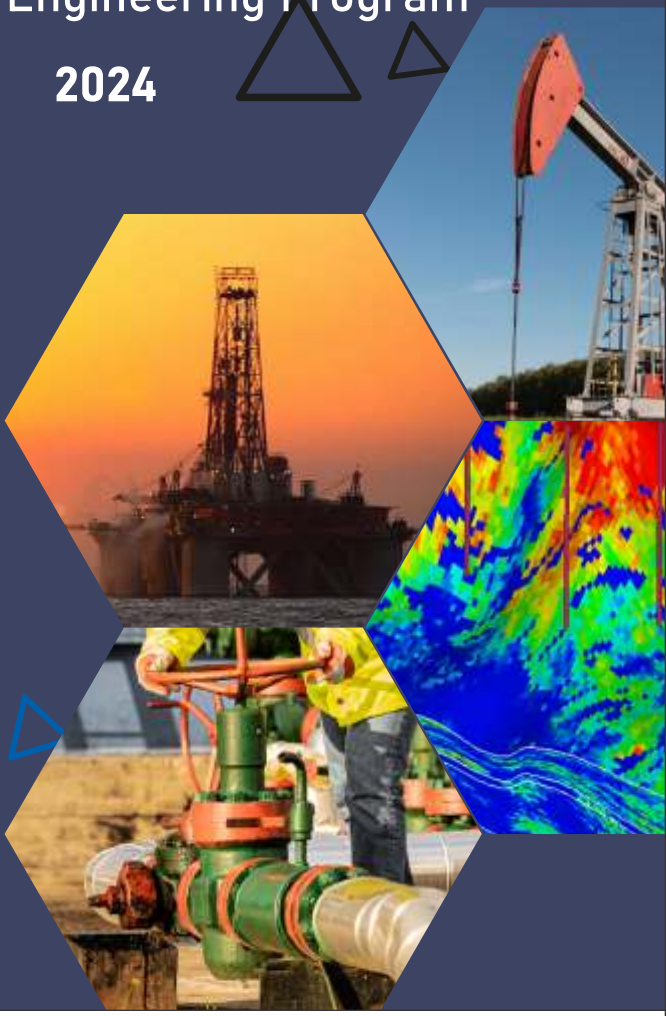
Curriculum for

PETROLEUM AND GAS ENGINEERING

Bachelor of Engineering Program

2024



Pakistan Engineering Council
&
Higher Education Commission
Islamabad

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Contents

PREFACE

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

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

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

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

This curriculum document would serve as a guideline whereas allowing HEIs to tame/ change within the framework by introducing courses in support of local/ required industrial demand as well as satisfying the revised 11 GAs (Graduate Attributes) and 13 PCs (Professional 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 11th 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 (R) Javed Mahmood Bukhari Convener (ECRDC-Main)/ Member PEC Governing Body/ Rector NUST, Islamabad	Convener
2.	Engr. Prof. Dr. Altaf Mukati Vice President (Academics) SZABIST University, Karachi	Dy. Convener
3.	Engr. Prof. Dr. Bhawani Shankar Chowdhry, PEC Governing Body / Prof. Emeritus /Advisor MUET, Jamshoro	Member
4.	Engr. Prof. Dr. Shahid Khattak Convener, Elect Engg. & Allied Disciplines	Member
5.	Engr. Prof. Dr. Ehsan Ullah Khan Kakar Convener, Civil Engg. & Allied Disciplines	Member
6.	Engr. Prof. Dr. Syed Mushtaq Shah Convener, Mechanical Engg. & Allied Disciplines	Member
7.	Engr. Prof. Dr. Amanat Ali Bhatti Convener, Metallurgy & Materials, Mining, Petroleum & Gas Engg. and 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

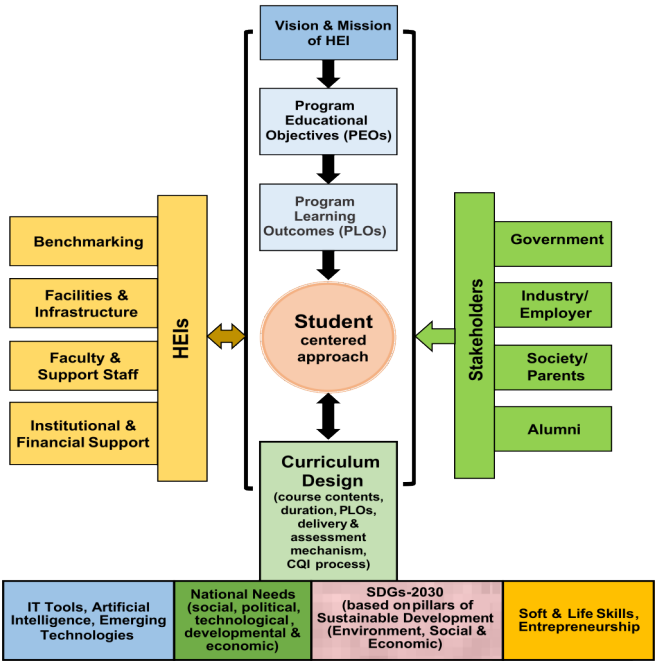
2. ECRDC Agenda

- 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

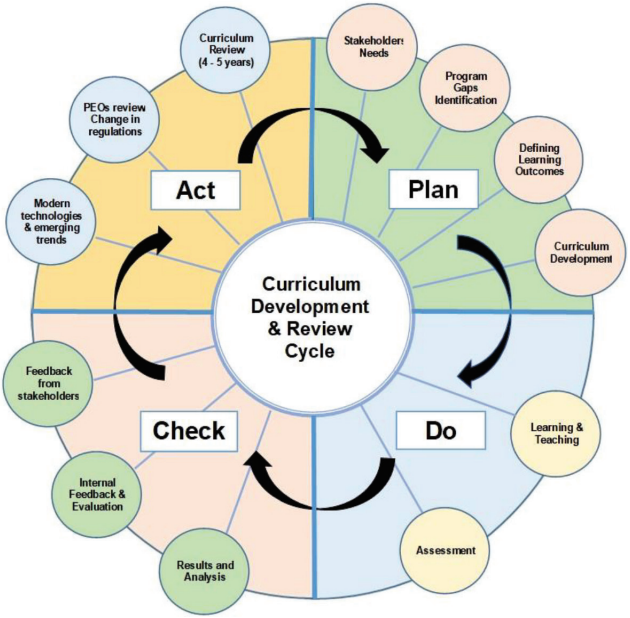
Outcome Based Education (OBE) is an approach of teaching and learning that focuses on what students should be able to attain at the end of the educational program. OBE is a student's centered system which concerns what the students will know and be able to do as learning outcomes. The curriculum development 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 Metallurgy & Materials, Mining & Petroleum and Gas Engineering Disciplines

The PEC Engineering Curriculum Review and Development Committee (ECRDC) of Metallurgy & Materials, Mining & Petroleum and Gas Engineering Disciplines took up the task to review and update the curriculum for the BE Metallurgical and Materials Engineering degree program. The subject Committee had conducted several meetings besides multiple sessions of Sub-Groups and the concluding meeting of ECRDC (Metallurgy & Materials, Mining & Petroleum and Gas Engineering Disciplines) was conducted on 17-18 May, 2024 at PEC Head Office Islamabad. The Committee consisted of following members:

1.	Engr. Prof. Dr. Amanat Ali Bhatti Convener, Materials, Metallurgical, Mining and Petrogas & Allied Disciplines	Convener Sub-Group ECRDC
2.	Engr. Abdullah Shahwani Member PEC Governing Body/ DG Mines & Minerals Department, Balochistan	Member
3.	Engr. Muhammad Raza Chohan Member PEC Governing Body/ Advisor (Academics & Accreditation)/ Nominee of HEC	Member
4.	Engr. Dr. Khan Gul Jadoon Professor, Karakoram International University, Gilgit	Co-opted Member
5.	Engr. Dr. Muhammad Khurram Zahoor Chairman and Professor, University of Engineering & Technology, Lahore	Co-opted Member
6.	Engr. Dr. Muhammad Asif Rafiq Professor, University of Engineering & Technology, Lahore	Co-opted Member
7.	Engr. Dr. Ibrahim Qazi Professor, Institute of Space Technology, Islamabad	Co-opted Member

8.	Engr. Dr. Abdul Haque Tunio Professor, Mehran University of Engineering & Technology, Jamshoro	Co-opted Member
9.	Engr. Dr. Syed Wilayat Hussain Professor, Institute of Space Technology, Islamabad	Co-opted Member
10.	Engr. Dr. Gul Hameed Awan Professor, University of Engineering & Technology, Lahore	Co-opted Member
11.	Engr. Dr. Muhammad Imran Khan Assistant Professor, Ghulam Ishaq Khan Institute of Engineering Sciences and Technology, Swabi	Co-opted Member
12.	Engr. Dr. Fahad Irfan Siddiqui Associate Professor, Mehran University of Engineering & Technology, Jamshoro	Co-opted Member
13.	Engr. Dr. Ishaq Ahmad Associate Professor, University of Engineering & Technology, Peshawar	Co-opted Member
14.	Engr. Dr. Tahir Ahmad Professor, University of the Punjab Lahore	Co-opted Member
15.	Engr. Muhammad Kashif Asst. Manager Engineering Quality (Quality Assurance), Atlas Honda Lirnited, Lahore	Co-opted Member
16.	Engr. Niaz Ahmed Sr. Additional Registrar/ HoD-EAD	Secretary ECRDCs
17.	Engr Osaf Mahmood Malik Section Head (Curriculum & Development)	Additional Registrar-EAD
18.	Engr. Syed Haider Abbas Bokhari	Assistant Registrar-EAD

19.	Engr. Muhammad Junaid Khan	Assistant Registrar-EAD
20.	Mr. Muhammad Irfan	Office Superintendent -EAD

Sub-Group Petroleum and Gas Engineering

1.	Engr. Dr. Muhammad Khurram Zahoor Chairman and Professor, UET Lahore	Lead Sub-Group
2.	Engr. Dr. Amanat Ali Bhatti PEC Governing Body/ Professor UET Lahore	Member
3.	Engr. Dr. Abdul Haque Tunio Professor, MUET Jamshoro	Member
4.	Engr. Dr. Javed Haneef Chairman, Department of Petroleum Engineering, NED UET, Karachi	Member
5.	Engr. Dr. Ubedullah Ansari Assistant Professor, Institute of Petroleum & Natural Gas Engineering, MUET, Jamshoro	Member
6.	Engr. Dr. Imtiaz Ali Assistant Professor, Department of Petroleum and Gas Engineering, BUITEMS, Quetta	Member
7.	Engr. Zaid Ashraf General Manager, Reservoir Management Department, OGDCL, Islamabad	Member
8.	Engr. Muhammad Farhan Idrees Senior Engineer Production, Pakistan Petroleum Limited, Lahore	Member

9.	Engr. Dr. Arshad Shehzad Ahmad Shahid Assistant Professor, Petroleum & Gas Engineering Department, UET, Lahore	Member/ Secretary Sub-Group

The ECRDC Metallurgy & Materials, Mining & Petroleum and Gas Engineering Disciplines appreciated the extraordinary efforts and contribution of Engr. Dr. Amanat Ali Bhatti (Convener), Engr. Dr. Muhammad Khurram Zahoor (Lead Sub-Group), Engr. Dr. Arshad Shehzad Ahmad Shahid (Member Sub-Group) & Engr. Osaf Mahmood Malik (Section Head Curriculum & Development) for compilation of course contents and proof reading of this curriculum booklet.

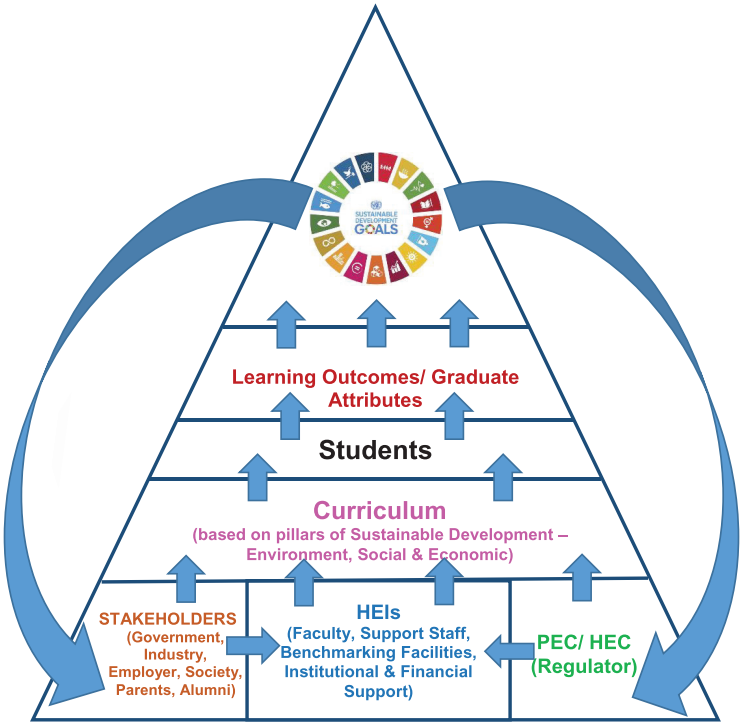
6. Agenda of ECRDC for Metallurgy & Materials, Mining & Petroleum and Gas Engineering Disciplines

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

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

- Goal-1: No Poverty
- Goal-2: Zero Hunger
- Goal-3: Good Health and Well-being

- Goal-4: Quality Education
- Goal-5: Gender Equality
- Goal-6: Clean Water and Sanitation
- Goal-7: Affordable and Clean Energy
- Goal-8: Decent Work and Economic Growth
- Goal-9: Industrial Innovation and Infrastructure
- Goal-10: Reduced Inequalities
- Goal-11: Sustainable Cities and Communities
- Goal-12: Responsible Consumption and Production
- Goal-13: Climate Action
- Goal-14: Life Below Water
- Goal-15: Life on Land
- Goal-16: Peace, Justice and Strong Institution
- Goal-17: Partnerships for the Goals



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

7. Attainment of Graduate Attribute and Professional Competencies

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

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

7.1 Knowledge and Attitude Profile

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

- **WK1:** A systematic, theory-based understanding of the **natural sciences** applicable to the discipline and awareness of relevant **social sciences.**

- **WK2:** Conceptually-based **mathematics, numerical analysis, data analysis, statistics** and formal aspects of **computer and information science** to support detailed analysis and modelling; applicable to the discipline.

- **WK3:** A systematic, theory-based formulation of **engineering fundamentals** required in the relevant engineering discipline.

- **WK4: Engineering specialist knowledge** that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.

- **WK5:** Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports **engineering design and operations** in a practice area.

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

in the engineering discipline.

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

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

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

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

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

The engineering curriculum is the most important instrument for grooming the students based on 11x Graduate Attributes (GAs) encompassed under the Program Learning Outcomes (PLOs). Program outcomes are the narrower statements that describe what students are expected to know and be able to do at the time of graduation. These PLOs mainly relate to the knowledge, skills and attitude that the students acquire while progressing through the program. Specifically, it is to be demonstrated that the students have acquired the defined GAs. The program must demonstrate that by the time of graduation, the students have attained a certain set of knowledge, skills and behavioral traits, at-least to some acceptable minimum level. This minimum threshold value (i.e., KPI for PLO attainment) should not be less than 50% even to begin with; however, as the program progresses through its evolution, it is expected that this minimum threshold value would subsequently be raised to higher values through program's CQI. Specifically, it is to be demonstrated that all students of a batch to be accredited have acquired the following graduate attributes (GAs) set according to the revised framework of International Engineering Alliance (IEA) version-4.0:

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

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

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

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

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

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

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

- **PLO-8 Individual and Collaborative Team Work:** Function effectively as an individual, and as a member or leader in diverse and inclusive teams and in multi-disciplinary, face-to-face, remote and distributed settings (WK-9).

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

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

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

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

7.3 Professional Competence Profiles

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

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

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

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

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

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

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

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

- **EC7 Legal, regulatory, and cultural**: Meet all legal, regulatory, and cultural requirements and protect public health and safety in the course of all Engineering activities.
- **EC8 Ethics**: Conduct Engineering activities ethically.
- **EC9 Manage engineering activities**: Manage part or all of one or more complex Engineering activities.
- **EC10 Communication and Collaboration**: Communicate and collaborate using multiple media clearly and inclusively with a broad range of stakeholders in the course of all Engineering activities.
- **EC11 Continuing Professional Development (CPD) and Lifelong learning**: Undertake CPD activities to maintain and extend competences and enhance the ability to adapt to emerging technologies and the ever- changing nature of work.
- **EC12 Judgement**: Recognize complexity and assess alternatives in light of competing requirements and incomplete knowledge. Exercise sound judgement in the course of all complex Engineering activities.
- **EC13 Responsibility for decisions**: Be responsible for making decisions on part or all of complex Engineering activities.

The professional competence profiles are stated generically and are applicable to all engineering disciplines. The application of a competence profile may require amplification in different regulatory, disciplinary, occupational or environmental contexts. In interpreting the statements within a particular context, individual statements may be amplified and given particular emphasis but must not be altered in substance or ignored.

8. Mapping of Bachelors of Engineering Program with UN SDGs

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

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

Therefore, the UN SDGs have been considered in curriculum design (Figure 2). The Bachelors of Engineering Program may be mapped with the UN SDGs keeping in mind its curriculum, other pre-requisites (if any) e.g. survey camp, internship, community service etc., co- and extra- curricular activities as well as the HEI's charter (having emphasis on the particular program). The mapping can be done (through the key phrases in SDGs) on the basis of low, medium and/or high emphasis as well as direct/indirect relevance. The non-exhausted list of considered key phrases of UN SDGs for the purpose of mapping is available in Annexure A (Note: HEI may get it shortened or lengthened as per the need of the respective engineering program).

The purpose of emphasizing the SDGs is to (i) join hands with the Provincial/ Federal government in playing their effective role from HEI point of view and (ii) to educate/aware the student population about the challenges of the world to be overcome in their professional careers with the help of these UN SDGs.

