellence
   - Continuous Improvement Improving Cross-functional Processes, Finding & Eliminating Wastes,
   - Reducing Costs of Quality (COQ)
2. **Material Flow and its Importance**
   - Material Flow and its Importance, Barriers to Flow, wastes, Inconsistencies, and physical strain. Components of work, Barriers to Flow Three culprits (Wastes, unevenness, overburden), Consequences of barrier to flow.
3. **Managing Projects**
   - Project Pipeline Development and Prioritization, Overview of PM Lifecycle, Project Planning Toolbox – WBS, Gantt Chart, Risk Management etc.
   - Project Execution & Monitoring, Project Closure.
4. **Introduction to 8 Wastes**
   - Overproduction Waste, People Waste, Transportation Waste, Inventory Waste, Motion or Movement Waste, Idle Time Waste, Scrap / Re Work Waste, Excess Processing,8 Waste Example

5. Improvement in Processes

- Continuous Improvement in Processes Better waste management, Zero breakdown time, Higher Safety - Zero Incidents

SUGGESTED TEACHING & ASSESSMENT METHODS

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

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Sandra L Furterer, Douglas C Wood, The ASQ Certified Manager of Quality/Operational Excellence · 2021
2. Ron Basu, Managing Projects in Research and Development 2016

TRANSPORT PHENOMENON

Credit Hours: 3+0=3
Pre-Requisites: Nil

DESCRIPTION

This course covers focuses on the processes related to momentum, energy, and mass transport systems. This course covers the derivation and application of equations governing fluid motion (Navier-Stokes), energy transfer (heat conduction, forced and free convection), and mass movement in binary and multi-component mixtures. Understanding these transport processes is crucial for designing and optimization for food safety, quality, and efficiency in production.

COURSE LEARNING OUTCOMES

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

1. Analyze mechanism of transport processes
2. Formulate conservation statements for steady and unsteady transport processes in food industry.

COURSE OUTLINE

1. **Transfer processes**
   - A review of the mechanisms of momentum, energy, and mass transport.
2. **Momentum transport**
   - Derivation of equations of continuity and motion (Navier-Stokes)
   - Application to laminar flow problems
3. **Energy transport**
   - Derivation of energy equation.
   - Application to heat transfer problems involvingconduction, forced and free convection
4. **Mass transport**
   - Derivation of species conservation equations for binary and multi-componentmixtures.
   - Application to mass transfer problems with and without chemical reaction

5. Transport in turbulent flow

- Fluctuations and time-averaged quantities. Time averaged form of the **governing** equations of momentum, energy, and mass transport. Expressions for the Reynoldsstresses, turbulent energy, and mass flux. Temperature and concentration distribution in turbulentpipe flows

SUGGESTED TEACHING & ASSESSMENT METHODS

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

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Bird, R.B., Stewart, W.E., Lightfoot, E.N., Transport Phenomena, Volume 1, John Wiley and Sons, 2006.
2. Raj, B., Introduction to Transport Phenomena: Momentum, Heat and Mass, PHI Learning Pvt. Ltd., 2012

OCCUPATIONAL HEALTH & SAFETY

Credit Hours: 1+0=1
Pre-Requisites: Nil

DESCRIPTION

This course introduces the student to the study of workplace occupational health and safety. The student will learn safe work practices in offices, industry and construction as well as how to identify and prevent or correct problems associated with occupational safety and health in these locations as well as in the home.

COURSE LEARNING OUTCOMES

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

1. Identify hazards in the home, laboratory and workplace that pose a danger or threat to their safety or health, or that of others.
2. Control unsafe or unhealthy hazards and propose methods to eliminate the hazard.
3. Present a coherent analysis of a potential safety or health hazard both verbally and in writing, citing the Ontario Occupational Health and Safety Regulations as well as supported legislation.
4. Demonstrate a comprehension of the changes created by WHMIS and OSHA legislation in everyday life.