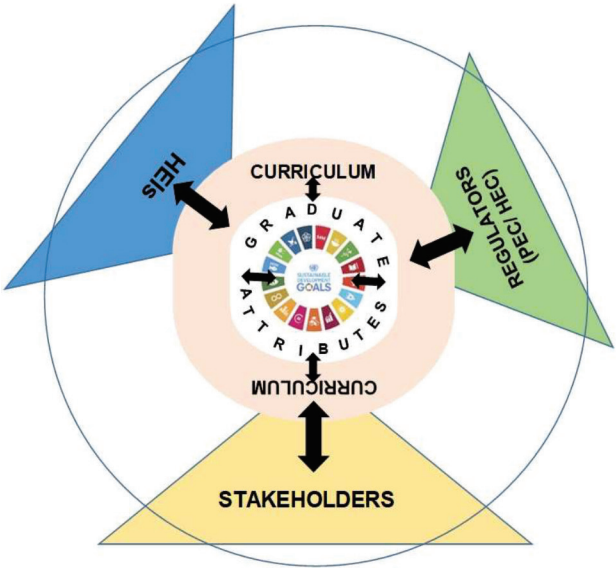


Figure 2: Consideration of UN SDGs in curriculum design

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

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

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

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

As an example, the following engineering and non-engineering courses titles have been mapped with the UN SDGs for the guidance purpose (Annexure – B):

- Fundamentals of Petroleum Engineering
- Petrophysics
- Sociology for Engineers

HEI is expected to design the mapping considering the designed 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
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 appropriatenessof 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 in and diversity of team	**EC-10** Communication and Collaboration	**WK-9** **Ethics, inclusive behavior and conduct**	SDG- 5, 10, 16
PLO-9 **Communication:** Level of communication according to type 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: Min. 38 Credit Hours
    - o Engineering Domain: Min. 72 Credit Hours
    - o FYDP/ Capstone Project: 06 Credit Hours
    - o Multidisciplinary Engineering Courses: Min. 06 Credit Hours
    - o HEIs have flexibility of 08-14 Credit Hours to add courses either in Engineering, Non-Engineering or both Domains to fulfill the program objectives in line with the overall Vision/ Mission of the Institute concerned.
- **Number of Weeks per Semester**: 15 - 18
- **Number of Credit Hours per Semester**: 15 - 18

The curriculum matrix covering the defined knowledge and attitude profiles should therefore be composed of non-engineering domain (humanities, math, management and natural sciences), and engineering domain with Petroleum and Gas 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 (Languages or study of religion)	2
		Social Science	*** Social Science	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	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	Multidisciplinary Engg Courses		Specific to Program Objectives and outcome	6
			Occupational Health and Safety (Mandatory 01 credit hours)	
WK-4/ WK-5/ WK-6/ WK-7/ WK-8/ WK-9	Final Year Design Project (FYDP)/ Capstone	Integration of innovative, creative, technical, management and presentation skills of a graduate towards final year.		6

WK-6/ WK-7/ WK-9	Industrial Training	Internship (06-08 Weeks)	Mandatory & Qualifying
WK-2/ WK-4/ WK-5/ WK-6/ WK-7/ WK-8	**Innovative and Critical Thinking (under relevant courses):** - Complex Problem Solving - Complex Engineering Activities - Semester Project - Case Studies - Open Ended Labs - Problem-Based Learning (PBL)		
	(Flexible Engineering/ Non-Engineering) Courses may be adjusted as per the requirements		8-14
		Total (Credit Hours)	**130-136**

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

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

*** PEC ECRDC designed courses.

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

- Selection of internship in line 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 Petroleum and Gas 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 Petroleum and Gas 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-7,	**Humanities**	English	Functional English **	3	0	3	**6**
			Expository Writing **	3	0	3	
		Culture	Islamic Studies/ Ethics **	2	0	2	**6**
			Ideology and Constitution of Pakistan **	2	0	2	
			Arts and Humanities Elective*	2	0	2	
		Social Sciences	Civics and Community Engagement **	2	0	2	**4**
			Social Sciences Elective***	2	0	2	
	Computer Sciences	Basic Computing	Applications of ICT **	2	1	3	**3**
WK-9,	**Management Sciences**	Professional Practice	Entrepreneurship **	2	0	2	**4**
			Project Management **	2	0	2	
WK-2/, WK-1	**Natural Sciences**	Mathematics	Calculus	3	0	3	**12**
			Vector and Complex Analysis	3	0	3	
			Differential Equations and Transforms	3	0	3	
			Numerical Methods	3	0	3	
		Natural Sciences	Applied Physics	2	1	3	**6**
Total (General Education/ Non-Engineering Domain)				**36**	**2**	**38**	**38**

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

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

*** PEC ECRDC designed courses.

Knowledge Profile (WK-1 to WK-9)	Knowledge Area	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 Sciences**	ICT/AI/ Data Science/ Programming	Introduction to Computer Programming for Data Science	2	1	3	**6**
			Machine Learning	2	1	3	
WK-2/, WK-3	**Engineering Foundation**		Fundamentals of Petroleum Engineering	3	0	3	**23**
			Petroleum Geology & Geophysical Prospecting	3	0	3	
			Applied Geology	2	1	3	
			Engineering Drawing & Graphics	0	1	1	
			Workshop Practice	0	1	1	
			Strength of Materials	2	1	3	
			Applied Thermodynamics	2	1	3	
			Fluid Mechanics	2	1	3	
			Electrical Engineering and Electronics	2	1	3	
WK-1/, WK-2/, WK-4	**Major Based Core (Breadth)**		Petrophysics	2	1	3	**22**
			Drilling Engineering-I	3	1	4	
			Properties of Reservoir Fluids	2	1	3	
			Reservoir Engineering	3	1	4	
			Petroleum Production Engineering-I	3	1	4	
			Natural Gas Processing and Transportation	3	1	4	

WK-5/, WK-6	**Major Based Core (Depth)**		Drilling Engineering-II	3	1	4	**22**
			Well Logging and Interpretation	2	1	3	
			Principles of Reservoir Simulation	2	1	3	
			Reservoir Management	3	1	4	
			Petroleum Production Engineering-II	3	1	4	
			Principles of Enhanced Oil Recovery	3	1	4	
WK-1/, WK-2/, WK-3/, WK-4	**Multi-Disciplinary Engineering**		Reservoir Geomechanics	2	0	2	**6**
			Field Operations in Petroleum Engineering	3	0	3	
			Occupational Health and Safety	1	0	1	
WK-6/, WK-7/, WK-8	**Final Year Design Project (FYDP)/ Capstone**	Industrial/ Innovative/ Creative Project	FYDP (Part-I)	0	3	3	**6**
			FYDP (Part-II)	0	3	3	
			Total (Engineering Domain)	**66**	**19**	**85**	**85**
WK-6/ WK-7	**Industrial Training**	6-8 weeks industrial training mandatory (Non- Credit)				**Mandatory & Qualifying**	
	Flexible Engineering / Non-Engineering Courses		Well Testing and Analysis	2	1	3	**13**
			Natural Science Elective-I	2	1	3	
			Flexible Elective-II	2/3	1/0	3	
		Maximum Four (04) credit hour course (s) duly approved by HEI's Statutory Bodies can be offered under flexible Engineering & Non-Engineering Category.		4	0	4	
			Total (Flexible Domain)	**10/ 11**	**3/2**	**13**	**13**
			Total (Credit Hours)			**136**	

Note:

1. Credits of Holy Quran Translation (QT), Sirat-ul-Nabi (Peace Be Upon Him) and any elective of multidisciplinary / Interdisciplinary courses will be allowed as over and above 136 Cr. Hrs. after necessary approval of relevant forum of HEI.
2. The above-mentioned Framework, Curriculum and Scheme of Studies are for guideline purposes to HEIs in Pakistan.

12. Scheme of Studies for Bachelor of Petroleum and Gas Engineering Curriculum

1st Year				
First Semester				
Sr. No	**Course Title**	**(Credit Hours)**		**Total Credit Hours**
		Theory	**Lab**	
1.	Fundamentals of Petroleum Engineering	3	0	3
2.	Applications of ICT	2	1	3
3.	Functional English	3	0	3
4.	Islamic Studies/ Ethics	2	0	2
5.	Calculus	3	0	3
6.	Applied Geology	2	1	3
	Total	**15**	**2**	**17**

Second Semester				
Sr. No	**Course Title**	**(Credit Hours)**		**Total Credit Hours**
		Theory	**Lab**	
1.	Vector and Complex Analysis	3	0	3
2.	Petroleum Geology & Geophysical Prospecting	3	0	3
3.	Introduction to Computer Programming for Data Science	2	1	3
4.	Applied Physics	2	1	3
5.	Workshop Practice	0	1	1
6.	Engineering Drawing & Graphics	0	1	1
7.	Natural Sciences Elective-I ***	2	1	3
	Total	**12**	**5**	**17**

2nd Year				
Third Semester				
Sr. No	**Course Title**	**(Credit Hours)**		**Total Credit Hours**
		Theory	**Lab**	
1.	Occupational Health and Safety	1	0	1
2.	Petrophysics	2	1	3
3.	Drilling Engineering-I	3	1	4
4.	Arts & Humanities Elective*	2	0	2
5.	Strength of Materials	2	1	3
6.	Electrical Engineering and Electronics	2	1	3
7.	Civics and Community Engagement	2	0	2
	Total	**14**	**4**	**18**

Fourth Semester				
Sr. No	**Course Title**	**(Credit Hours)**		**Total Credit Hours**
		Theory	**Lab**	
1.	Properties of Reservoir Fluids	2	1	3
2.	Fluid Mechanics	2	1	3
3.	Applied Thermodynamics	2	1	3
4.	Ideology and Constitution of Pakistan	2	0	2
5.	Expository Writing	3	0	3
6.	Differential Equations and Transforms	3	0	3
	Total	**14**	**3**	**17**

3rd Year				
Fifth Semester				
Sr. No	**Course Title**	**(Credit Hours)**		**Total Credit Hours**
		Theory	**Lab**	
1.	Well Logging and Interpretation	2	1	3
2.	Reservoir Engineering	3	1	4
3.	Reservoir Geomechanics	2	0	2
4.	Natural Gas Processing and Transportation	3	1	4
5.	Numerical Methods	3	0	3
6.	Project Management	2	0	2
	Total	**15**	**3**	**18**

Sixth Semester				
Sr. No	**Course Title**	**(Credit Hours)**		**Total Credit Hours**
		Theory	**Lab**	
1.	Petroleum Production Engineering-I	3	1	4
2.	Social Sciences Elective **	2	0	2
3.	Well Testing and Analysis	2	1	3
4.	Field Operations in Petroleum Engineering	3	0	3
5.	Entrepreneurship	2	0	2
6.	Flexible Elective-II ****	3	0	3
	Total	**15**	**2**	**17**

4th Year				
Seventh Semester				
Sr. No	**Course Title**	**(Credit Hours)**		**Total Credit Hours**
		Theory	**Lab**	
1.	Machine Learning	2	1	3
2.	Petroleum Production Engineering-II	3	1	4
3.	Principles of Reservoir Simulation	2	1	3
4.	Flexible Course	4	0	4
5.	FYDP (Part-I)	0	3	3
	Total	**11**	**6**	**17**

Eighth Semester				
Sr. No	**Course Title**	**(Credit Hours)**		**Total Credit Hours**
		Theory	**Lab**	
1.	Reservoir Management	3	1	4
2.	Principles of Enhanced Oil Recovery	3	1	4
3.	Drilling Engineering-II	3	1	4
4.	FYDP (Part-1)	0	3	3
	Total	**9**	**6**	**15**

* List of Arts and Humanities Electives (2+0)	** List of Social Sciences 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 • Applied Psychology • Engineering Management • Financial Management • Marketing Management • Leadership and Personal Grooming • Petroleum Economics & Risk Analysis • Any other relevant course decided by the HEI as per requirement.

****** List of Flexible Electives-II (3 Cr. Hrs.)**
• Geo-Energy Resources • Unconventional Resources • Well Completion • Offshore Field Development • Instrumentation & Control • Chemical Technology of Petroleum • Surveying and Levelling • Any other relevant course decided by the HEI as per requirement.

*****List of Natural Sciences Elective-I**
• Applied Chemistry • Petroleum Chemistry • Any other relevant course decided by the HEI as per requirement.

13. Program Specific Laboratories

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

- Drilling Engineering Lab
- Petrophysics Lab
- Reservoir Fluids Lab
- Simulation/ Computing Lab
- Engineering Drawing Lab
- Workshop Practice Lab
- Fluid Mechanics Lab
- Thermodynamics Lab
- Instrumentation and Control Lab
- Surveying and Levelling Lab
- Chemistry Lab
- Chemical Technology of Petroleum Lab
- Strength of Materials Lab
- Electrical and Electronics Lab
- Applied Geology Lab
- Physics Lab

Note:

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

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

14. Course Details and Teaching-Assessment Approaches

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

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

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

Further, Assessment may be carried out through 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: 3+0
Pre-Requisite: Nil

DESCRIPTION

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

COURSE LEARNING OUTCOMES

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

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

COURSE OUTLINE

1. **Foundations of Functional English:**
   - Vocabulary building (contextual usage, synonyms, antonyms and idiomatic expressions)

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

2. Comprehension and Analysis:

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

3. Effective Communication:

- Principles of communication (clarity, coherence, conciseness, courteousness, correctness, etc.).

PRACTICAL REQUIREMENT

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

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Understanding and Using English Grammar" by Betty Schrampfer Azar.
2. "English Grammar in Use" by Raymond Murphy.
3. "The Blue Book of Grammar and Punctuation" by Jane Straus.
4. "English for Specific Purposes: A Learning-Centered Approach" by Tom Hutchinson and Alan Waters.
5. "Cambridge English for Job-hunting" by Colm Downes.
6. "Practical English Usage" by Michael Swan.
7. "Reading Literature and Writing Argument" by Missy James and Alan P. Merickel.
8. "Improving Reading: Strategies, Resources, and Common Core Connections" by Jerry Johns and Susan Lenski.
9. "Comprehension: A Paradigm for Cognition" by Walter Kintsch.
10. "Communication Skills for Business Professionals" by J.P Verma and Meenakshi Raman.

EXPOSITORY WRITING

UGE Policy V1.1: General Education Course

Credits: 3+0
Pre-Requisite: Functional English

DESCRIPTION

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

COURSE LEARNING OUTCOMES

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

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

COURSE OUTLINE

1. **Introduction to Expository Writing:**
   - Understanding expository writing (definition, types, purpose and applications)
   - Characteristics of effective expository writing (clarity, coherence and organization)
   - Introduction to paragraph writing
2. **The Writing Process:**
   - Pre-writing techniques (brainstorming, free-writing, mind-mapping, listing, questioning and outlining etc.)
   - Drafting (three stage process of drafting techniques)
   - Revising and editing (ensuring correct grammar, clarity, coherence, conciseness etc.)
   - Proof reading (fine-tuning of the draft)
   - Peer review and feedback (providing and receiving critique)

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

PRACTICAL APPLICATIONS AND CAPSTONE PROJECT

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

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "The St. Martin's Guide to Writing" by Rise B. Axelrod and Charles R. Cooper.
2. "They Say / I Say: The Moves That Matter in Academic Writing" by Gerald Graff and Cathy Birkenstein.
3. "Writing Analytically" by David Rosenwasser and Jill Stephen.
4. "Style: Lessons in Clarity and Grace" by Joseph M. Williams and Joseph Bizup.

5. “The Elements of Style” by William Strunk Jr. and E.B. White.
6. “Good Reasons with Contemporary Arguments” by Lester Faigley and Jack Selzer.
7. “Writing to Learn: How to Write - and Think - Clearly About Any Subject at All” by William Zinsser.
8. “The Norton Field Guide to Writing” by Richard Bullock, Maureen Daly Goggin, and Francine Weinberg.
9. “The Art of Styling Sentences” by Ann Longknife and K.D. Sullivan.

“Writing Today” by Richard Johnson-Sheehan and Charles Paine

ISLAMIC STUDIES

UGE Policy V1.1: General Education Course

Credits: 2+0

Pre-Requisite: Nil

DESCRIPTION

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

COURSE LEARNING OUTCOMES

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

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

COURSE OUTLINE

1. **Introduction to Islam:**
   - Definition of Islam and its core beliefs.
   - The Holy Quran (introduction, revelation and compilation).
   - Hadith and Sunnah (compilation, classification, and significance).
   - Key theological concepts and themes (Tawhid, Prophethood, Akhirah etc.).
2. **Sirah of the Holy Prophet (Peace Be Upon Him) as Uswa-i-Hasana:**
   - Life and legacy of the Holy Prophet PBUH
   - Diverse roles of the Holy Prophet PBUH (as an individual, educator, peace maker, leader etc.)
3. **Islamic History and Civilization:**
   - World before Islam.
   - The Rashidun Caliphate and expansion of Islamic rule.
   - Muslims contributions to philosophy, science, medicine, mathematics, and culture.

4. **Islamic Jurisprudence (Fiqh):**
    - Fundamental sources of Islamic jurisprudence.
    - Pillars of Islam and their significance.
    - Major schools of Islamic jurisprudence.
    - Significance and principles of Ijtihad.
5. **Family and Society in Islam:**
    - Status and rights of women in Islamic teachings.
    - Marriage, family, and gender roles in Muslim society.
    - Family structure and values in Muslim society.
6. **Islam in the Modern World:**
    - Relevance of Islam in the modern world (globalization, challenges and prospects).
    - Islamophobia, interfaith dialogue, and multiculturalism
    - Islamic responses to social, ethical, and technological changes
7. **Introduction to Islamic Trade and Finance:**
    - Islamic Financing Structures
    - The Stability of Islamic Financial System
    - Financial Engineering
    - Regulation of Islamic Financial Institutions

SUGGESTED INSTRUCTIONAL/READING MATERIALS

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

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

IDEOLOGY AND CONSTITUTION OF PAKISTAN

UGE Policy V1.1: General Education Course

Credits: 2+0

Pre-Requisite: Nil

DESCRIPTION

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

COURSE LEARNING OUTCOMES

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

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

COURSE OUTLINE

1. **Introduction to the Ideology of Pakistan:**
   - Definition and significance of ideology.
   - Historical context of the creation of Pakistan (with emphasis on socio-political, religious, and cultural dynamics of British India between 1857 till 1947).
   - Contributions of founding fathers of Pakistan in the freedom movement including but not limited to Allama Muhammad Iqbal, Muhammad Ali Jinnah., etc.
   - Contributions of women and students in the freedom movement for separate homeland for Muslims of British India.
2. **Two-Nation Theory:**
   - Evolution of the Two-Nation Theory (Urdu-Hindi controversy, Partition of Bengal, Simla Deputation 1906, Allama Iqbal's Presidential Address 1930, Congress Ministries 1937, Lahore Resolution 1940).
   - Role of communalism and religious differences.