COURSE OUTLINE

1. **Health and Safety Foundations**
    - Nature and scope of health and safety
    - Reasons/benefits and barriers for good practices of health and safety
    - Legal frame work and OHS Management System
2. **Fostering a Safety Culture:**
    - Four principles of safety- RAMP (Recognize, Assess, Minimize, Prepare)
    - Re-thinking safety-learning from incidents
    - Safety ethics and rules
    - Roles and responsibilities towards safety, Building positive attitude towards safety
    - Safety cultures in academic institutions

3. Recognizing and Communicating Hazards:

- Hazards and Risk
- Types of hazards: Physical (mechanical and non-mechanical), Chemical (Toxic and biological agents), Food, fire, construction, heat and temperature, noise and vibration, falling and lifting etc
- Learning the language of safety: Signs, symbols and labels Finding Hazard Information
- Material safety data sheets
- Safety data sheets and the GHS (Globally Harmonized Systems)

4. Accidents & Their Effect on Industry

- Costs of accidents
- Time lost
- Work injuries, parts of the body injured on the job, Chemical burn injuries, Construction injuries, Fire injuries

5. Assessing and Minimizing the Risks from Hazards

- Risk Concept and Terminology
- Risk assessment procedure
- Risk Metric's
- Risk Estimation and Acceptability Criteria
- Principles of risk prevention
- Selection and implementation of appropriate Risk controls
- Hierarchy of controls

6. Preparing for Emergency Response Procedures

- Fire
- Chemical Spill
- First Aid, Safety Drills / Trainings, Firefighting , Evacuation in case of emergency

7. Stress and Safety at Work Environment

- Workplace stress and sources
- Human reaction to workplace stress
- Measurement of workplace stress
- Shift work, stress and safety
- Improving safety by reducing stress
- Stress in safety managers
- Stress and workers compensation

8. Incident Investigation

- Importance of investigation
- Recording and reporting
- Techniques of investigation
- Monitoring
- Review
- Auditing Health and Safety

SUGGESTED TEACHING & ASSESSMENT METHODS

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

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes,
Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. The A-Z of health and safety by Jeremy Stranks, 2006.
2. The Manager's Guide to Health & Safety at Work by Jeremy Stranks, 8th edition, 2006.
3. Occupational safety and health law handbook by Ogletree, Deakins, Nash, Smoak and Stewarts, second edition, 2008.

FOOD BIOCHEMISTRY

Credit Hours: 2+1=3
Pre-Requisites: Nil

DESCRIPTION

This course introduces students to the structure and chemistry of food substances such as carbohydrates, proteins, fats, water, vitamins and enzymes. It also treats the metabolism and chemistry of energy transformations.

COURSE LEARNING OUTCOMES

1. Explain properties and chemical structure of food components, including macro and micronutrients, and their role and interaction in raw food systems and food processing.
2. Describe basics of food additives and its application in food system.
3. Demonstrate the classes and risk associated with food toxins and their control.
4. Participate in lab activities with proper safety measures(PPEs)
5. Imitate experiments for detection and classification of various food components through chemical reactions

COURSE OUTLINE

1. **Basic Concept of Biochemistry**:
   - Overview of cellular structure and process, Lipid and membranes. Acid, base and buffers.
2. **Carbohydrates and its Metabolism:**
   - Structure. Classification, Dietary fibre, Digestion of carbohydrates, Oxidation of glucose (Glycolysis), Citric acid cycle and production of energy.
3. **Lipids:**
   - Structure. Classification, Fatty acids and triacylglycerides, Digestion of lipid, Fatty acid oxidation.
4. **Amino Acids and Protiens:**
   - Classification of amino-acids, Protein structure and functions, Protein digestion and amino acid absorption
5. **Micronutrients:**
   - Vitamins, Minerals elements.
6. **Enzymes:**
   - Structure, Classification, Mechanism of enzymes, application.

7. **Biochemistry of Food:**
   - Biochemistry of fruits, vegetables, meat and poultry.

SUGGESTED TEACHING & ASSESSMENT METHODS

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

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes,
Final Term

Suggested Assessment Methods Practicals

Laboratory Participation
Laboratory Report/Manual
Laboratory Quiz /Viva Voce

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Nelson DL and Cox MM, 2012. Lehninger Principles of Biochemistry. 6th Edition; WH Freeman, New York. (available at www.ncbi.nlm.nih.gov)
2. Fatih Yildiz, 2017 Advances in Food Biochemistry. First Edition; CRC Press
3. Stryer et al., 2006. Biochemistry. 6th Edition; WH Freeman, New York. (available at www.ncbi.nlm.nih.gov)
4. Voet D and Voet TG, 2008. Biochemistry. Fourth Edition; John Wiley and Sons, New York.
5. Nollet, L. M., Toldrá, F., Benjakul, S., Paliyath, G., & Hui, Y. H. (2012). Food biochemistry and food processing. John Wiley & Sons.