3. **Introduction to the Constitution of Pakistan:**
   - Definition and importance of a constitution.
   - Ideological factors that shaped the Constitution(s) of Pakistan (Objectives Resolution 1949).
   - Overview of constitutional developments in Pakistan.
4. **Constitution and State Structure:**
   - Structure of Government (executive, legislature, and judiciary).
   - Distribution of powers between federal and provincial governments.
   - 18th Amendment and its impact on federalism.
5. **Fundamental Rights, Principles of Policy and Responsibilities:**
   - Overview of fundamental rights guaranteed to citizens by the Constitution of Pakistan 1973 (Articles 8-28).
   - Overview of Principles of Policy (Articles 29-40).
   - Responsibilities of the Pakistani citizens (Article 5).
6. **Constitutional Amendments:**
   - Procedures for amending the Constitution.
   - Notable constitutional amendments and their implications.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

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

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

COMMUNICATION AND PRESENTATION SKILLS

Credits: 2+0

Pre-Requisite: Nil

DESCRIPTION

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

COURSE LEARNING OUTCOME

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

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

COURSE OUTLINE

Writing Skills

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

Reading Skills

- Skimming and Scanning
- Critical Reading
- Reading for Understanding

- Techniques and strategies to develop sound vocabulary.

Listening Skills

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

Speaking Skills

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

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

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

BEGINNERS SPANISH

Credits: 2+0

Pre-Requisite: Nil

DESCRIPTION

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

COURSE LEARNING OUTCOME

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

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

COURSE OUTLINE

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

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

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

ELEMENTARY ARABIC

Credits: 2+0
Pre-Requisite: Nil

DESCRIPTION

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

COURSE LEARNING OUTCOME

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

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

COURSE OUTLINE

Vocabulary

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

Grammar

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

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

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

ELEMENTARY FRENCH

Credits: 2+0
Pre-Requisite: Nil

DESCRIPTION

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

COURSE LEARNING OUTCOME

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

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

COURSE OUTLINE

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

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

ELEMENTARY CHINESE

Credits: 2+0
Pre-Requisite: Nil

DESCRIPTION

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

COURSE LEARNING OUTCOME

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

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

COURSE OUTLINE

- Use 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 INSTRUCTIONAL/ READING MATERIALS

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

HISTORY

Credits: 2+0
Pre-Requisite: Nil

COURSE LEARNING OUTCOME

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

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

COURSE OUTLINE

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

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Burke, Varieties of Cultural History, Cornell University Press, 1977
2. Carlo, Ginzburg. Clues. Myths, and the Historical Method, John Hopkins: University Press, 1992
3. Carr, E. H., What is History? Harmondsworth: Penguin, 1961
4. 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: 2+0
Pre-Requisite: Nil

COURSE LEARNING OUTCOME

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

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

COURSE OUTLINE

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

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Hales, S. D. (2021). This is philosophy: An introduction. John Wiley & Sons.
2. Hospers, J. (2013). An introduction to philosophical analysis. Routledge.
3. Hurley, P. J. (2014). A concise introduction to logic. Cengage Learning.
4. Rachels, J., & Rachels, S. (1986). The elements of moral philosophy (p. 9). Philadelphia: Temple University Press.
5. Solomon, R. C., & Higgins, K. M. (2013). The big questions: A short introduction to philosophy. Cengage Learning.
6. Stewart, D. (2010). Fundamentals of Philosophy. 6th. Boston: Pearson

PROFESSIONAL ETHICS

Credits: 2+0
Pre-Requisite: Nil

DESCRIPTION

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

COURSE LEARNING OUTCOME

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

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

COURSE OUTLINE

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

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

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

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

CIVICS AND COMMUNITY ENGAGEMENT

UGE Policy V1.1: General Education Course

Credits: 2+0
Pre-Requisite: Nil

DESCRIPTION

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

COURSE LEARNING OUTCOMES

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

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

COURSE OUTLINE

1. **Introduction to Civics and Citizenship**
   - Definition of civics, citizenship, and civic engagement
   - Historical evolution of civic participation
   - Types of citizenship: active, participatory, digital etc.
   - The relationships between democracy and citizenship
2. **Civics and Citizenship**
   - Concepts of civics, citizenship, and civic engagement.
   - Foundations of modern society and citizenship.
   - Types of citizenship: active, participatory, digital, etc
3. **State, Government and Civil Society**
   - Structure and functions of government in Pakistan.
   - The relationship between democracy and civil society.
   - Right to vote and importance of political participation and representation.
4. **Rights and Responsibilities**
   - Overview of fundamental rights and liberties of citizens under Constitution of Pakistan 1973.

- Civic responsibilities and duties.
- Ethical considerations in civic engagement (accountability, non-violence, peaceful dialogue, civility, etc.)

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

SUGGESTED PRACTICAL ACTIVITIES (OPTIONAL)

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

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

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

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

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

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

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

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

SOCIOLOGY FOR ENGINEERS

Credits: 2+0
Pre-Requisite: Nil

DESCRIPTION

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

COURSE LEARNING OUTCOMES

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

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

COURSE CONTENT

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

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

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

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

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

  Community Development & Social consequences of Industrialization,

Development Processes of Societal Development, Cooperation and Conflict in Community Development in Engineering Context.

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

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

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

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

- **Industrial & Organizational Psychology**

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

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

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

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

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

- **Case Studies of Different Development Projects in Social Context**

- **SIA (Social Impact Assessment):**

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

- **Engineering Intervention for Social Stratification**

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

SUGGESTED INSTRUCTIONAL/READING MATERIALS

1. Godhade, J. B., and S.T. Hunderkari. 2018. Social Responsibility of Engineers. International Journal of Academic Research and Development. Vol. 03; Special Issue. March, 2018.

2. Nichols,S.P.andWeldon,W.F.2017. Professional Responsibility: The Role of Engineering in Society Center for Electro-mechanics, The University of Texas at Austin, USA.

3. Aslaksen,E.W.2016. The Relationship between Engineers and Society: is it currently fulfilling its potential? Journal and Proceedings of the Royal Society of New SouthWales,Vol.148.Nos.455-456. Gumbooya Pty Lte, Allambie Heights, Australia.

4. Bell, S. Engineers, Society and Sustainability. Synthesis Lectures on Engineers, Technology, and Society. Edited by Caroline Baillie, University of Western Australia. Morgan and Claypool Publishers

5. Jamison,A.,Christensen,S.H.,andLars,B.2011.A Hybrid Imagination: Science and Technology in cultural perspective

6. Vermaas,P.,Kroes,P.,Poet,l.,andHoukes,W.2011. APhilosophyofTechnology:FromTechnical Artefacts to Socio technical systems.

7. Mitcham,C.,andMunoz,D.2010.HumanitarianEngineering. MorganandClaypoolPublishers. Riley,D.2008.Engineering and Social Justice. Morgan and Claypool Publishers.

8. Bugliarello,G.1991.TheSocial Functions of Engineering: A Current Assessment, A Chapter in“ Engineering as A Social Enterprise. Sociology

SOCIOLOGY

Credits: 2+0
Pre-Requisite: Nil

COURSE LEARNING OUTCOMES

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

COURSE CONTENT

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

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

SUGGESTED INSTRUCTIONAL/READING MATERIALS

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

SOCIAL PSYCHOLOGY

Credits: 2+0
Pre-Requisite: Nil

COURSE LEARNING OUTCOMES

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

COURSE CONTENT

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

SUGGESTED INSTRUCTIONAL/READING MATERIALS

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

CRITICAL THINKING

Credits: 2+0
Pre-Requisite: Nil

COURSE LEARNING OUTCOMES

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

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

COURSE CONTENT

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

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

Seeking approval from decision makers and Stakeholders

SUGGESTED INSTRUCTIONAL/READING MATERIALS

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

HUMAN RESOURCE MANAGEMENT

Credits: 2+0
Pre-Requisite: Nil

COURSE LEARNING OUTCOMES

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

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

COURSE CONTENT

- 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

SUGGESTED INSTRUCTIONAL/READING MATERIALS

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

ORGANIZATIONAL BEHAVIOR

Credits: 02
Pre-Requisite: Nil

DESCRIPTION

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

COURSE LEARNING OUTCOMES

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

COURSE CONTENT

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

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

Group and Inter group Behaviour

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

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

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

ENGINEERING LAW

Credits: 2+0
Pre-Requisite: Nil

COURSE LEARNING OUTCOMES

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

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

COURSE CONTENT

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

SUGGESTED INSTRUCTIONAL/READING MATERIALS

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

ENGINEERING ECONOMICS

Credit Hours: 2+0
Pre-Requisites: Nil

DESCRIPTION

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

COURSE LEARNING OUTCOMES

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

COURSE CONTENT

Engineering Economics

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

Interest Rate and Economic Equivalence

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

Understanding Money and Its Management

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

Present-Worth Analysis

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

Annual Equivalent-Worth Analysis

- Annual Equivalent-Worth Criterion

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

Rate-of-Return Analysis

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

Cost Concepts Relevant to Decision Making

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

Depreciation and Corporate Taxes

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

Developing Project Cash Flows

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

Project Risk and Uncertainty

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

Special Topics in Engineering Economics

- Replacement Decisions
- Capital Budgeting Decisions
- Economic Analysis in the Service Sector

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

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

APPLIED PSYCHOLOGY

Credit Hours: 2+0
Pre-Requisites: Nil

DESCRIPTION

This course provides an essential foundation in psychological principles tailored to the needs of engineering students. The course explores the scientific and historical contexts of psychology, the biological bases of behavior, and the intricate processes of sensation, perception, learning, memory, cognition, and language. It also covers intelligence, creativity, motivation, emotion, personality, and social psychology, with a focus on practical applications in engineering contexts. Through this course, students will gain insights into human behavior that enhance their professional and interpersonal skills in the field of mechatronics engineering.

COURSE LEARNING OUTCOMES

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

1. Understand Fundamental Psychological Concepts
2. Analyze the Biological Basis of Behavior
3. Examine Sensation and Perception Processes
4. Explore Learning and Memory Mechanisms
5. Evaluate Cognitive Processes and Language

COURSE OUTLINE

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

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

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

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

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

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

Intelligence and Creativity
- Concept of intelligence
- Theories of intelligence
- Assessment of intelligence
- Mental retardation
- Concept of creativity and its stages

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

Personality
- Defining personality
- Theories of personality
- Personality assessment

Social Thinking and Social Influence
- Social facilitation
- Attribution theory
- Crowd behavior
- Conformity, Obedience
- Helping behavior

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

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

ENGINEERING MANAGEMENT

Credit Hours: 2+0
Pre-Requisites: Nil

DESCRIPTION

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

COURSE LEARNING OUTCOMES

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

COURSE CONTENT

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

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

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

FINANCIAL MANAGEMENT

Credit Hours: 2+0
Pre-Requisites: Nil

DESCRIPTION

This course introduces essential financial principles and practices tailored for engineering students. The course covers risk and return fundamentals, short-term financing decisions, cash conversion cycle, management of marketable securities, inventory and receivables management, leverage and capital structure, payout policy, and long-term debt management. Students will learn to apply financial management concepts to enhance decision-making processes, optimize resource allocation, and support strategic engineering projects.

COURSE LEARNING OUTCOMES

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

1. Understand Risk and Return Principles
2. Manage Short-term Financing Decisions
3. Optimize Inventory and Receivables Management
4. Evaluate Leverage and Capital Structure
5. Understand Long-term Debt Management and Payout Policies

COURSE CONTENT

Risk and return (Required rate)

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

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

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

Cash Operating / Conversion Cycle

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

Management of Marketable Securities

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

Receivables Management

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

Management of Receipts and Disbursements

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

Generic Current Assets' Management

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

Management of Current Liabilities

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

Leverage and Capital Structure

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

Payout Policy

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

Long-term Debt Management

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

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

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

MARKETING MANAGEMENT

Credit Hours: 2+0
Pre-Requisites: Nil

DESCRIPTION

This course explores the essential marketing principles and strategies relevant to engineering professionals. This course provides an understanding of how marketing management has evolved and its impact on customer value. Topics include market segmentation, customer value creation, consumer behavior analysis, brand positioning, product and pricing strategies, value networks, marketing communications, and sales promotions. The course aims to equip students with the skills to apply marketing concepts to engineering products and services, fostering strong customer relationships and effective market positioning.

COURSE LEARNING OUTCOMES

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

1. Understand the Scope and Evolution of Marketing
2. Identify and Target Market Segments
3. Analyze Consumer Markets and Buying Behavior
4. Craft and Communicate Brand Positioning
5. Develop Product and Pricing Strategies
6. Design and Manage Marketing Channels and Communications

COURSE CONTENT

- Defining Marketing For The 21st Century. Importance and scope of Marketing.
- Discussion on Course Outline:
- Some fundamental Marketing Concepts, How Marketing Management changed. How does the Marketing affect customer Value? Discussion on Project Outline
- Identifying Market Segments and Targets. Different levels of market segmentation & requirements of effective segmentation? How companies divide a market into segments?
- Creating and delivering Customer Value, satisfaction and loyalty. What is the lifetime value of customers and how can marketers maximize it? How can companies cultivate strong customer relationship? How can companies both attract and retain customers?
- Analyzing Consumer Markets & Globalization How do consumer characteristics influence buying behavior & major psychological processes influence consumer Reponses to the marketing program?
- Crafting the Brand Positioning How can a firm choose and communicate an effective positioning in the market & how brands are differentiated.
- Creating Brand Equity Neuro Marketing How brands create brand Equity
- Setting Product Strategy Product characteristics & classification How companies differentiate products?

- How should a company set prices initially for products or services? When should company initiate a price change? How should a company respond to a competitor's price change?
- Designing and Managing Value Networks and Channels. The students need to recognize the importance of designing marketing channel system
- Managing Retailing, Wholesaling Why companies choose different marketing channels and how these marketing channels perform?
- Designing & Managing Integrated Marketing Communications Role of Marketing Communication. What are the guidelines for effective marketing communication mix?
- Managing Mass Communications: What steps are required in developing an advertising program? How should sales promotion decisions be made? What are the guidelines for effective brand-building events and experiences?
- Sales Promotions, Events Public Relations. Service Marketing Presentation

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

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

LEADERSHIP AND PERSONAL GROOMING

Credit Hours: 2+0
Pre-Requisites: Nil

DESCRIPTION

This course is designed to develop essential leadership skills and personal development strategies tailored for future engineering professionals. The course covers fundamental leadership concepts, servant leadership, community development frameworks, social capital, community building practices, and professional ethical standards. Students will learn to assess community assets, build effective organizations, market their initiatives, mobilize resources, and measure progress in community and economic development projects.

COURSE LEARNING OUTCOMES

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

1. Understand Leadership Fundamentals
2. Analyze Community Development Foundations
3. Apply Social Capital and Community Building Principles
4. Conduct Community Development Assessments
5. Develop and Market Community Organizations

COURSE CONTENT

Fundamentals of Leadership and Servant Leadership

- What is leadership; Leadership Traits; Servant Leadership

Foundations of Community Development

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

Social Capital, Community Building and Community Development Practice

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

Community development assessment,

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

Building Powerful Community Organizations

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

Marketing your Organization

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

Mobilizing Resources: Raising Money

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

Measuring Progress

- Community development indicators, Best practices & Benchmarking

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

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

PETROLEUM ECONOMICS & RISK MANAGEMENT

Credits: 2+0
Pre-Requisite: Nil

DESCRIPTION

This course equips you with the financial tools and economic principles to evaluate the viability of oil and gas projects. You'll learn about cash flow analysis, international fiscal models, capital budgeting techniques, and risk management specific to the petroleum industry.

COURSE LEARNING OUTCOMES

- Construct cash flow models for oil and gas projects, considering capital expenditures, operating costs, and various fiscal terms.
- Apply capital budgeting techniques (NPV, IRR, PI) to evaluate project profitability under uncertainty.
- Analyze the impact of international contracts (concessions, production sharing) on project economics and risk.

COURSE CONTENT

Introduction:
Definition and some of the basic concepts. Profit Planning. Typical oil company objectives. The role of management in planning. Planning of capital expenditures. Some Basic Principles of Economics. Demand, supply, and equilibrium price. Crude oil price volatility Inflation. Uncertainty and Risk.

The Time Value of Money:
The Concept of Interest. Simple and compound interest. Nominal and effective interest rate. Cash Flow Diagram. The Time Value of Money. Present value of the future sum. Future value of the present sum

Before-Tax Cash Flow Models:
Cash Flow Model. Data Required for Project Evaluation. Forecasting Product Stream. Product Pricing. Capital Expenditures (CAPEX). Geological and geophysical (G&G) costs. Estimating drilling costs. Facility costs. Operating Expenditure (OPEX). Abandonment costs and sunk costs. Opportunity costs.

International Petroleum Economics (After-Tax Cash Flow Models):
Types of Contract Arrangements. The concessionary system. Sample concessionary system cash flow spreadsheet. The production sharing system. Sample PSC cash flow spreadsheet. Rate of return (ROR) contracts. Effects of Various Fiscal Terms.

Capital Budgeting Techniques:
Accounting Approaches. Payback period. The average return on investment (AROI). Discounted Cash Flow Approaches. Discounted payback period. Net present value (NPV). Internal rate of return (IRR). Profitability index (PI).

Project Decision & Risk Analysis:
Handling of Uncertainty in Capital Investment. The Decision Analysis Cycle. Application of Decision Analysis. Typical Industry Risks. Descriptive Statistics. Mean, Median and Mode. Understanding Probability Concept. Rule of Probability.

SUGGESTED INSTRUCTIONAL/READING MATERIALS

1. Project Economics & Decision Analysis, Volume I & II, ISBN: 978-0878148191 & II ISBN: 978-0878148558, M. A. Mian, Pennwell Books.
2. Economics of Worldwide Petroleum Production, Richard D. Seba. ISBN: 978-0930972219.
3. Engineering Economy, William G. Sullivan, Elin M. Wicks, C. Patrick Koelling, 16th Edition, Pearson Education Ltd. ISBN:978-0133439274.

ENTREPRENEURSHIP

UGE Policy V1.1: General Education Course

Credits: 2+0
Pre-Requisites: Nil

DESCRIPTION

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

COURSE LEARNING OUTCOMES

By the end of this course, students shall have:

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

COURSE OUTLINE

1. Introduction to Entrepreneurship:

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

2. Entrepreneurial Skills:

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

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

3. Opportunity Recognition and Idea Generation:

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

4. Marketing and Sales:

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

5. Financial Literacy:

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

6. Team Building for Startups:

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

7. Regulatory Requirements to Establish Enterprises in Pakistan:

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

PRACTICAL REQUIREMENTS

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

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Entrepreneurship: Successfully Launching New Ventures" by Bruce R. Barringer and R. Duane Ireland.
2. "Entrepreneurship: Theory, Process, and Practice" by Donald F. Kuratko.
3. "New Venture Creation: Entrepreneurship for the 21st Century" by Jeffry A. Timmons, Stephen Spinelli Jr., and Rob Adams.
4. "Entrepreneurship: A Real-World Approach" by Rhonda Abrams.
5. "The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses" by Eric Ries.
6. "Effectual Entrepreneurship" by Stuart Read, Saras Sarasvathy, Nick Dew, Robert Wiltbank, and Anne-Valérie Ohlsson.

PROJECT MANAGEMENT

Credits: 2+0
Pre-Requisite: Nil

DESCRIPTION

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

COURSE LEARNING OUTCOMES

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

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

COURSE OUTLINE

- **Project Management Concepts**

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

- **Project Proposal Development**

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

- **Project Feasibility**

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

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

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

- **Project Contract & Procurement Management**

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

- **Project Planning and Scheduling**

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

- **Project Costing & Estimation**

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

- **Project HRM & Communication Management**

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

- **Project Risk Management**

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

- **Computer Application in Project Management**

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

- **Project Quality Management**

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

- **Project Closure & Termination**

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

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

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

APPLICATIONS OF ICT

UGE Policy V1.1: General Education Course

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

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

COURSE LEARNING OUTCOMES

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

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

COURSE OUTLINE

1. **Introduction to Information and Communication Technologies:**
   - Components of Information and Communication Technologies (basics of hardware, software, ICT platforms, networks, local and cloud data storage etc.).
   - Scope of Information and Communication Technologies (use of ICT in education, business, governance, healthcare, digital media and entertainment, etc.).
   - Emerging technologies and future trends.
2. **Basic ICT Productivity Tools:**
   - Effective use of popular search engines (e.g., Google, Bing, etc.) to explore World Wide Web.
   - Formal communication tools and etiquettes (Gmail, Microsoft Outlook, etc.).

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

3. ICT in Education:

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

4. ICT in Health and Well-being:

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

5. ICT in Personal Finance and Shopping:

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

6. Digital Citizenship and Online Etiquette:

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

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

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

PRACTICAL REQUIREMENTS

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

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

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

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

CALCULUS

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

This course covers the fundamental concepts of differential and integral calculus, focusing on techniques, applications, and theoretical underpinnings.

COURSE LEARNING OUTCOMES

1. Apply differentiation and integration techniques to solve real-world problems.
2. Analyze the behavior of functions using concepts like derivatives and asymptotes.
3. Evaluate definite integrals and apply them to compute areas, volumes, and moments.

COURSE CONTENT

A review of differentiation: Geometrical interpretation of a derivative; Infinitesimal; Differential coefficient; Derivatives of higher order; Indeterminate forms and L. Hopital's; Asymptotes; Curvature; Approximation and error estimates.

Further techniques of integration; Integration by reduction formula; Fundamental Theorem of integral Calculus; Definite integral and its properties; Area enclosed between curves; Arc length; Volume of a solid; Volume of a solid revolution; Area of surface of revolution; Moments; Centroids. Improper Integrals; Infinite series

SUGGESTED INSTRUCTIONAL/READING MATERIALS

1. Thomas' Calculus, Joel R. Hass, Christopher E. Heil, 14th edition, Pearson, 2017, ISBN: 978-0134438986
2. Calculus, Howard Anton, Irl C. Bivens, 10th Edition, 2012, John Wiley ISBN: 978-8126556403.
3. Calculus: The Classic Edition 6th Edition by Earl W. Swokowski

VECTOR AND COMPLEX ANALYSIS

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

This course delves into advanced mathematical tools used in physics and engineering, exploring vector operations, integration techniques, and complex number theory.

COURSE LEARNING OUTCOMES

1. Apply vector calculus (gradient, divergence, curl) to analyze physical phenomena like force fields and flow.
2. Utilize theorems like Green's, Gauss's divergence, and Stokes' to solve problems in integration.
3. Analyze complex functions and their properties to solve equations and understand advanced mathematical concepts.

COURSE CONTENT

A review of vector algebra, scalar and vector products; Scalar triple product; Vector triple product; Scalar and vector point functions; Differentiation and integration of vector point functions; Gradient of a function; Divergence, curl and their physical interpretations; Green's theorem in the plane; Gauss' divergence theorem and Stock's theorem; Cartesian tensors.

Polar and exponential forms of complex numbers; Product and quotient of complex numbers in polar form; Properties of complex numbers; Logarithm of a complex number; De Moivres Theorem, The nth roots of a number; Solution of equations; Circular and hyperbolic functions; Inverse hyperbolic functions; Limit, continuity and differentiability of complex functions; Analytic functions, Harmonic functions; Cauchy fundamental theorem and its consequences; Cauchy Integral formula; Derivatives of an analytic function; Singularities and calculus of residues; Contour integration.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Mathematics for Engineers and Scientists" by Muhammad Iqbal Bhatti and Muhammad Nasir Ch, published by Allied Book Centre, Urdu Bazar Lahore.
2. "Advanced Engineering Mathematics" by E. Kreyszig, published by John Wiley & Sons,
3. "Vector Analysis" by M.R. Spiegel, McGraw – Hill Book Company.
4. "Elements of Complex Variables" by Pennisi, L. L. Holt, Rinehart and Winston, U.S.A.
5. "Vector and Tensor Analysis" by N.A. Shah, A–One Publishers, Urdu Bazar, Lahore.

DIFFERENTIAL EQUATIONS AND TRANSFORMS

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

This course equips you with powerful mathematical tools to model dynamic systems and analyze periodic functions. You'll learn to solve differential equations, understand wave phenomena, and represent periodic functions using Fourier series.

COURSE LEARNING OUTCOMES

1. Solve various types of differential equations, including first-order, second-order, and systems, to model physical systems.
2. Apply Laplace transforms to solve differential equations with initial value problems.
3. Analyze periodic functions using Fourier series representations, including complex Fourier series and Fourier transforms.

COURSE CONTENT

1. Formation of differential equations; Solution of various types of first order differential equations; Orthogonal trajectories, Application in physical problems. Linear differential equations of second order, Complementary function, and particular integral. Solution of non-homogeneous linear differential equations of second order and higher by (i) the method of undetermined coefficients (ii) the method of variation of parameters Application of second order differential equations; System of differential equations.
2. Formation of partial differential equations; Equations reducible to ordinary differential equations. Equations of the form $Pp + Qq = R$; Solution by the method of separation of variables. Wave, heat, and Laplace equations.
3. Introduction to Laplace transform: Laplace transform of elementary functions, Laplace transform theorems, Inverse Laplace transform, applications to the solutions of initial value problems, Convolution theorem and applications.
4. Periodic functions, Even and odd functions. Fourier series of functions of period 2 and arbitrary period; Half range series. Complex Fourier series, Fourier transform and applications.

SUGGESTED INSTRUCTIONAL/READING MATERIALS

1. "Mathematics for Engineers and Scientists" by Muhammad Iqbal Bhatti and Muhammad Nasir Ch., published by Allied Book Centre, Urdu Bazar Lahore.

2. "Advanced Engineering Mathematics" by E. Kreyszig, published by John Wiley & Sons.
3. Elementary Differential Equations and Boundary Value Problems, by Boyce and Diprima, 10th Edition, Wiley, 2012
4. "Advanced Engineering Mathematics" by H.K. Dass, published by S. Chand & Company, New Delhi.
5. "Ordinary Differential Equations" by N.A. Shah, A-one publishers, Urdu Bazar, Lahore.

NUMERICAL METHODS

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

This course introduces numerical methods for solving various engineering problems. It covers techniques for finding roots of equations, solving linear systems, interpolation, differentiation, integration, and solving partial differential equations.

COURSE LEARNING OUTCOMES

1. Apply numerical methods to solve nonlinear equations and linear systems.
2. Approximate derivatives and integrals using numerical techniques.
3. Solve partial differential equations numerically.

COURSE CONTENT

1. Solution of non-linear equations: Open methods, bracketing methods for locating roots, initial approximation and convergence criteria, Newton Raphson, and Secant methods.
2. Solution of linear simultaneous equations: Jacobi's method; Gauss-Seidle method.
3. Finite differences: Difference operators and tables; Differences of polynomials.
4. Interpolation and polynomial approximation: Taylor series approximation, introduction to interpolation, Newton's polynomials, Newton's divided difference table and interpolation, Lagrange's interpolation, Chebyshev polynomials.
5. Numerical differentiation: approximating the derivative.
6. Numerical integration: Introduction to quadrature, trapezoidal, composite trapezoidal and Simpson's rules.
7. Solution of partial differential equations: Hyperbolic Equations, Parabolic Equations, Elliptic equations.
8. Computations: Numerical techniques in context of engineering applications and solutions of problems by using MATLAB.

SUGGESTED INSTRUCTIONAL/READING MATERIALS

1. "Numerical Methods for Engineers" by S. C Chapra & R. P Canale, McGraw-Hill.

2. "Numerical Methods using MATLAB" by John H. Mathews, Pearson Education.

3. "Applied Numerical Methods for Engineers using MATLAB" by Robert J. Schilling & Sandra L. Harris, Brooks/Cole.

4. "Numerical Methods for Engineers and Scientists" by D. Joe Hoffman.

APPLIED PHYSICS

Credit Hours: 2+1
Pre-Requisites: Nil

DESCRIPTION

"Applied Physics" introduces fundamental principles of physics and their practical applications in mechatronics engineering. Topics include vectors, mechanics, electrostatics, magnetism, semiconductor physics, waves and oscillations, optics and lasers, and modern physics concepts. The course integrates theory with hands-on laboratory sessions to reinforce understanding and application of physical principles in engineering systems.

COURSE LEARNING OUTCOMES

1. Understand and apply vector analysis techniques to describe physical quantities and their transformations in engineering problems.
2. Apply Newton's laws of motion to analyze mechanical systems, including the calculation of forces, work, energy, and momentum.
3. Analyze electrostatic and magnetic fields, and their effects on charged particles and magnetic materials, with applications in sensors and actuators.
4. Describe semiconductor physics principles, including P-N junctions and transistors, and their role in electronic devices and circuits.
5. Analyze wave phenomena and optics principles, including interference, diffraction, and laser operation, with applications in communication and sensing technologies.
6. Explain key concepts in modern physics, such as quantum mechanics, atomic structure, and nuclear physics, and their applications in various engineering fields.

COURSE OUTLINE

Vectors:

1. Review of vectors, Ordinary Differentiation of Vector, Gradient of Scaler field, Divergence and Curl of Vector Field, Line and Surface Integrals with applications.

Mechanics:

2. 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.

Electrostatics And Magnetism:

3. 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.

Semiconductor Physics:

4. Energy levels in a Semiconductor, Hole concept, Intrinsic and Extrinsic regions, Law of Mass Action. P-N junction, Transistors.

Waves And Oscillations:

5. 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.

Optics And Lasers:

6. Huygens Principle, Two-slit interference, Single-Slit Diffraction, Resolving power of Optical Instruments. Principles for Laser action, Types of Laser, Applications of Laser.

Modern Physics:

7. 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.

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

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Halliday, Resnick, Krane, Physics, 10th Edition.
2. Hugh D. Young, R. A. Freedman, University Physics, 12th Edition.
3. Serway, Jewett, Physics for Scientists & Engineers, Latest Edition.

14.2 Engineering Domain

INTRODUCTION TO COMPUTER PROGRAMMING FOR DATA SCIENCE

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

Introduction to computer programming for data science" introduces fundamental programming within a problem-solving framework applicable to data science. There is an emphasis on designing and writing small programs to solve data science problems that include data processing, data manipulation and data visualization tasks. Through theoretical study and practical exercises, students gain insight into the internal workings of computers and develop skills essential for designing efficient and reliable computing systems.

COURSE LEARNING OUTCOMES

1. Understand the fundamentals of Data Science
2. Apply the Programming Concepts for Writing Python Code
3. Apply the visual basics and Python Libraries for solving specific engineering problems

COURSE CONTENT

Introduction to Hardware, Software Engineering, Networking, Operating Systems and Database Concepts.

- Data acquisition, storage and presentation using MS Office.
- Pseudo Code: Problem solving techniques, and Flow Charts.
- Introduction to programming languages like, Visual Basic and Python etc.
- Class Project: Solving specific engineering problems.
- Good understanding of the worldwide data resources and internet applications.

PRACTICAL REQUIREMENTS

Various Programming codes

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Computer Science an Overview, by J. Glenn Brook Shear
2. Simple Program Design, by Lesley Anne Robertson
3. Visual Basic and tutorials by Schaum Series
4. Discovering Computers by Shelly Vermaat

MACHINE LEARNING

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

This course provides students with an in-depth introduction to the two main areas of Machine Learning: supervised and unsupervised learning. Various models and algorithms for regression, classification, clustering from two approaches: probabilistic methods and non-probabilistic methods. Different application areas of machine learning such as bioinformatics, text analytics and marketing and sales will be discussed as case studies in this course.

COURSE LEARNING OUTCOMES

1. Identify potential applications of machine learning in practice.
2. Represent data as features to serve as input to machine learning models.
3. Select the appropriate machine learning task for a potential application.

COURSE CONTENT

This course provides students with an in-depth introduction to the two main areas of Machine Learning: supervised and unsupervised learning. Will cover some of the main models and algorithms for regression, classification, clustering from two approaches: probabilistic methods and non-probabilistic methods. Different application areas of machine learning such as bioinformatics, text analytics and marketing and sales will be discussed as case studies in this course.

PRACTICAL REQUIREMENTS

1. Analysing regression techniques on dataset(s)
2. Applying probabilistic and non-probabilistic approaches.
3. Implementation of supervised learning models on datasets.
4. Implementation of unsupervised learning models on datasets.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Bayesian Reasoning and Machine Learning by David Barber, 2012
2. Pattern Recognition and Machine Learning by Christopher Bishop, 2006
3. Tom Griffiths webpage: http://cocosci.berkeley.edu/tom/bayes.html
4. Manning and Schütze (1999): Foundations of Statistical Natural Language Processing, MIT Press
5. Jurafsky and Martin (2008): Speech and Language Processing (An Introduction to Natural Language

FUNDAMENTALS OF PETROLEUM ENGINEERING

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

This course provides students an opportunity to acquire a comprehensive understanding fundamental intersections between energy requirements, petroleum as a primary energy source, and its impact on both national and international landscapes. In addition, it provides the historical, geopolitical, and technical aspects of the petroleum industry, providing insights into the complex energy demand, supply, and the role of petroleum engineers in society.

COURSE LEARNING OUTCOMES

1. Explain Engineering Knowledge related to Petroleum & Gas Engineering fundamentals.
2. Apply the acquired knowledge towards Problem Analysis.

COURSE CONTENT

National and International energy requirements. Sources of energy. Role of Petroleum as an energy source. Brief history of International Petroleum industry. Influence of Petroleum on International politics. Highlights of local Petroleum industry. Job Scope of Petroleum engineering graduates.

Overview of Petroleum Engineering, Composition, physical properties, geological and geophysical prospecting, cable tool drilling, rotary drilling mechanisms, drilling fluids, formation evaluation, reservoir, and production engineering concepts.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Introduction to Petroleum Engineering, John R. Fanchi, Richard L. Christainsen, John Wiley, ISBN: 978-1119193449
2. Petroleum Engineering: Drilling and Well Completions, Carl Gatlin, Prentice Hall, ISBN: 978-0136621553.
3. Debby Denehy, Fundamentals of Petroleum, 5th Edition, PETEX, ISBN: 978-0886982317
4. Properties of Petroleum Fluids, 3rd Edition, William D. McCain Jr., PennWell Books, ISBN: 978-1593703738

PETROLEUM GEOLOGY & GEOPHYSICAL PROSPECTING

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

Petroleum geology and geophysical prospecting course explores the geological history of petroleum, understanding its origin, migration, and accumulation. Investigate the geological features of reservoirs under various prevailing conditions, emphasizing their exceptional characteristics. Gain insights into rock deformation, classification of folds, faults, and joints, as well as the application of geophysical exploration methods, particularly seismic methods, for interpreting subsurface formations.

COURSE LEARNING OUTCOMES

1. Explain engineering knowledge related to Petroleum Geology & Geophysical exploration.
2. Illustrate knowledge related to rock discontinuities to explain the migration and distribution of petroleum in sedimentary basins.

COURSE CONTENT

Geological history of Petroleum, The origin, migration and accumulation of petroleum, Reservoirs with abnormal pressure and temperature. Geological distribution of petroleum in the world. Geological basins of Pakistan, Geology of existing oil and gas fields in Pakistan. Surface geological methods for petroleum exploration, Use of topography and surface features for oil prospecting.

Modes of deformation of rocks, parts, varieties, and formation of folds faults, etc. and expression of these features on geological field maps, Geological mapping, and the application of photogrammetry.

Geophysical exploration methods with emphasis on seismic methods and History of exploration in Pakistan. Overview of seismic reflection and refraction survey. Preparation of travel time curve

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Basic Exploration Geophysics, by E. S. Robinson, ISBN: 978-0-471-87941-1.
2. Geophysical Prospecting, by Milton, B. Dobrin, ASIN: B010WFNR98, 4th Edition.
3. Geology of petroleum, A.I. Levorsen. ASIN: B000H4RFY8.
4. Basic Petroleum Geology, Peter K. Link., ISBN-13: 978-0930972226, 3rd Edition.
5. Petroleum Geology of Pakistan, Iqbal B. Kadri. ASIN: B0006F6X1Y
6. Petroleum Geology, Basin Architecture and Stratigraphy of Pakistan, Incorporating Exploration and Development Data by Nusrat K. Siddiqui.