******List of Electives -II for Food Engineering**

- Renewable Energy Resources
- Environmental Engineering
- Waste Management
- Any other relevant course decided by the HEI as per requirement

ELECTIVE-II

RENEWABLE ENERGY RESOURCES

Credit Hours: 2+0=2
Pre-Requisites: Nil

DESCRIPTION

Students pursuing renewable energy courses will equip themselves with a comprehensive understanding of all the natural resources.

The Renewable Energy course will deal with the study of renewable sources like natural resources, sunlight, geothermal heat, wind, or hydro power.

COURSE LEARNING OUTCOMES

1. Describe renewable energy sources and their potential
2. Explain industrial and renewable technologies for energy production

COURSE OUTLINE

1. Introduction a. Fundamentals of renewable energy resources b. Utilization of renewable energy resources
2. Solar Energy a. Solar radiation and its measurement b. Solar thermal energy collectors c. Solar thermal energy conversion systems d. Solar photovoltaic system
3. Wind energy a. small hydropower b. Electric power generation by ocean energy
4. Biomass energy a. Fuel cells b. Biomass gasification c. Liquid bio-fuel /biodiesel.
5. Wind Power a. Wind energy potential b. Vertical and horizontal axis wind mills c. Wind operated pumps and water lifts d. Other applications of wind power in agriculture.
6. Energy and Environment a. Energy for crop production b. Dairy farming c. Poultry farming d. Energy consumption for waste water treatment and solid wastes e. Energy conservation for Greenhouse effect g. Energy dissipation through industrial and engine emissions and their impact on environment.

SUGGESTED TEACHING & ASSESSMENT METHODS

Lecturing (audio/video aids
Written Assignments/ Quizzes
Tutorials

Case Studies relevant to engineering disciplines.
Semester Project
Guest Speaker
Industrial/ Field Visits
Group discussion
Report Writing.

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Assessment Methods Practicals

Laboratory Participation
Laboratory Report/Manual
Laboratory Quiz /Viva Voce

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Boyle, G. Renewable Energy: Power for a Sustainable Future. 3rd ed. OUP Oxford, 2012.
2. Kishore, V.V.N. Renewable Energy Engineering and Technology: Principles and practice. The Energy and Resources Institute (TERI), 2009.
3. Kalogirou, S.A. Solar Energy Engineering: Processes and Systems. 1st ed. British Library, 2009.
4. Viswanathan, B. and Scibioh, M.A. Fuel Cells: Principles and Applications. Taylor & Francis Group, 2007.
5. Boyle, G., Everett, B. and Ramage, J. Energy Systems and Sustainability. 2nd ed. OUP and Open University, 2004.

ENVIRONMENTAL ENGINEERING

Credit Hours: 2+0=2
Pre-Requisites: Nil

DESCRIPTION

Environmental Engineering deals with the development and enhancement of infrastructure that prevents the contamination and degradation of natural resources, like air, water, land, etc. It includes concepts from other disciplines, such as Chemistry, Biology, Ecology, Hydrology, and Economics.

COURSE LEARNING OUTCOMES

1. Apply multidisciplinary approaches including engineering, chemistry, mathematics, physics, geosciences, and biology to manage the unique challenges and balance the competing social, political, economic, and technical goals of environmental problems and solutions.
2. Demonstrate mastery of core social science concepts and methods as they pertain to environmental problem-solving

COURSE OUTLINE

Environmental Monitoring (Air, Water & Soil), Objectives of sampling and monitoring programme. Design and types of samples; pre-sampling requirements/information, sampling and design purposes, Pollution Concept, Types of Pollution, air pollution control technologies, water pollution control technologies, water treatment technologies, soil pollution control technologies, noise pollution control technologies, Biotechnology for environment, industrial pollution control, Occupational safety devices.

Principles and purposes of IEE and EIA: Significance for the society. Cost and benefits of EIA. Main stages in EIA process. Public consultation and participation in EIA process. EIA methods and techniques for impact prediction and evaluation.

SUGGESTED TEACHING & ASSESSMENT METHODS

Lecturing (audio/video aids
Written Assignments/ Quizzes
Tutorials
Case Studies relevant to engineering disciplines.
Semester Project
Guest Speaker

Industrial/ Field Visits
Group discussion
Report Writing.