APPLIED GEOLOGY

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

This course familiarizes the students with the diverse branches of geology, covering Earth's origin, interior, and mineralogical composition. Understanding mountain building, drainage patterns, weathering agents, and deformational structural features of rocks. Studying continental drift, plate tectonics, earthquakes, and volcanism. Gain insights into rock and mineral formation, classification, and the occurrence of economic minerals.

COURSE LEARNING OUTCOMES

1. Explain physical and chemical properties of the lithosphere including minerals and rocks, geologic time, and earth history; and crustal materials, landforms, and dynamics in the context of plate tectonics theory.
2. Explain different geological processes including Weathering, Erosion, Volcanism, Earthquake and Plate tectonics and interpret that how these can influence our lives.
3. Compare the development of different landforms and deformational structural features of rocks, dip, strike, faults, folds, joints, fissures, and unconformities

COURSE CONTENT

Introduction to various branches of geology, origin of the earth and its place in universe, interior of the earth and chemical composition of the earth's crust, Mountain building and valley formation, drainage patterns and their types, agents of weathering and erosion, Deformational structural features of rocks, dip, strike, faults, folds, joints and fissures, unconformities etc. Introduction to continental drift and plate tectonics, earthquakes, and volcanism with special reference to Pakistan, Formation of rocks and minerals, classification of rocks, Occurrence of economic minerals and dimension stones of Pakistan.

PRACTICAL REQUIREMENTS

1. International geological symbols for rocks, structures, and minerals
2. Measurement of dip and strike
3. Geological map reading
4. Mohs Scale Hardness
5. Identification of rock forming minerals
6. Study of wooden models of faults and folds etc

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. K. M. Banger, Textbook of Geology
2. H. H. Read, Rutley's Mineralogy
3. Dana, Dana's Manual of Mineralogy
4. Santosh Kumar Grag, Textbook of Geology
5. Raymond, L. A., The Study of Igneous, Sedimentary and Metamorphic Rocks, McGraw Hill.
6. Arthur Holmes and Dorris Holmes, Physical Geology
7. F. G. H. Blyth, Geology for Engineers

ENGINEERING DRAWING & GRAPHICS

Credits: 0+1
Pre-Requisite: Nil

DESCRIPTION

This course provides a comprehensive introduction to technical drawing, emphasizing the use of instruments and the planning of drawing sheets. Students will learn essential skills such as lettering, dimensioning, isometric projection, and the creation of freehand sketches from solid objects. It also covers the intricacies of sectioning solids, designing riveted joints, screw thread systems, and various mechanical components such as keys, cotter, couplings, and bearings, providing practical insights into engineering drawing for applications like pipe connections and engine details.

COURSE LEARNING OUTCOMES

1. A clear conception and appreciation of form, Proportion, and purpose.
2. Description of various drawing tools and sheet planning.
3. Ability to convert isometric views into orthographic projection on sheets.
4. Ability to apprehend complete shape and inner details of any object from their drawings.

PRACTICAL REQUIREMENTS

The course covers: Introduction to the subject use of instruments, Planning of a drawing sheet, the projector of simple solids simple position, and the oblique and auxiliary planes. Lettering and dimensioning the principal requirement of a working drawing. Isometric and pictorial projection of solid figures, making of freehand sketches from solid objects and from orthographic projection. Section of solids, riveted joints. Screw thread systems nut and bolt, keys, and cotter, coupling and simple bearings. Pipe connections, engine detail.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Fundamentals of Engineering Drawing by Warrem J. Luzjader.
2. Elementary Engineering by N.D. Bhatt.
3. Elementary of Solid Geometry by M.K. Guna.
4. A first year Engineering Drawing by A.C. Parkinson.

WORKSHOP PRACTICE

Credits: 0+1
Pre-Requisite: Nil

DESCRIPTION

This course provides hands-on training across various workshop environments, beginning with a detailed examination of center lathe operations and accessories in the Machine Shop. Focusing on the Fitting and Fabrication Shop, students learn the use and maintenance of various tools, along with practical applications involving power tools. The Carpentry Shop segment covers timber types, joints, and machine operations, while the Electrical Shop equips students with essential skills in house wiring, testing methods, and electrical system components.

COURSE LEARNING OUTCOMES

1. Understand and apply concepts of metal cutting machine to a part according to the given drawing.
2. Understand and apply the concepts of basic electrical wiring and circuits.
3. Understand and apply the concepts of basic woodworking and use of various woodworking tools according to the given drawing.
4. Understand and apply the concepts of metal part filing and various fitting processes.
5. Testing of comprehensive technical knowledge of all the four labs/ shops.

PRACTICAL REQUIREMENTS

Machine Shop: Detailed study of center lathe and accessories. Plain and Taper turning. Basic lath operations including turning, facing, simple screw cutting/ treading, knurling, Grooving (Drilling and Boring), cutting tools and their grinding. Brief Introduction of shaper, milling Sharing and Surface Grinding Machine. Assigning of Practical Jobs.

Fitting and Fabrication Shop: The use and care of fitter's tools. Marking out of job. Practice in Metal filing. Sawing, Drilling, dieing, Tapping and reaming. Brief introduction and use of power Hack Saw, Arbor Press, Sheet Sharing Machine, Sheet Rolling Machine, Punching Machine and Drilling Machine. Assigning of practical Jobs.

Carpentry Shop: The use and care of tools. Type of Timber, its defects and preservation methods practice in planning and sawing. Different types of wood joints. Study of sawing, planning, turning mortise and tenon machines. Assigning Practical Jobs.

Electrical Shop: Electric shocks and treatment. The use and care of tools used by electrician. Types and uses of cable and electrical accessories for house wiring, practice in simple house wiring, testing methods. Switch gear used on domestic installation and DB system. Earthing System. Assigning of Wiring arrangements practical.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Workshop Technology Part-1 by W.A.J Chapman.
2. Electrical Wring by Richter and Schwan
3. Wiring Manual by Pak Cables Limited.

STRENGTH OF MATERIALS

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

This course gives insight into essential geometrical properties of plane areas and introduces fundamental concepts related to applied forces, including load transfer mechanisms and resultant calculations. Students will analyze bending moment and shear force diagrams for determinate beams and gain insights into stress-strain behavior, torsion of circular sections, and bending and axial stresses in pipes. The outline emphasizes practical applications and problem-solving techniques for static determinacy, compound bars, temperature stresses, and impact loads.

COURSE LEARNING OUTCOMES

1. To analyse homogeneous and determinate structural members subjected to tension, compression, torsion and bending.
2. To illustrate the shear force and bending moment diagrams of all types of determinate beams
3. To compute the shear stress, bending stress, deflection, rotation and strength in different structural elements using different approaches

COURSE CONTENT

Important geometrical properties of plane areas, Introduction to forces, load transfer mechanism, resultant and reaction calculations, Bending moment and shear force diagrams for determinate beams for general loading. Principle of superposition, relationship between load, shear force and bending moment.

Types of stresses and strains, stress-strain behavior of ductile and brittle materials. Statically determinate and indeterminate problems, compound bars. Temperature stresses. Torsion of solid and hollow circular sections. Strain energy due to torsion and impact loads. Concept of bending and axial stresses in pipes.

PRACTICAL REQUIREMENTS

1. Layout Plan of Strength of Materials Laboratory.
2. Study of small instruments.
3. To perform direct shear test on plain mild steel bar.
4. To perform punching shear test on plain mild steel bar.
5. To perform tension test on plain mild steel bar.
6. To perform compression test on wooden cubes, when load is applied:-
   - i) Perpendicular to grain.
   - ii) Parallel to the grains.
7. To perform hardness test on mild steel and High Carbon steel specimen.

8. To perform bending test on wooden beam.
9. To verify the principal of super position by beam deflection.
10. To perform impact test on steel specimen:-
    i) In tension.
    ii) In bending.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Mechanics of Materials by Andrew Pytel 2nd Edition, 2011.
2. Mechanics of Materials by R.C. Hibbeler.
3. Mechanics of Engineering Materials by F.V. Warnock, P.P. Benham

APPLIED THERMODYNAMICS

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

This course deals with the fundamental thermodynamic quantities such as internal energy, enthalpy, and heat capacity. It covers key principles, including the first and second laws of thermodynamics, and explores thermodynamic properties of fluids, phase equilibrium, and heat transfer concepts, including overall heat transfer coefficients and heat exchanger types.

COURSE LEARNING OUTCOMES

1. Students will be able to explain the fundamental laws of thermodynamics.
2. Students will be able to analyse the thermodynamic properties of fluids.

COURSE CONTENT

- Fundamental concepts in thermodynamics
- First law of thermodynamics and its application for open and closed systems
- Second law of thermodynamics and its applications for heat engines, refrigerators and heat pumps, entropy, and its significance.
- Evaluation of thermodynamic properties of substances (PVT behavior and equations of states).
- Heat effect: heat effects with and without phase change, calculation of entropy changes in processes.
- Phase equilibrium: Degrees of freedom; Gibbs phase rule, criterion for phase equilibrium; Raoult's law and its applications, P-x,y and T-x,y diagrams; Bubble- and dew-point calculations

PRACTICAL REQUIREMENTS

As defined by the course content.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Applied Thermodynamics for Engineering Technologists, by A. Mc Conkey, T. D. Eastop, Pearson.
2. Process Heat Transfer, D.Q. Kern.
3. Surface Production Operation Volume-I, Design of Oil Handling Systems and Facilities by Ken Arnold & Manrice Stewart.

FLUID MECHANICS

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

Introduces the key concepts such as hydrostatics, kinematics, hydrodynamics, and hydraulics. Students will explore fluid properties, including specific weight, surface tension, and viscosity, and cover topics such as fluid statics, forces on submerged surfaces, buoyancy, and fluid kinematics. The course also includes hydrodynamics with a focus on energy in flowing liquids, Bernoulli's equation, and flow measurement techniques. Additionally, students will study steady flow through pipes, addressing Darcy's Weisbach equation, energy losses, and principles of pipe network analysis.

COURSE LEARNING OUTCOMES

1. To describe the physical properties of fluids.
2. To compute pressure and center of pressure on submerged surfaces and to analyse stability of floating and submerged bodies.
3. To describe discharge and pressure measurement devices and to prepare hydraulic grade lines and energy lines for pipes.
4. To describe discharge measurement devices and apply empirical methods for uniform flow in open channels

COURSE CONTENT

Introduction to fluid mechanics, hydrostatics, kinematics, hydrodynamics, hydraulics, solids and fluids, liquids, and gases. Units and dimensions, physical properties of fluids, specific weight, specific volume, specific gravity, surface tension, compressibility, viscosity, newton's equation of viscosity.

Fluid Statics: pressure intensity and pressure head, pressure specific weight relationship, absolute and gage pressure, measurement of pressure, piezometer, Manometer, pressure transducer, differential manometer, and bourdon gage. Forces on submerged plane and curved surfaces and their applications. Buoyancy and floatation, equilibrium of floating and submerged surfaces.

Fluid Kinematics: steady and unsteady flow, laminar and turbulent flow, uniform and non-uniform flow, path lines, streamlines and stream tubes, velocity and discharge, equation of continuity for compressible and incompressible fluids.

Hydro dynamics/Fluid dynamics: different forms of energy in a flowing liquid, head, Bernoulli's equation and its application, energy lines and hydraulic grade lines, free and forced vortex.

Flow Measurement: orifice meter, pitot tube and pitot static tube, venturi meter.

Steady flow through pipes: Darcy's Weisbach equation for flow in pipes, energy losses in pipelines, hydraulic grade lines and energy lines, pipes in series and parallel, transmission of energy through pipes, introduction to computer aided analysis of pipe network.

PRACTICAL REQUIREMENTS

1. To study the layout of Fluid Mechanics and Hydraulics lab.
2. Determination of various properties of fluid.
3. To measure head loss in a pipe of uniform diameter.
4. To determine the hydrostatic forces on a submerged plane and locate the position of center of pressure i.e. depth of center of pressure.
5. To investigate the validity of Bernoulli's equation when applied to a steady flow of water in a tapered duct.
6. To determine the coefficient of discharge for the horizontal venturimeter or for the calibration of venturimeter.
7. To determine coefficient of contraction (Cc), coefficient of velocity (Cv) and coefficient of discharge (Cd) of an orifice
8. To determine coefficient of discharge (Cd) of an orifice and hence to calibrate it.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Fluid mechanics with Engineering Applications by Robert L. Daugherty, SI Edition
2. A textbook of fluid mechanics and hydraulic machines by Dr. R. K. Bansal
3. A textbook of Hydraulics, Fluid Mechanics and hydraulic machinery by R. S. Khurmi
4. Fluid Mechanics by J. F. Douglas

ELECTRICAL ENGINEERING & ELECTRONICS

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

This course covers fundamental concepts in electrical engineering, starting with electrical units and basic circuit laws. Students will explore circuit components, analyze multiple-load and complex circuits, and study magnetism, electromagnetism, and power in AC circuits. It also includes topics such as capacitance, inductance, transformers, RLC circuits, electric motors, and instruments and measurements. Practical applications are emphasized.

COURSE LEARNING OUTCOMES

1. Apply the fundamental concepts of electrical engineering.
2. Analyse the basic operation of AC/DC circuits and components.
3. Evaluate working of major extensively used AC machines.
4. Assess the importance of solid-state electronics with their applications.

COURSE CONTENT

Basics Concepts, Electrical and Units, Basic Circuits Laws and Measurements, Circuit Components, Multiple-Load Circuits, Complex-Circuit Analysis, Magnetism and Electromagnetism, Alternate Current and Voltage Power in AC Circuits, Capacitance, Inductance Transformers, R, C, and L Circuits, Electric Motors, Instruments and Measurements, Wiring Concepts.

PRACTICAL REQUIREMENTS

1. Resistance Measurement by Color Code and its comparison with the Ohm-Meter Reading.
2. Study of Ohm's Law
3. Study and Proof of KCL
4. Study and Proof of KVL
5. Voltage Division Rule
6. Current Division Rule
7. Superposition Principle
8. Study and Use of Oscilloscope
9. RC Time Constants (Plot charging and discharging curves)
10. RL Time Constants (Plot charging and discharging curves)
11. To study resonance in an RLC circuit and find resonant frequency.
12. To find power in a single phase AC circuit by one voltmeter ammeter method.
13. To find power in a three phase AC circuit by two wattmeter method.
14. Demo (Speed Control of DC Motor using Armature Voltage Control)
15. Demo (Speed Control of DC Motor using Field Excitation Control)

SUGGESTED INSTRUCTIONAL/ READING MATERIALS
1. Electricity: Principles & Applications, By Richard Fowler, 8th Edition, Mc-Graw Hill

PETROPHYSICS

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

Gives insight into petrophysical properties and its application to interpret well logs, analyse reservoir characteristics, and optimize hydrocarbon extraction strategies. The students will learn to integrate geology, physics, and engineering concepts to assess reservoir potential.

COURSE LEARNING OUTCOMES

1. To be able to explain knowledge related to fundamental properties of the fluid permeated reservoir rocks.
2. To be able to apply theoretical and practical knowledge to measure and calculate the petrophysical properties of the reservoir rocks.
3. To be able to apply the core analysis data for calculations of petrophysical properties and hydrocarbons in place.
4. To be able to explain special rock properties relevant for the understanding of reservoir rocks.

COURSE CONTENT

Introduction to formation evaluation, core analysis. Fundamental properties of fluid permeated rocks; porosity, Permeability, fluid saturations, compressibility and surface kinetics. Relative Permeability and Capillary Pressure, Core sampling and preservation. Measurement of basic rock properties. Interpretation of basic core analysis data. Special rock properties; electrical, acoustic, thermal.

Application of core analysis data. Calculations of petrophysical properties.

PRACTICAL REQUIREMENTS

1. To draw the layout plan of Petrophysics & Core laboratories
2. To determine the grain density of given core sample
3. To find the fluid saturation in the given core sample using modified Saturation Method.
4. To clean the given core sample using Extraction Methods.
5. To clean the given core sample using Soxhlet Extraction Methods.
6. To find the fluid saturation in the given core sample using Retort Oven.
7. To find the porosity of the given sample using Gravimetric Method.
8. To find the porosity of the given sample using Volumetric Method.
9. To calibrate Helium Porosimeter.
10. To measure the porosity of the given sample using Helium Porosimeter.
11. To measure the permeability of given Core sample using Gas Permeameter

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Petrophysics, Djebbar Tayyab, 4th Edition, Gulf Professional Publishing ISBN: 978-0128031889
2. Applied Petroleum Reservoir Engineering, B.C. Craft & M.F. Hawkins, Ronald E Terry, ISBN: 978-0130398840.
3. Fundamental of Reservoir Engineering, L.P. Dake, ISBN: 978-0444418302.
4. Petroleum Reservoir Engineering Physical Properties, James W. Amyx, ISBN: 0070016003.
5. API RP-40.

DRILLING ENGINEERING-I

Credits: 3+1
Pre-Requisite: Fundamentals of Petroleum Engineering

DESCRIPTION

Deals with drilling operations, including planning, rotary drilling techniques, rig components, drilling fluid properties, bit selection, and pressure considerations. The students will learn about various drilling hazards, well types, and advanced drilling techniques, providing a comprehensive foundation for petroleum and gas engineering.

COURSE LEARNING OUTCOMES

1. Students will be able to explain engineering knowledge related to drilling engineering.
2. Students will be able to analyse processes, and techniques involved in drilling engineering.
3. Students will be able to outline problem solutions using drilling engineering process and techniques.

COURSE CONTENT

Purpose of drilling, types of Different Wells, planning the well. Rotary drilling-its introduction, Basic rig components and their function, mud pumps rating and capacities. Development in drilling system. Rotary drilling bits, Bit types, standard classification, selection, Dull Bit Grading, and evaluation. Introductions to drilling fluids, their function, general nature, and composition, types of drilling mud, mud additives, and mud calculations. Air, natural gas, and aerated mud used as drilling fluids, Calculation of air and horsepower requirements. hydrostatic heads of liquids, the hydrostatic heads of mud and cement slurries. Formation pressures and its types, pressure relations in the earth and bore hole total overburden pressure. Formation pressure measurement using different techniques, drilling hazards and their remedies, and underbalanced drilling.

PRACTICAL REQUIREMENTS

1. Layout of Drilling Engineering Laboratory.
2. Introduction of different models of Rig components.
3. Density of Mud Determination using Mud Balance
4. Prepare a mud of known density.
5. To determine the Gel strength of a drilling mud using Fann V. G. meter
6. To determine the Plastic viscosity, Apparent viscosity and Bigham Yield point and true yield point using Fann V.G meter.
7. To determine the Gel strength of a drilling mud using Baroid Rheometer
8. To determine the viscosity using Rotational Viscometer

9. To prepare mud cake by standard filter press and mud cell assembly
10. To study the filtration loss quality of a drilling mud by Baroid Miniature filter press
11. To determine the clay/ sand contents of the drilling mud using sieve analysis
12. To determine the oil, water, solids, and clay content of the drilling mud
13. To determine API gravity, specific gravity of drilling mud

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Oil well Drilling Engineering by Don W. Dareing, ISBN: 978-0791861875, ASME Press
2. Applied Drilling Engineering by Adam. T. Bourgoyne Jr., Keith. K. Millheim, SPE Textbook Series, Vol 2, ISBN: 978-1555630010, Society of Petroleum Engineers
3. Well Engineering and Construction by Hussain Rabia, ISBN: 978-0954108700, Entrac Consulting
4. Petroleum Well Construction by Michael J. Economides, Larry T. Watters, Shari Dunn-Norman, ISBN: 978-0471969389, John Wiley; 1st edition
5. Formulas and Calculations for Drilling, Production, and Workover: All the Formulas You Need to Solve Drilling and Production Problems by William C. Lyons, Thomas Carter, Norton J. Lapeyrouse, ISBN: 978-0128034170, Gulf Professional Publishing; 4th edition.

PROPERTIES OF RESERVOIR FLUIDS

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

Student will learn and will be able to apply fluid phase behavior concepts in single, binary, and multi-component systems, emphasizing gas properties like dry gas, wet gas, and gas condensates. The students will be able to determine hydrocarbon and field water properties, including hydrates, crucial for reservoir engineering and resource estimation with the help of field and laboratory analysis, correlations, equations of state, and software utilization.

COURSE LEARNING OUTCOMES

1. To be able to explain engineering concepts related to phase behavior for single and multi-component mixtures.
2. To be able to demonstrate the solutions involving concepts related to the ideal and real fluids and apply them to actual cases.
3. To be able to apply solution methodologies for determining the different fluid properties produced from oil/ gas fields.
4. To be able to understand engineering concepts related to reservoir waters and hydrates

COURSE CONTENT

- Basic concept of phase behaviour; single, binary, and multi-component systems. Properties of the different reservoir liquids and gases. Properties of dry and wet gases, Gas condensates.
- Properties of Black oil, Determination of reservoir fluid properties by
  1. Field data
  2. Laboratory Analysis
  3. Correlation's
  4. Equations of state
- Properties of oil field waters and Hydrates.
- Use of existing/available software for phase behavior calculations.

PRACTICAL REQUIREMENTS

Determination of different oil properties including
1. Flash Point of Crude Oil.
2. Cloud & Pour Point of Crude Oil.
3. Density/ Specific Gravity of Crude Oil.
4. Kinematic Viscosity of Crude Oil.
5. Sulfur percentage in Crude Oil.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Properties of Petroleum Fluids by William D. McCain Jr. 3rd Edition, PennWell Books, 2017, ISBN: 978-1593703738.

2. Phase Behavior of Petroleum Reservoir Fluids, Karen Schou Pedersen, Peter L. Christensen, Jawad Azeem Shaikh, 2nd Edition, CRC Press, 2014, ISBN: 978-1439852231

RESERVOIR ENGINEERING

Credits: 3+1
Pre-Requisite: Nil

DESCRIPTION

Discuses concepts including reservoir classification, fluid flow systems, Darcy's law, pressure distribution, and flow equations. Deals with permeability calculations, productivity indices, reservoir drive mechanisms, and techniques for evaluating oil in place, and hydrocarbon recovery strategies.

COURSE LEARNING OUTCOMES

1. Students shall be able to explain fundamental engineering knowledge related to classifications of reservoirs and porous media fluid flow regimes
2. Students shall be able to demonstrate the practical applications of pressure distribution and pressure gradients within the reservoir.
3. Students shall be able to comprehend the Darcy's Law, explain its applications and solutions.
4. Students shall be able to investigate the pressure profile, permeability alterations and illustrate the concepts of average pressure and average permeability of the reservoir.

COURSE CONTENT

Fundamentals of reservoirs engineering, classification of reservoir fluids flow systems, geometry of the reservoir, steady state and unsteady state flow, Darcy's law of fluid flow through porous media, Dimensional analysis of Darcy's law, Basic flow equations, Pressure distribution and pressure gradient for linear, radial, compressible, slightly compressible, and incompressible steady state flow conditions. Determination of average pressure in radial flow system, Readjustment time, Productivity index, Specific productivity index and injectivity index, Relationship between well-bore radius and flow rate in radial flow system. Continuity equation and its derivation. Diffusivity equation and its different forms. Volumetric evaluation of oil in place and empirical reserve estimates. Different types of driving mechanism for hydrocarbon reservoirs.

PRACTICAL REQUIREMENTS

Simulation software utilization

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Applied Petroleum Reservoir Engineering, Ronald E. Terry, J. Brandon Rogers. ISBN: 978-0133155587
2. Reservoir Engineering Handbook, Tarek Ahmed PhD, **ISBN:** 978-1856178037

3. Fundamental Principles of Reservoir Engineering by Brian F. Towler, ISBN: 978-1555630928
4. Oil Reservoir Engineering, Sylvain Joseph Pirson, ISBN: 0882755005.
5. Fundamental of Reservoir Engineering, Ben H. Caudle, ASIN: B0007GPIIQ.
6. Reservoir Engineering Manual, Frank W. Cole, ASIN: B003AA4LKW.

PETROLEUM PRODUCTION ENGINEERING-I

Credits: 3+1
Pre-Requisite: Nil

DESCRIPTION

Deals with petroleum production systems, covering reservoir deliverability estimation, Inflow Performance Relationship (IPR) models, and wellbore/ tubing performance analysis. Handles choke performance, well deliverability using different analysis, and forecasting production behavior.

COURSE LEARNING OUTCOMES

1. Students will be able to understand the fundamental of petroleum production system and apply the knowledge of science and engineering to understand different porous media flow regimes
2. Students will be able to understand the inflow performance relationship (IPR), apply the appropriate IPR model to analyse the reservoir performance and design/predict future reservoir performance.
3. Students will be able to investigate the well flow dynamics, different well flow model and resultant pressure drop/traverse calculations.
4. Students will be able to analyse the whole production system, through integrated knowledge approach, and its time related performance using state of the art simulator

COURSE CONTENT

Introduction to Petroleum Production systems; components and working principles, properties of oil and natural gas, deliverability of oil and gas reservoir; various estimation models and their selection on the basis of flow regimes and pressure levels, deliverability of horizontal wells, Inflow Performance Relationship (IPR) models; straight line and curve IPR, time dependency of the IPR models, composite IPR of stratified reservoirs, Wellbore/ Tubing performance of oil and gas wells; single phase and multi-phase well flow models, homogeneous and separated flow models, mechanistic and empirical models, pressure traverse and pressure drop estimation, Estimating the choke performance; single phase, multiphase, critical and sub critical flow models, deliverability of oil and gas wells; principle of system analysis (NODALTM Analysis) with simplified well configuration, use of IPR and TPR (Tubing Performance Relationship), forecast of Well production; forecasting the behavior of and oil or gas well using the principle of Nodal analysis and material balance.

PRACTICAL REQUIREMENTS

1. Different production software's utilization
2. Studio work
3. Presentations

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Petroleum Production Systems: A computer Assisted Approach by Boyun Guo, William C. Lyons and Ali Ghalambor Elsevier Science & Technology Books, ISBN: 0750682701.
2. Petroleum Production Systems, 2nd Edition, Michael J. Economides, A. Daniel Hill, Christine Ehlig- Economides, Ding Zhu, Prentice Hall ISBN: 013658683X
3. Production Optimization using NODAL™ Analysis, by H. Dale Beggs, OGCI, ISBN: 978-0930972141.

NATURAL GAS PROCESSING & TRANSPORTATION

Credits: 3+1
Pre-Requisite: Nil

DESCRIPTION

Students will study natural gas industry fundamentals, including gas properties, transmission, sweetening, and dehydration processes. Students will get knowledge regarding gas distribution, pipeline welding techniques, flow measurements, preparing them for roles in gas processing and transportation sectors.

COURSE LEARNING OUTCOMES

1. Apply engineering knowledge relevant to physical properties of natural gas to solve fundamental problems.
2. Discuss the significance and working of various steps/ stages involved in natural gas processing.
3. Outline the working and working principles of various gas flow measurement devices.
4. Understand the principles and process of natural gas pipeline design and construction/ installation to develop solutions to pipeline design problems.
5. Distinguish/ discuss various corrosion monitoring methods.
6. Compare various corrosion control methods for their efficiency and develop a suitable cathodic protection system.

COURSE CONTENT

Introduction to natural gas industry; Natural gas properties; Flow and compression calculations; Natural gas processing: phase separation, dehydration, sweetening and fractionation of natural gas including design of dehydration units; Gas flow measurements; Natural gas transmission; Distribution of natural gas in the city; Gas stations; Design of natural gas pipelines; Natural gas pipeline construction; Gas storage; Maintenance of natural gas pipelines: pigging and corrosion prevention/ control.

PRACTICAL REQUIREMENTS

Coverage/ completion of lab manuals/ tutorials focusing on:

1. Application of ideal and real gas laws and determination of z-factor in different cases and by different methods
   a. Using given composition and Standing & Katz chart
   b. Using gas gravity and Standing & Katz chart
   c. Using empirical correlations
2. Determination of viscosity of natural gas samples using analytical/ empirical correlations

a. Carr et al. Correlation
b. Lee et al. Correlation

3. Determination of water content in sweet and sour natural gas streams
   a. McKetta & Wehe Correlation
   b. Wichert & Wichert Correlation
4. Estimation/ prediction of gas hydrates formation in natural gas pipeline/ compression systems using correlations
5. Use of modern tools/ software for solution of pipeline flow and flow assurance problems
   a. Design of surface network(s)
   b. Prediction/ prevention of wax/ hydrates formation.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Donald L. Katz et al., Handbook of Natural Gas Engineering, ISBN: 9780070333840.
2. Saeid Mokhatab & William A. Poe, Handbook of Natural Gas Transmission & Processing, ISBN: 9780080466972
3. A. W. Peabody, Peabody's Control of Pipeline Corrosion, ISBN: 9781575903361
4. E. Shashi Menon, Pipeline Planning & Construction – Field Manual, ISBN: 9780123838674
5. Xiuli Wang & Michael Economides, Advanced Natural Gas Engineering, ISBN: 9781933762388

DRILLING ENGINEERING-II

Credits: 3+1
Pre-Requisite: Drilling Engineering-I

DESCRIPTION

Covers key aspects of drilling operations, emphasizing on directional drilling and well control. It includes planning well trajectories, kick-off procedures, deflection tools, factors affecting penetration rates, and an overview of horizontal drilling. It also discusses drill stem testing, formation damage prevention, oil well cementing techniques, and drilling economics.

COURSE LEARNING OUTCOMES

1. Students will be able to design and develop solutions to engineering problems by using engineering principles and techniques.
2. Students will be able to analyse engineering problems utilizing drilling engineering concepts and methods.
3. Students will be able to investigate engineering problems and evaluate them by considering technical and economical constraints.
4. Students will be able to apply modern tools and latest technologies to optimize complex drilling operations.

COURSE CONTENT

Directional drilling and deviation control, Definitions, and reasons for directional drilling, planning the directional well trajectory, planning the kick-off and trajectory change, Deflection tools. Factors affecting rate of penetration (ROP), overview of horizontal drilling.

Drill stem testing (DST), test procedure and common considerations, Test tool components and their arrangement, Analysis of test data, formation damage causes and prevention of formation damage.

Oil well cementing. Primary oil well cementing techniques, types of cement, cement additives and factors considered for the preparation of cement recipe, cement volumes calculation, Squeeze cementing, stage cementing techniques and well control.

Drilling economics, equipment cost, slim hole drilling, Managed Pressure Drilling (MPD), HTHP drilling challenges, drilling optimization considering different cost factors, and fishing operations. Offshore Drilling Operations, offshore rig selection criteria, offshore well construction.

PRACTICAL REQUIREMENTS

1. Studio work of Casing Design
2. Presentations

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Applied Drilling Engineering by Adam. T. Bourgoyne Jr., Keith. K. Millheim, SPE Textbook Series, Vol 2, ISBN: 978-1555630010, Society of Petroleum Engineers
2. Well Engineering and Construction by Hussain Rabia,, ISBN: 978-0954108700, Entrac Consulting
3. Horizontal Well Technology, by S.D. Joshi, ISBN: 978-0878143504, PennWell Corp. 1st Edition
4. Petroleum Well Construction by Michael J. Economides, Larry T. Watters, Shari Dunn-Norman, ISBN: 978-0471969389, John Wiley; 1st edition
5. Formulas and Calculations for Drilling, Production, and Workover: All the Formulas You Need to Solve Drilling and Production Problems by William C. Lyons, Thomas Carter, Norton J. Lapeyrouse, ISBN: 978-0128034170, Gulf Professional Publishing, 4th edition
6. Offshore Petroleum Drilling and Production by Sukumar Laik, ISBN: 978-1498706124, CRC Press; 1st edition

WELL LOGGING & INTERPRETATION

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

This course equips students with a comprehensive understanding of well logging within the field of engineering. Through a structured curriculum, students will develop the a theoretical understanding of well logging as well as students will be equipped with the practical skills and knowledge necessary to excel in applying these principles to address challenges in the industry.

COURSE LEARNING OUTCOMES

1. Students will be able to explain engineering knowledge related to well logging
2. Students will be able to analyse logs, processes, and techniques particular to well logging
3. Students will be able to design solution to problems by using well logging data interpretation principles/techniques.
4. Students will be able to apply modern tools and techniques to resolve well logging data problems.

COURSE CONTENT

Basic Concepts applied to well logging: Logging environment, porosity, permeability, fluid saturations, formation density, resistivity, invasion process and resistivity profiles.

Electrical Logs: SP logs, conventional, normal, lateral, and micro devices.

Nuclear Logs: Gamma ray, neutron and formation density logs Sonic or acoustic log.

Cross plots of various logs.

Quantitative Analysis: Formation water resistivity and saturation determination. Lithology and porosity determination. interpretation of spontaneous potential log, gamma ray log, porosity logs, resistivity logs and magnetic resonance imaging log, to identify the rock and calculate its fluid properties.

CBL (cement bond log)/VDL (variable density log).

PRACTICAL REQUIREMENTS

1. Interpretation of different resistivity profiles.
2. Determination of formation temperature using well log data.
3. Determination of variation in different resistivity with a change in temperature.

4. Determination of formation water resistivity from spontaneous potential log.
5. Determination of corrected resistivity of flushed zone and un-invaded rock using Tornado charts.
6. Determination of shale volume using SP/gamma ray log data.
7. Determination of shale corrected porosity of the rock by using sonic log data.
8. Determination of lithology and porosity of the rocks using various cross plots

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Theory, Measurement & Interpretation of Well Logs by Zaki Bassiouni, SPE Textbook Series Vol.4, ISBN: 978-1555630560.
2. Open hole Log Analysis and Formation Evaluation by Richard M. Bateman, SPE Textbook Series, Second Edition, ISBN: 978-1613991565.
3. Cased Hole Log Interpretation, Principles/ Applications by Schlumberger.

PRINCIPLES OF RESERVOIR SIMULATION

Credits: 2+1
Pre-Requisite: Reservoir Engineering

DESCRIPTION

Discusses concepts, advantages, and limitations of reservoir simulation, covering formulation of models for single and multiphase flow in porous media under various reservoir conditions. The students will learn numerical methods for solving field problems, enabling performance prediction for effective reservoir management and hydrocarbon recovery optimization.

COURSE LEARNING OUTCOMES

1. On completion of the course students will be able to explain Engineering Knowledge related to reservoir simulation
2. On completion of the course students will be able to design solutions using principles of reservoir simulation
3. On completion of the course students will be able to analyse problems related to methodologies applicable in reservoir simulation.
4. On completion of the course students will be able to Design and Investigate reservoir performance/management efficiently.

COURSE CONTENT

- Introduction: Overview and role of reservoir simulation in petroleum, its advantages, and limitations, basic steps of a reservoir simulation study.
- Formulation: Developing a model for single phase, incompressible, slightly compressible, and compressible fluids at different reservoir conditions, formulation of partial differential equations governing single phase and multiphase flow in porous media.
- Reservoir modelling: Types of models, required data, model initialization, gridding system, space, and time discretization.
- Numerical solution: Numerical methods to solve partial differential equations, implicit and explicit solution methods, stability, convergence, and accuracy considerations.
- Applications: Reservoir modeling, history matching, and performance prediction.

PRACTICAL REQUIREMENTS

Introduction: Developing a model for single phase, incompressible, slightly compressible, and compressible fluids at different reservoir conditions

Solution: Selection of Reservoir simulator and computer aided design. Use of Black oil Simulator. Input data keywords and data file preparation. Fine tuning for history matching and Performance prediction through Class Projects. Quizzes/ viva voces. / Surprise tests etc.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Turgay Ertekin, Jamal H. Abou-Kassem, Gregory R. King, Basic Applied Reservoir Simulation, SPE Textbook Series Vol. 7, Richardson Texas. **ISBN:** 978-155563089-8
2. Donald W. Peaceman, Fundamentals of Numerical Reservoir Simulation, Elsevier Science, **ISBN:** 978-044455298-3.
3. Calvin C. Mattax, Robert L. Dalton, Reservoir Simulation, SPE Monograph Series Vol. 13, **ISBN:** 978-155563028-7.
4. M. R. Islam, S. M. Farouq Ali, Jamal H. Abou-kassem, Petroleum Reservoir Simulation: A basic Approach, Gulf Publishing company, **ISBN:** 978-097651136-6

RESERVOIR MANAGEMENT

Credits: 3+1
Pre-Requisite: Reservoir Engineering

DESCRIPTION

This reservoir engineering course equips students with the expertise to evaluate material balance equations for oil reservoirs, determining relative permeability ratios from field data. Students will master modeling performance calculations for depletion drive reservoirs and learn empirical prediction techniques for immiscible processes. Students will analyze water and gas fingering, as well as coning, with a focus on their impact on field development planning.