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Assessment Methods Practicals

Laboratory Participation
Laboratory Report/Manual
Laboratory Quiz /Viva Voce

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Masters, G.M. and W.P. Ela. Introduction to Environmental Engineering and Science, third edition, 2007, published by Pearson Education.
2. Mackenzie Davis, and David Cornwell, Introduction to Environmental Engineering, Fifth Edition, 2006, McGraw-Hill.
3. Mackenzie L. Davis, and Susan J. Masten, Principles of Environmental Engineering and Science, Third Edition, 2002, McGraw-Hill

WASTE MANAGEMENT

Credit Hours: 2+0=2
Pre-Requisites: Nil

DESCRIPTION

The main goal of this waste management course is to enlighten the essential principles entailed in the management of society's waste in a manner that meets public health and environmental concerns as well as taking into consideration the public desire to reuse and recycle waste materials

COURSE LEARNING OUTCOMES

1. Explain the hierarchical structure in solid waste management and a requirement for an integrated solution.
2. Examine the technical points that are required to set up a solid waste management system.
3. Apply the legal legislation related to solid waste management.

COURSE OUTLINE

- **Introduction:** Food industrial wastes, Liquid and solid waste from food processing operations, Waste disposal, Characterization, Regulatory aspects of waste management.
- **Waste prevention and reduction:** Water conservation in food processing, Maintaining sanitary conditions of water, Waste control considerations
- **Food waste disposal techniques:** Guidelines for design, Construction, Operation, Monitoring, Remedial actions, and closure oflandfills
- **Waste treatment of Food Industries:** Physical, chemical and biological treatments of waste, Waste utilization from food industries: Sugar industry, Fruits & Vegetables, Meat & poultry, Fish, Oil & Fats, Dairy industry, Cerealindustry

SUGGESTED TEACHING & ASSESSMENT METHODS

Written Assignments/ Quizzes
Tutorials
Case Studies relevant to engineering disciplines.
Semester Project
Guest Speaker

Industrial/ Field Visits
Group discussion
Report Writing.

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes,
Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Worrell, W., & Vesilind, P. Solid waste engineering, SI Version. Nelson Education, 2011.
2. Wang, Lawrence K., Mu-Hao S. Wang, Yung-Tse Hung, Nazih K. Shammas, and Jiaping Paul Chen, eds. Handbook of advanced industrial and hazardous wastes management. Vol. 7. CRC press, 2017.
3. Tchobanoglous, George, and Frank Kreith. Handbook of solid waste management. McGraw- Hill Education, 2002.
4. Cheremisinoff, Nicholas P. Handbook of solid waste management and waste minimization technologies. Butterworth-Heinemann, 2003

ENGINEERING DRAWING & GRAPHICS

Credit Hours: 1+1=2
Pre-Requisites: Nil

DESCRIPTION

This course focuses on developing skills in technical drawing and graphical representation relevant to the field. It covers principles of engineering graphics, including orthographic projections, isometric drawings, dimensioning, and tolerancing.

COURSE LEARNING OUTCOMES

1. Describe basics of engineering drawing and able to draw projections of 3D models
2. Explain 2D and 3D models by using modern tools and commands

COURSE OUTLINE

1. Introduction to Computer Aided Drafting

- Introduction to the Engineering design process
- Technical Graphics basics
- Orthographic projection and Isometric drawings
- Basic concepts of conventional engineering drawings
- Opening a new drawing, paper setting, coordinate systems: User's coordinate system (UCS)
- Cartesian coordinates Polar coordinates; saving a drawing.
- Apply the Commands: Grid, Ortho, Escape, Erase, Trim, Undo, Draw Lines, Circles, Ellipse, Rectangle and Arcs.

2. Creating Elementary Objects

- Apply the Commands: Grid, Ortho, Escape, Erase, Trim, Undo, Draw Lines, Circles, Ellipse, Rectangle and Arcs.

3. Basic Object Editing

- Apply the following commands: Move, offset, rotate, fillet, chamfer, array and mirror.

4. Dimensioning

- Show the following dimensioning: Linear, aligned, radial and changing dimensional setting.

5. Solid Modeling

- Apply the following commands to create 3-D models: Region, extrude, revolve, slice and show plan; elevation and end view of a 3-D model.

6. Controlling Drawings

- Apply the following commands for a given drawing: Hatching, coloring and rendering.

7. Text

- Apply the following commands on the given drawing: Creating text, style of text and changing text properties.

8. Plotting Drawings

- Apply the following commands: Plotting, print preview and printing.

SUGGESTED TEACHING & ASSESSMENT METHODS

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

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Assessment Methods Practicals

Laboratory Participation
Laboratory Report/Manual
Laboratory Quiz /Viva Voce

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Engineering Design Graphics with AutoCAD; James H. Earle, 12th ed. 2007, Addison Wesley.