COURSE LEARNING OUTCOMES

1. Students will be able to evaluate material balance equation and its different forms for oil reservoirs and determine Krg/Kro (relative permeability ratio) from field data.
2. Students will be able to model performance calculation for depletion drive reservoirs and empirical prediction technique for immiscible processes.
3. Students will be able to evaluate performance of water drive reservoirs using Frontal Advance Rate theory of Buckley and Leveret.
4. Students will be able to analyse water and gas fingering and coning with consideration to field development planning

COURSE CONTENT

Introduction and objectives of reservoir management and its importance in maximizing hydrocarbon recovery. Material balance equation and its different forms with their application in petroleum reservoirs. The key concepts of relative permeability and capillary pressure with respect to reservoir fluid dynamics. Reservoir performance prediction using different techniques and required data. Reservoir simulation integration in reservoir management. Overview of production optimization techniques and integrated asset management (IAM). Reservoir management challenges and solutions

PRACTICAL REQUIREMENTS

Exercises and Class Projects on:

i. MBE and its different forms
ii. Performance prediction with different techniques
iii. Field development planning
2. Software Applications and Presentations.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Oil reservoir Engineering by S.J. Pirson, ISBN-13:978-0070500747, 2nd Rev Edition
2. Advanced Reservoir Engineering by Tarek Ahmed, ISBN 9780750677332.
3. Applied Petroleum Reservoir Engineering, B.C. Craft & M.F. Hawkins, ISBN: 978-0133155587.
4. Reservoir Management: Principles and Practice" by Steve H. Henderson
5. Reservoir Engineering Handbook" by Tarek Ahmed
6. Reservoir Management for Waterfloods" by R.C. Selley, Stephen A. Sonnenberg
7. Integrated Reservoir Asset Management" by John R. Fanchi.

PETROLEUM PRODUCTION ENGINEERING-II

Credits: 3+1
Pre-Requisite: Petroleum Production Engineering-I

DESCRIPTION

This course empowers students with the ability to comprehend and identify various causes of low productivity, considering a range of influencing factors. Students will gain the understanding of different skin components and their significance in predicting well performance. Additionally, students will gain the expertise to compare various stimulation techniques and assess their applications in the context of reservoir engineering.

COURSE LEARNING OUTCOMES

1. Students will be able to understand and identify different causes of low productivity and its various factors.
2. Students will be able to understand the comprehend different skin components and their significance in well performance predictions.
3. Students will be able to compare different stimulation techniques with its applications.
4. Students will able to design lift system with its applications.

COURSE CONTENT

Causes of low well productivity: Reservoir dominated factors, well bore dominated factors, mechanical failures.

Well Performance Prediction: Decline curve analysis, Material balance method, and reservoir simulation.

Well services and work over jobs: Squeeze jobs, re-perforation, well cleaning.

Stimulation Techniques:

Hydraulic Fracturing: Introduction, inducing, productivity ratio, fracture area, fracturing fluid coefficients, fractures efficiency, fracturing hydraulics, fracture design and calculation.

Acidizing: Introduction, types of treatment, acid-fracturing design, Sandstone acidizing design, Carbonate acidizing design, Productivity Improvement from Acidization, Acid Systems, Acid Additives.

Artificial Lift Methods: Introduction and selection criteria of artificial lift methods. Sucker rod pumps, Gas lift, Electric submersible pumps, Hydraulic pumps (application, operational procedure, advantages, and limitations).

PRACTICAL REQUIREMENTS

1. Establishing different Inflow Performance Relationships (IPR).

2. Determination of vertical lift performance of a well using choke and bottom-hole parameters.
3. Determination of reservoir/bottom-hole parameters using surface production data.
4. Interpretation of production logging tool data for well diagnostics.
5. Determination of productivity ratio of a reservoir stimulation job.
6. Well hydraulics calculations for an anticipated stimulation job.
7. Complete hydraulic fracture design and its modeling.
8. Complete acid fracturing job and its modeling.
9. Graphically determining the point of gas injection for a gas lift design.
10. Universal valve spacing design for a gas lift installation.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Petroleum Production Systems: A computer Assisted Approach by Boyun Gue, William C. Lyons and Ali Ghalambor ISBN: 0750682701.
2. Introduction to Petroleum Production; Volume I & II by D. R. Skinner, ISBN: 0872017672.
3. Surface Operation in Petroleum Production, by G. V. Chillingarian, J. O. Robertson, ISBN: 0444424733.
4. Production Operations, by Thomas O. Allen and Alan P. Roberts, ISBN: 978-0930972196.
5. Petroleum Production Systems by Michael J. Economides, A. Daniel Hill, ISBN: 013658683X.

PRINCIPLES OF ENHANCED OIL RECOVERY

Credits: 3+1
Pre-Requisite: Nil

DESCRIPTION

This course explores factors common to enhanced recovery methods, including displacement mechanics, injection well location, and sweep efficiency. Specific methods such as water flooding, gas injection, miscible drive, and thermal recovery are covered, along with other techniques like polymer injection. Practical considerations, performance calculations, and problem-solving with computer algorithms are emphasized.

COURSE LEARNING OUTCOMES

1. Students will be able to explain the fundamental of Enhanced Oil Recovery i.e., basic concepts, technologies, role, current, and common factors related to EOR.
2. Students will be able to analyse the principle and mechanisms of the EOR methods including key constraints for the successful EOR operations.
3. Students will be able to relate design/development of Solution for the EOR related issues.
4. Students will be able to design through modern tool usage, to solve problems in homogenous and heterogeneous reservoirs

COURSE CONTENT

Factors Common to all Enhanced Recovery Methods: Scope of Enhanced Oil Recovery (EOR); EOR screening criteria; Effect of petrophysical and fluid properties: Wettability, Saturation, Relative permeability, Interfacial tension, Viscosity; Linear displacement; Two- and three-dimensional displacement. Injection well location; Areal sweep efficiency for pattern floods.

Water Injection: Displacement mechanics and performance calculations; Practical considerations in water injection projects Frontal Advance and Buckley and Leveret theory.

Immiscible Displacement by Gas Injection: Preliminary studies and field evaluation of injection efficiency; Injection and production well completions; Surface installations, compression, and treatment methods; Special applications of gas injection.

Miscible Drive: Miscible slug flooding; Thermodynamic miscibility; Ternary diagram; Basic and improved methods of miscible drive; Carbon dioxide flooding.

Gas Recycling in Gas-Condensate Reservoirs: Thermodynamics of gas recycling; Sweep efficiency; Well locations; Production control; Production equipment and determination of operating conditions.

Thermal Recovery Methods: Data requirements; Hot fluid displacement; In-situ combustion.

Chemical EOR Processes: Use of polymers; Foam injection; Use of surfactant solutions and micro-emulsions.

Calculations: Example calculations and solution of problems involving various EOR scenarios

PRACTICAL REQUIREMENTS

Coverage/ completion of lab manuals/ tutorials focusing on following topics and involving the usage of modern tools:

1. Screening criteria for EOR studies/ projects
2. Mobility Ratio: Governing factors and effects/ implications of its variation
3. Fractional flow theory and related calculations
4. Pre-breakthrough, breakthrough and post-breakthrough scenarios at production wells during waterflooding
5. Applications of ternary diagrams in miscible processes
6. Design calculations for thermal EOR methods.
7. Design calculations for chemical EOR methods.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Deryck Bond and Samuel Krevor., The Imperial college lectures in petroleum engineering: topics in reservoir management, Volume 3 World Scientific, ISBN 978-1786342843.
2. Chemical Enhanced Oil Recovery (cEOR) - a Practical Overview Edited by Laura Romero-Zeron, ISBN: 978-9535127000, In Tech.
3. Sheng, J.J., Enhanced Oil Recovery Field Case Studies, Gulf Professional publishing, Elsevier, ISBN: 978-0123865458

RESERVOIR GEOMECHANICS

Credits: 2+0
Pre-Requisite: Nil

DESCRIPTION

This course provides a thorough understanding of rock mechanics fundamentals and experimental techniques, covering stress and strain analysis, mechanical deformation, strength assessment, and failure analysis. It also explains about subsurface stresses, including principal earth stresses, borehole breakouts, and drilling-induced fractures, while introducing the Mechanical Earth Model and its construction process. Additionally, it explores wellbore geo-mechanics, focusing on stress distribution, rock deformation modes, and the optimization of horizontal well trajectories.

COURSE LEARNING OUTCOMES

1. Apply rock mechanics concepts to assess subsurface conditions and geomechanical behavior.
2. Evaluate subsurface stresses and construct mechanical earth models to optimize wellbore trajectories.
3. Explain geomechanical effects on reservoir performance and predict changes through modelling.

COURSE CONTENT

Fundamentals and experimental rock mechanics

a. Stress and strain analysis, mechanical deformation, strength, and failure analysis.

Subsurface Stresses

a. Principal earth stresses: principal and effective, regional, and local stresses, overburden stress, horizontal stress orientation, borehole breakouts, drilling-induced tensile fractures, classification of faults.
b. Concept and construction of the Mechanical Earth Model, data requirements and types of input data.

Wellbore geo-mechanics and wellbore stability

a. State of stresses around the wellbore
b. Modes of rock deformation around the wellbore
c. Optimization of horizontal well trajectory based on stress regime.

Introduction to reservoir compaction. Geo-mechanical changes in the petrophysical properties. Introduction to geo-mechanical modeling

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Erling. Fjar et al, Petroleum Related Rock Mechanics, Elsevier, **ISBN:** 978-0444502605.
2. Mark D. Zoback, "Reservoir Geo-mechanics" 1st Edition, ISBN: 978-0521146197.
3. Tarek Ahmed, "Reservoir Engineering Handbook" (fourth Edition) Elsevier ISBN: 978-1856178037.

FIELD OPERATIONS IN PETROLEUM ENGINEERING

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

This course provides an overview of key activities in drilling operations, including executing fishing, cementing, and coring operations. It also covers well completion tasks such as perforation jobs, liner placement, and sand control procedures. Moreover, the course outlines production operations, including procedures for scale removal, nitrogen shooting, coiled tubing operations, acidizing, hydraulic fracturing, and snubbing.

COURSE LEARNING OUTCOMES

1. Apply knowledge related to field operations in petroleum engineering.
2. Analyze procedures associated with Drilling, Well Completion and Production Field Operations for their effective utilization in problem analysis.
3. Evaluate design of solutions related to Drilling, Well Completion and Production Field Operations while keeping appropriate considerations in view.
4. Relate to tools and techniques involved in field operations in petroleum engineering, in the broader context of lifelong learning

COURSE CONTENT

Drilling Operations: Executing Fishing, Cementing and Coring operations.

Well Completion: Performing perforation job; Liner placement; Executing Sand control procedures; Conducting Well Testing operations.

Production Operations: Procedures related to Scale Removal, Nitrogen Shooting, Coiled Tubing operations, Acidizing, Hydraulic Fracturing, Snubbing

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Advanced Well Control, David Watson, Terry Brittenham, ISBN: 978-1555631017.
2. Petroleum Well Construction, Michael J. Economides, Larry T. Watters, ISBN: 978-0471969389.
3. Applied Drilling Engineering, A. T. Bourgoye Jr., K. K. Millheim, ASIN: B01L0PRBX2.
4. Petroleum Production Systems, Michael J. Economides, A. Daniel Hill Christine Ehlig-Economides, ISBN: 978-0137031580, 2nd Edition.

5. Production Operations (Volume 1, 4th Edition), Thomas O. Allen, Alan P.Roberts, ISBN: 978-0930972196.
6. Natural Gas Production Engineering, Chi U. Ikoku, ISBN: 978-0471894834.

OCCUPATIONAL HEALTH AND SAFETY

Credit Hours: 1+0
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 CONTENT(THEORY)

Health and Safety Foundations:

(a) Nature and scope of health and safety

(b) Reasons/benefits and barriers for good practices of health and safety

(c) Legal frame work and OHS Management System

Fostering a Safety Culture:

(a) Four principles of safety- RAMP (Recognize, Assess, Minimize, Prepare)

(b) Re-thinking safety-learning from incidents

(c) Safety ethics and rules

(d) Roles and responsibilities towards safety

(e) Building positive attitude towards safety

(f) Safety cultures in academic institutions

Recognizing and Communicating Hazards:

(a) Hazards and Risk

(b) Types of hazards: Physical (mechanical and non-mechanical), Chemical (Toxic and biological agents), electrical, fire, construction, heat and temperature, noise and vibration, falling and lifting etc.
(c) Learning the language of safety: Signs, symbols and labels

Finding Hazard Information

(a) Material safety data sheets
(b) Safety data sheets and the GHS (Globally Harmonized Systems)

Accidents & Their Effect on Industry

(a) Costs of accidents
(b) Time lost
(c) Work injuries, parts of the body injured on the job
(d) Chemical burn injuries
(e) Construction injuries
(f) Fire injuries

Assessing and Minimizing the Risks from Hazards

(a) Risk Concept and Terminology
(b) Risk assessment procedure
(c) Risk Metric's
(d) Risk Estimation and Acceptability Criteria
(e) Principles of risk prevention
(f) Selection and implementation of appropriate Risk controls
(g) Hierarchy of controls

Preparing for Emergency Response Procedures

(a) Fire
(b) Chemical Spill
(c) First Aid
(d) Safety Drills / Trainings:
- Firefighting
- Evacuation in case of emergency

Stress and Safety at Work environment

(a) Workplace stress and sources
(b) Human reaction to workplace stress
(c) Measurement of workplace stress
(d) Shift work, stress and safety
(e) Improving safety by reducing stress
(f) Stress in safety managers
(g) Stress and workers compensation

Incident Investigation

(a) Importance of investigation
(b) Recording and reporting
(c) Techniques of investigation
(d) Monitoring
(e) Review
(f) Auditing Health and Safety

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.

WELL TESTING AND ANALYSIS

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

This course enables students to apply fundamental engineering knowledge to various types of well testing. Students will gain proficiency in illustrating both quantitative and qualitative methodologies for problem analysis related to different well tests.

COURSE LEARNING OUTCOMES

1. Students will be able to applies engineering knowledge related to the fundamental concepts of well testing and its different types.
2. Students will be able to illustrate solution methodology for problem analysis related to different well test both quantitatively and qualitatively.
3. Students will be able to conclude the investigation of efficient well test analysis using different test procedures and techniques.

COURSE CONTENT

Analytical solution of the diffusivity equation for constant rate and constant pressure under transient and pseudo-steady state flow regimes; skin effect due to well-bore damage and storage; Analytical / numerical solution of diffusivity equation including damage and storage presented in the graphical form and its use as a diagnostic plot; Principle of superposition and Horner's approximation of pseudo-time.

Pseudo build-up analysis; Ideal build-up test and actual build-up test; Determination of reservoir permeability, skin factor, flow efficiency etc.; Pseudo-skin; Analysis of hydraulically fractured wells; Determination of static drainage area by P* and Muscat method; Distance to fault and areal extent determination; Transient equation for gases including well-bore damage, storage, and turbulence factor.

Drawdown analysis oil and gas well; Multi rate testing; Deliverability Testing for gas wells; multi-well testing; Use of type curves and derivative curves; Discussion of Ramey's, Gringarten's and Mckinley's type curves.

PRACTICAL REQUIREMENTS

1. Class Project.
2. Class assignment on each chapter of the book taught.
3. Quizzes/ viva voces. / Surprise tests etc.
4. Presentations.
5. Software Application.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

- Lee, Rollins & Spivey., Pressure Transient Testing, SPE, ISBN: 978-1555630997
- John Lee., Well Testing, SPE Textbook Series, ISBN: 978-0895203175.
- M A Sabet., Well Test Analysis, Gulf Publishing Company, ISBN: 9780872015845
- George Stewart., Well Test Design & Analysis, PennWell Corporation, ISBN: 978-1593702311

***List of Natural Sciences Elective-I
• Applied Chemistry • Petroleum Chemistry • Any other relevant course decided by the HEI as per requirement.

APPLIED CHEMISTRY

Credit Hours: 2+1
Pre-Requisites: Nil

DESCRIPTION

This course delves into the industrial applications of inorganic and organic chemistry. It explores the production processes for key inorganic chemicals and examines reaction mechanisms with industrial uses for various organic reactions.

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

COURSE CONTENT(PRACTICALS)

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

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Applied Chemistry and Chemical Engineering" A. K. Haghi, Devrim Balkose, Omari V.
2. Mukbaniani, Andrew G. Mercader, Apple Academic Press, 2018
3. Comprehensive Analytical Chemistry; Molecular Characterization and Analysis of

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

PETROLEUM CHEMISTRY

Credit Hours: 2+1
Pre-Requisites: Nil

DESCRIPTION

This course explores the chemistry of petroleum, including its composition and analysis techniques. It covers instrumental methods like spectroscopy and chromatography, along with statistical data treatment for accurate interpretation of results.

COURSE LEARNING OUTCOMES

1. Analyze the basic properties, nature, and composition of crude oil and natural gas.
2. Utilize principles of spectroscopy (UV-Vis, IR, AAS, MS, NMR) for petroleum analysis.
3. Employ various chromatographic methods (column, paper, TLC, ion exchange, GPC, HPLC) and interpret data statistically.

COURSE OUTLINE

- Petroleum chemistry: Basic introduction, General characteristics, Nature, composition and chemical constitution of crude oil and natural gases
- Instrumental and Spectroscopic Analytical Techniques:
- Principles of spectroscopy, Electromagnetic spectrum, UV-Visible, IR, AAS spectroscopy, Mass Spectrometry, proton NMR
- Physio-Chemical methods of Separation and Analysis
- Chromatography, Basic principles and classification, column chromatography, paper and thin layer, ion exchange, gel permeation, gas and high-performance liquid chromatographic methods, electrophoresis,
- Statistical Data Treatment
- Introduction, Types of Errors, Accuracy and Precision, Determinate and Indeterminate Errors, Mean, Median, Range, Variance, Coefficient of Variance, Q-Test, t-Test, F-Test, Standard Deviation, Relative Standard Deviation, Mean Standard Deviation, Confidence limit, Significant and Insignificant Figures, Numericals.