2. Technical Graphics Communication; Gary Robert Bertoline, Eric N Wiebe, Nathan W. Hartman, William A. Ross, 4th ed. 2008, McGraw Hill.
3. AutoCAD 2008: A Problem Solving Approach; Sham Tickoo, 1st ed. 2007, Autodesk Press.

ENGINEERING MECHANICS

Credit Hours: 2+0=2
Pre-Requisites: Nil

DESCRIPTION

This course covers the principles of mechanics and their application to engineering problems. It provides a fundamental understanding of forces and motions affect the behavior of structures and materials within the food industry. Topics covers Newton's laws of motion, equilibrium, forces, momentum, stress, and strain.

COURSE LEARNING OUTCOMES

1. Define different theoretical concepts related to engineering mechanics
2. Explain concepts related to motion of a particle or a system of particles acted upon forces or a rigid body acted upon by forces and moments.
3. Apply the method of work and energy, impulse and momentum to problem model as a single particle, system of particles and a rigid body
4. Imitate and practice experiment under guidance / supervision

COURSE OUTLINE

1. **Introduction**
   - General principles; units of measurement
2. **Force Vectors**
   - Addition of vectors
   - Cartesian vectors, free vector, position vectors
   - Force directed along a line
3. **Equilibrium of a Particle**
   - Conditions for the equilibrium
   - Free body diagram; 3D force systems; force system resultants; moment of force
   - Virognon's theorem; cross product; moment of a couple; equivalent systems
4. **Equilibrium of a Rigid Body**
   - Equilibrium in 2D and 3D, constrains for a rigid body
   - Redundant and improper constraints

5. **Friction**
   - Types of friction, angle of repose, application of friction
6. **Kinematics of a Particle**
   - Rectilinear motion, curvilinear motion, motion of projectile
   - Absolute dependent motion of two particles
7. **Kinetics of a Particle**
   - Equation of motion for a system of particle, equation of motion in rectangular, cylindrical, normal and tangential coordinates, principles of work and energy for a system of particles
   - Linear momentum, conservation of momentum, impact, angular momentum; kinematics of a rigid body, translation, rotation

SUGGESTED TEACHING & ASSESSMENT METHODS

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

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes,
Final Term

Suggested Assessment Methods Practicals

Laboratory Participation
Laboratory Report/Manual
Laboratory Quiz /Viva Voce

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Engineering Mechanics Statics; R. C. Hibbeler, 11th ed. 2007, Pearson Prentice Hall.
2. Engineering Mechanics Dynamics; R. C. Hibbeler, 11th ed. 2007, Pearson Prentice Hall.

FOOD REGULATIONS & LEGISLATIONS

Credit Hours: 2+0=2
Pre-Requisites: Nil

DESCRIPTION

This course includes Pakistan's standards and quality control authority, the Pure Food Rules' enforcement and amendments, food adulteration detection methods, labeling perspectives and laws with regulations for implementation.

COURSE LEARNING OUTCOMES

1. Demonstrate Pakistan standards (Food) and Halal FSMS along with their implementation in food industry
2. Describe the ISO 22000 FSMS and Codex Alimentarius with some examples related to their application in food processing facility.
3. Explain major food regulatory agencies both local and international which deals with food regulations and Legislation.

COURSE OUTLINE

1. **Pakistan Standards**
   - Standards and Quality Control Authority: functions
2. **Pure Food Rules**
   - Background, definitions, significant features, enforcement, amendments; Food inspector and public analyst: qualifications, duties, powers
3. **Food Adulteration**
   - Adulterants, health hazards, methods of detection
4. **Food Labelling**
   - Perspectives on nutrition labeling; Islamic food laws and regulations: sources, principles, lawful foods, unlawful foods; Consumer laws in Pakistan
5. **International Food Laws**
   - Introduction; The World Trade Organization (WTO) - the agreement on the application of sanitary and phytosanitary measures; GATT; Codex Alimentarius: general, procedural manual, standards, codes, legal force

- Food Laws implementation, role and legal aspects of provincial Food authorities

SUGGESTED TEACHING & ASSESSMENT METHODS

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

Suggested Assessment Methods Theory

Mid-term
Report writing/ Presentation, Assignments, Project Report, Quizzes,
Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. The manual of food laws. Mobin ahmed siddiqui,2016
2. Islamic codex alimentarius. Awan ja 1992. Sci. Tech. In islamci world 10(1): 7-18
3. International standards for food safety. Rees n and watson d. 2000. Kluwer sci pub, new york.

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,l.,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