COURSE CONTENT (PRACTICALS)

1. Determination of Heat of Solution of a given salt solution.
2. Determination of Heat of Neutralization of given Acid-Base pair.
3. Determination of the Surface Tension of a given liquid by using Stalagmometer

4. Determination of Viscosity of a given liquid by using Ostwald's viscometer
5. Determination of the strength of Acid/Base by conductometric titration
6. Determination of the strength of Acid/Base by potentiometric titration
7. Separation of provided black ink by Thin Layer Chromatography
8. Separation of Food Dyes by Paper Chromatography
9. Separation of Metal Cations by Paper Chromatography
10. Determination of Errors
11. Determination of the strength of provided ion using complexometric titration
12. Determination of the strength of provided analyte using gravimetric analysis
13. Preparation of buffers solutions
14. Determination of percentage composition of provided analyte solution using spectrophotometric analysis.

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Standard Handbook of Petroleum and Natural Gas Engineering, Volume I, William C. Lyons, Gulf Publishing Company, Texas.
2. Modern Fourier Transform Infra-red Spectroscopy, by Chiristy, A. A, Y. Ozaki, and V. G. Gregorou, Elsevier.
3. Inorganic Mass Spectrometry: Fundamentals and Applications 1st Edition by Barshick, Christopher M., Douglas C, Duckworth, and David H, Smith Marcel Dekker,
4. Organic Spectroscopy 3rd edition by William Kemp, MACMILLAN.
5. X-Ray Fluoriscence Spectrometry, 2nd Edition by Jenkins, Ron, John Wiley & Sons.
6. Analytical Chemistry 5th edition by Gary D. Christian, John Wiley & Sons.
7. Fundamentals of Analytical Chemistry 5th edition by Skoog, West and Holler, Saunders Collage Publishing.

****** List of Flexible Electives -II (3 Cr. Hrs.)**
• Geo-Energy Resources • Unconventional Resources • Well Completion • Offshore Field Development • Instrumentation & Control • Chemical Technology of Petroleum • Surveying and Levelling • Any other relevant course decided by the HEI as per requirement.

GEO-ENERGY RESOURCES

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

This course covers Occupational Health & Safety (OHS) fundamentals, including risk assessment, hazard classification, and communication strategies. Students will explore OHS in the Upstream Petroleum Industry, emphasizing proactive management, accident impacts, and compliance with Pakistan's regulatory framework and international best practices.

COURSE LEARNING OUTCOMES

1. Students will be able to understand thermodynamic and fluid behavior within conventional and unconventional system.
2. Students will be able to apply knowledge to renewable/geothermal system for heat and energy generation.
3. Students will be able to understand environmental issues related to geothermal systems.

COURSE CONTENT

Introduction to the rock's classifications and origin

Types of various geo-energy resources

Introduction to the fundamentals of the mineral resource generation, hydrocarbon origin, composition, geological principles and processes and relationships with hydrocarbons generation and accumulation processes.

Thermodynamic behavior of hydrocarbon mixtures

Introduction of Geothermal Energy and its classification.

Thermal Structure of the Earth, Heat Transport and Thermal Parameters

Exploration and Analysis, Subsurface Systems & design issues

Uses of Geothermal Energy, Types of Geothermal Power Plants for heat and electricity generation

Enhanced Geothermal Systems (EGS), Environmental issues related to deep geothermal systems.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Hyne N.J. (2001) Petroleum Geology, Exploration, Drilling and Production. Pennwell. ISBN 0-87814-823.
2. - Bustillo Revuelta M. (2018) Mineral Resources. Springer. DOI 10-1007/987-3-319-58760-8-4
3. Geothermal Energy. 2nd Edition by Ingrid Stober and Kurt Bucher; Springer Nature Switzerland AG 2021. https://doi.org/10.1007/978-3-030-71685-1.

4. The Future of Geothermal Energy. Idaho National Laboratory, Massachusetts Institute of Technology 2006. ISBN: 0-615-13438-6.

5. Thermo-Hydro-Mechanical (THM) coupled simulations of innovative enhanced geothermal systems for heat and electricity production as well as energy storage. By Muhammad Haris; Cuvillier Verlag Goettingen, ISBN-13: 9783736976603, 2022.

UNCONVENTIONAL RESOURCES

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

This course explores unconventional energy sources, focusing on their economic, technical, and environmental aspects. It covers resource types, drilling methods, and characterization techniques.

COURSE LEARNING OUTCOMES

1. Analyze the economic, technical, and environmental factors affecting unconventional energy development, and explore methods for resource extraction.
2. Understand the unique characteristics of various unconventional resources like tight sands, shale reservoirs, and coalbed methane.
3. Utilize measurement techniques for characterization and select drilling and completion methods specific to unconventional reservoirs.

COURSE CONTENT

1. Introduction to Unconventional Energy Resources

a. Economic significance, technical, economic, political, and environmental constraints on development of unconventional resources.

2. Occurrences, resources, and reservoir characteristics

a. Low-permeability (Tight) sands.

b. Shale reservoirs (gas and oil).

c. Coal Bed Methane (CBM).

d. Gas hydrates.

e. Heavy oil.

3. Drilling and completion methods for unconventional reservoirs

4. Other unconventional energy resources

a. Geothermal energy.

b. Coal conversion to gas.

c. Coal-to-gas and in-situ gasification.

d. Water and environmental issues.

e. Natural fractures and their importance in unconventional resources.

5. Basic measurements for characterization of unconventional resources.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Reza Rezaee, Fundamentals of Gas Shale Reservoirs, 2015.
2. Usman Ahmed and Nathan Meehan; Unconventional Oil and Gas Resources-Exploitation and Development, CRC Press, 2016, pp 860.
3. Ma and Holditch, "Unconventional Oil and Gas Resources Handbook: Evaluation and Development", 1st Edition, Elsevier, 2015.
4. A Guide to Coal-bed Methane Operation, Gas Research.

WELL COMPLETION

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

This course explores well completion fundamentals, design considerations, various completion equipment types, and techniques for single and multistage completions.

COURSE LEARNING OUTCOMES

1. Understand the basics of well completion, factors influencing design, and the functions of various completion equipment.
2. Analyze open hole, cased hole, and liner completions, choosing the right option based on wellbore conditions and stimulation needs.
3. Utilize perforation techniques and select completion equipment like tubing, packers, and downhole tools for single-stage and multistage stimulation treatments.

COURSE CONTENT

Basics of well completion,
Considerations in well completion design,
Types of well completion equipment including tubing, packers, liners, tubular goods, side sleeve doors, landing nipples, Wellhead, and trees.
Open hole, cased hole, and liner completions.
Completions for multistage stimulation treatments and perforation techniques.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1-Advanced Well Completion Engineering Third Edition 2011 by Wan Renpu, ISBN 978-0-12-385868-9, Gulf Professional Publishing

2-Well Completion Design by Jonathan Bellarby, 1st Edition 2009, volume 56, Elsevier. ISBN: 978-0-444-53210-7, ISSN: 0376-7361

3- Well Completion and Servicing by Denis Perrin, Editions Technip, Paris 1999, Institut Francais Du Petrole Publications ISBN: 2-7108-0765-3 ISSN 1271-9048

4- Modern Completion Technology for Oil and Gas Wells by Ding Zhu and Kenji Furui Publisher McGraw Hill LLC, 2018 ISBN 1259642038, 9781259642036

OFFSHORE FIELD DEVELOPMENT

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

Overview of offshore oil and gas industry, Regulatory framework and environmental considerations, Exploration and Site Selection, Types of offshore structures, Conceptual design and feasibility studies, Fixed and floating platform design and installation, Offshore drilling and production operations, Subsea infrastructure and pipelines, Field Development Planning, Production optimization strategies, Asset integrity management, Decommissioning and abandonment planning, Deepwater challenges.

COURSE LEARNING OUTCOMES

1. Explore its regulatory framework, environmental impact, and methods for exploration and site selection.
2. Analyze different offshore structures, design, and install platforms, and implement drilling, production, and subsea operations.
3. Apply field development strategies, production optimization techniques, and asset integrity management practices, considering decommissioning and deep-water challenges.

COURSE CONTENT

Overview of offshore oil and gas industry, Regulatory framework and environmental considerations, Exploration and Site Selection, Types of offshore structures, Conceptual design and feasibility studies, Fixed and floating platform design and installation, Offshore drilling and production operations, Subsea infrastructure and pipelines, Field Development Planning, Production optimization strategies, Asset integrity management, Decommissioning and abandonment planning. Challenges related to deep-water wells.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Handbook of Offshore Oil and Gas Operations by James G. Speight, 2011, Imprint Gulf Professional Publishing, Copyright Elsevier, ISBN 978-1-85617-558-6
2. Offshore Oil and Gas Development: Background and Issues by Jonathon C. Brady, Nova Science Publishers, Inc.; UK (January 8, 2013) ISBN : 978-1617288296.
3. Subsea Engineering Handbook by Yong Bai and Qiang Bai, 2010, Imprint Gulf Professional Publishing, Copyright Elsevier. ISBN 978-1-85617-689-7

INSTRUMENTATION & CONTROL

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

This course explores electrical fundamentals and digital logic in measurement, then delves into instrumentation technology, process control principles, and control system design.

COURSE LEARNING OUTCOMES

1. Understand scientific concepts behind instruments, select and calibrate them, and interpret their symbols.
2. Explore sensors for temperature, flow, level, and other parameters, understanding their design and function.
3. Grasp the concepts of process control, design control systems with appropriate hardware, and analyze system dynamics for effective control.

COURSE CONTENT

- Fundamentals of electrical technology and digital logic employed in measurement.
- Review of scientific principles employed in instruments — Parts of instruments; Dynamics and static properties of instruments; Selection and calibration of instruments; Instrument identification and line symbols.
- Available technology of instrumentation like Temperature; Flow; Level; Weight; Load; Pressure; Composition.
- Introduction and significance of process control
- Design and hardware elements of a control system
- Feed-forward and feed-backward control structures.
- Dynamics of first- and second-order systems
- P, PI, and PID controllers
- Routh's criterion and Bode plots

PRACTICAL REQUIREMENTS

As defined by the course content.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Stephanopoulos, G., Chemical Process Control: An Introduction to Theory and Practice. Prentice Hall.

CHEMICAL TECHNOLOGY OF PETROLEUM

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

This course provides a thorough understanding of the entire petroleum processing chain, from exploration and recovery to refining, product derivation, and the environmental implications of these processes.

COURSE LEARNING OUTCOMES

1. To describe the classification, origin, recovery, composition, and properties of petroleum products.
2. To describe various refinery operations and petroleum derived products and methods
3. To discuss the environmental aspects of petroleum and refinery wastes.

COURSE CONTENT

- History, origin, occurrence, and recovery of reservoir fluids from petroleum reservoirs; Exploration, recovery, transportation, pretreatment methods.
- Properties of petroleum and petroleum analysis methods.
- Refining of petroleum: Atmospheric/ Vacuum distillation; Thermal/ catalytic cracking; Hydrotreating; reforming; desulfurization of petroleum products.
- Petroleum-derived products: Polymeric materials.

PRACTICAL REQUIREMENTS

As defined by the course content.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Speight, J. G., The Chemistry and Technology of Petroleum. 5th ed.; CRC Press.
2. The Chemical Technology of Petroleum by William A Gruse and D. R. Stevens.
3. Petroleum Refinery Engineering by W.L. Nelson.

SURVEYING AND LEVELLING

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

This course explores fundamental surveying concepts, distance and angle measurement techniques, levelling methods, and introduces topographic surveying and modern tools like GPS.

COURSE LEARNING OUTCOMES

1. Define and differentiate survey types, utilize measurement instruments, and adjust for errors.
2. Implement various methods and instruments for measuring horizontal distances and elevations, addressing curvature, refraction, and inaccuracies.
3. Employ theodolites and plane tables for angle measurement, traverse adjustments, and area computation, understanding contours and their creation methods.

COURSE CONTENT

- Fundamental concepts: Definitions, Uses & types of surveys, Units of Measurement, Main instruments and their accessories accuracy and precision, Errors and Mistakes, adjustments of errors.
- Measurement of Horizontal Distances: Different Methods and instruments for distance measurement. Errors and mistakes in taping and their adjustments.
- Leveling: Different methods and instruments used for leveling. Effects of Curvature of earth and Refraction of atmosphere, Types of Levels, Errors in leveling and their adjustment. Differential profile, and Reciprocal Leveling.
- Angles and Directions: Angles and Directions, Meridians and Azimuths, Bearing and their computation. Adjustments of Bearings, Types of Compasses.
- Surveying Operation: Types of Theodolites, Measurement of Horizontal and Vertical Angles, Temporary and Permanent Adjustments. Plane Table Surveying. Transit Tape Traverse. Adjustment of Traverse. Computation of Rectangular Co-ordinates., Computation of omitted measurements, area computation of closed traverse. Topographic map, Contours, and their characteristics. Different methods of Contouring.
- An Introduction to Geomatics and Global Positioning System: Geomatics defined, Branches of Geomatics, GPS Surveying techniques

PRACTICAL REQUIREMENTS

1. To establish vertical control using differential levelling.
2. Distance measurement with taping
3. Traversing
   a. Plane table traverse
   b. Transit tape traverse
4. Basic operations of Hand-Held GPS receiver.
5. To locate the coordinates of Different building around Campus using Hand Held GPS.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Elementary Surveying: An Introduction to Geomatics / Charles D. Ghilani, Paul R.Wolf. 13th Ed. (2012)
2. Surveying and Leveling by T. P. Kanetker, Published by: Pune Vidyarthi Griha Prakashan, 24th Ed. (2010).
3. Surveying Theory and Practice by Raymond Earl Davis, Francis Seeley Foote and William Horace Rayner.
4. Published by: McGraw Hill, 3rd Ed. (1981)

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

Sample Courses for SDGS

FUNDAMENTALS OF PETROLEUM ENGINEERING

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

This course provides students an opportunity to acquire a comprehensive understanding fundamental intersections between energy requirements, petroleum as a primary energy source, and its impact on both national and international landscapes. In addition, it provides the historical, geopolitical, and technical aspects of the petroleum industry, providing insights into the complex energy demand, supply, and the role of petroleum engineers in society.

Mapped SDGs

SDG-4: Quality Education	4.4 Increase the number of youth and adults for employment, decent jobs and entrepreneurship ……
SDG-7: Affordable and Clean Energy	7.2 Ensuring affordable energy to everyone ……

COURSE LEARNING OUTCOMES

1. Explain Engineering Knowledge related to Petroleum & Gas Engineering fundamentals.
2. Apply the acquired knowledge towards Problem Analysis.

COURSE CONTENT

National and International energy requirements. Sources of energy. Role of Petroleum as an energy source. Brief history of International Petroleum industry. Influence of Petroleum on International politics. Highlights of local Petroleum industry. Job Scope of Petroleum engineering graduates.

Overview of Petroleum Engineering, Composition, physical properties, geological and geophysical prospecting, cable tool drilling, rotary drilling mechanisms, drilling fluids, formation evaluation, reservoir, and production engineering concepts.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Introduction to Petroleum Engineering, John R. Fanchi, Richard L. Christainsen, John Wiley, ISBN: 978-1119193449
2. Petroleum Engineering: Drilling and Well Completions, Carl Gatlin, Prentice Hall, ISBN: 978-0136621553.
3. Debby Denehy, Fundamentals of Petroleum, 5th Edition, PETEX, ISBN: 978-0886982317
4. Properties of Petroleum Fluids, 3rd Edition, William D. McCain Jr., PennWell Books, ISBN: 978-1593703738

PETROPHYSICS

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

Gives insight into petrophysical properties and its application to interpret well logs, analyse reservoir characteristics, and optimize hydrocarbon extraction strategies. The students will learn to integrate geology, physics, and engineering concepts to assess reservoir potential.

Mapped SDGs:

SDG-4: Quality Education	4.4 Increase the number of youth and adults for employment, decent jobs and entrepreneurship……

COURSE LEARNING OUTCOMES

1. To be able to explain knowledge related to fundamental properties of the fluid permeated reservoir rocks.
2. To be able to apply theoretical and practical knowledge to measure and calculate the petrophysical properties of the reservoir rocks.
3. To be able to apply the core analysis data for calculations of petrophysical properties and hydrocarbons in place.
4. To be able to explain special rock properties relevant for the understanding of reservoir rocks.

COURSE CONTENT

Introduction to formation evaluation, core analysis. Fundamental properties of fluid permeated rocks; porosity, Permeability, fluid saturations, compressibility, surface kinetics. Relative Permeability and Capillary Pressure, Core sampling and preservation. Measurement of basic rock properties. Interpretation of basic core analysis data. Special rock properties; electrical, acoustic, thermal.

Application of core analysis data. Calculations of petrophysical properties.

PRACTICAL REQUIREMENTS

1. To draw the layout plan of Petrophysics & Core laboratories
2. To determine the grain density of given core sample
3. To find the fluid saturation in the given core sample using modified Saturation Method.

4. To clean the given core sample using Extraction Methods.
5. To clean the given core sample using Soxhlet Extraction Methods.
6. To find the fluid saturation in the given core sample using Retort Oven.
7. To find the porosity of the given sample using Gravimetric Method.
8. To find the porosity of the given sample using Volumetric Method.
9. To calibrate Helium Porosimeter.
10. To measure the porosity of the given sample using Helium Porosimeter.
11. To measure the permeability of given Core sample using Gas Permeameter

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Petrophysics, Djebbar Tayyab, 4th Edition, Gulf Professional Publishing ISBN: 978-0128031889
2. Applied Petroleum Reservoir Engineering, B.C. Craft & M.F. Hawkins, Ronald E Terry, ISBN: 978-0130398840.
3. Fundamental of Reservoir Engineering, L.P. Dake, ISBN: 978-0444418302.
4. Petroleum Reservoir Engineering Physical Properties, James W. Amyx, ISBN: 0070016003.
5. API RP-40.

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:

SDG-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 CONTENT

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

- 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.

Case Studies of Different Development Projects in Social Context

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:FromTec hnical Artefacts to Socio technical systems.
7. Mitcham,C.,andMunoz,D.2010.HumanitarianEngineering. MorganandClaypoolPubli shers. 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