Curriculum for

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

7.	Engr. Prof. Dr. Amanat Ali Bhatti Convener, 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

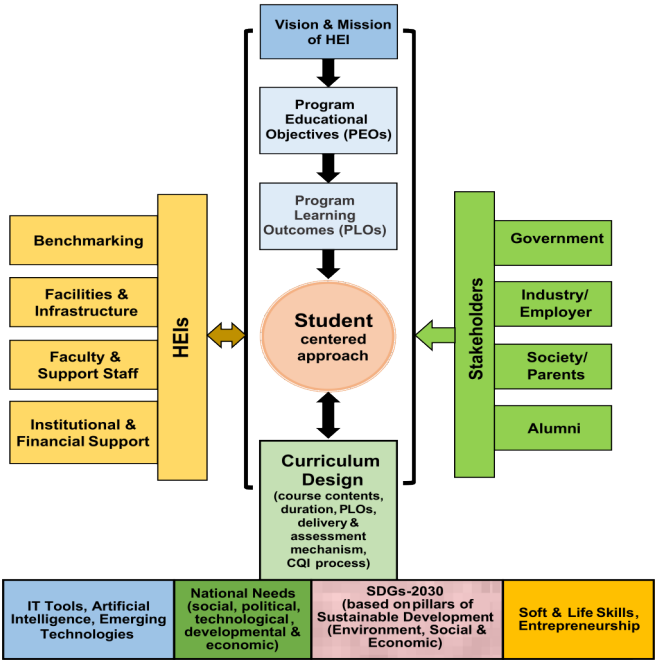
- The ECRDC is responsible to oversee the overall working of curriculum review and development for all engineering programs in terms of strategy, guidance & progress, and thereby submission to the relevant forum for adoption/ notification.

- 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

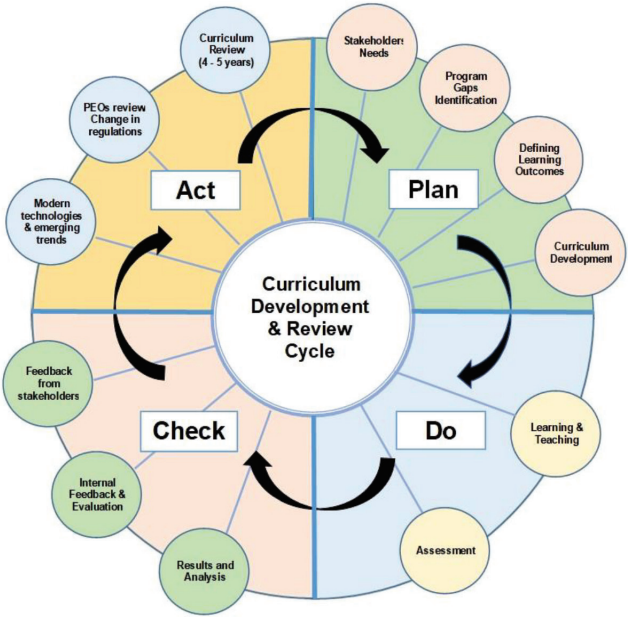
Outcome Based Education (OBE) is an approach of teaching and learning that focuses on what students should be able to attain at the end of the educational program. OBE is a student's centered system which concerns what the students will know and be able to do as learning outcomes. The curriculum development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

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 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

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

Sub-Group Mining Engineering

1.	Engr. Dr. Khan Gul Jadoon Professor, Karakoram International University (KIU), Gilgit	Lead Sub-Group
2.	Engr. Abdullah Shahwani Member, PEC Governing Body/ DG. Mines & Minerals Department, Balochistan	Member
3.	Engr. Dr. Fahad Irfan Siddiqui Associate Professor, MUET Jamshoro	Member
4.	Engr. Dr. Hafeez-ur -Rehman Associate Professor, BUITEMS Quetta	Member
5.	Engr. Dr. Azeem Raza Assistant Professor, UET Lahore	Member
6.	Engr. Falak Zaman Senior Inspector of Mines , Inspectorate of Mines, Minerals Development Department, Khyber Pakhtunkhwa	Member
7.	Engr. M. Waqar Ali Asad Professor, Curtin University, Australia	Member
8.	Engr. Dr. Ishaq Ahmed Professor, UET Peshawar	Member/ Secretary Sub-Group

The ECRDC Metallurgy & Materials, Mining & Petroleum and Gas Engineering appreciated the extraordinary efforts and contribution of Engr. Dr. Amanat Ali Bhatti (Convener), Engr. Dr. Khan Gul Jadoon (Lead Sub-Group), Engr. Dr. Ishaq Ahmad (Member/ Secretary Sub-Group) & Engr. Osaf Mahmood Malik (Section Head Curriculum & Development) for compilation of course contents and proof reading of this curriculum booklet.

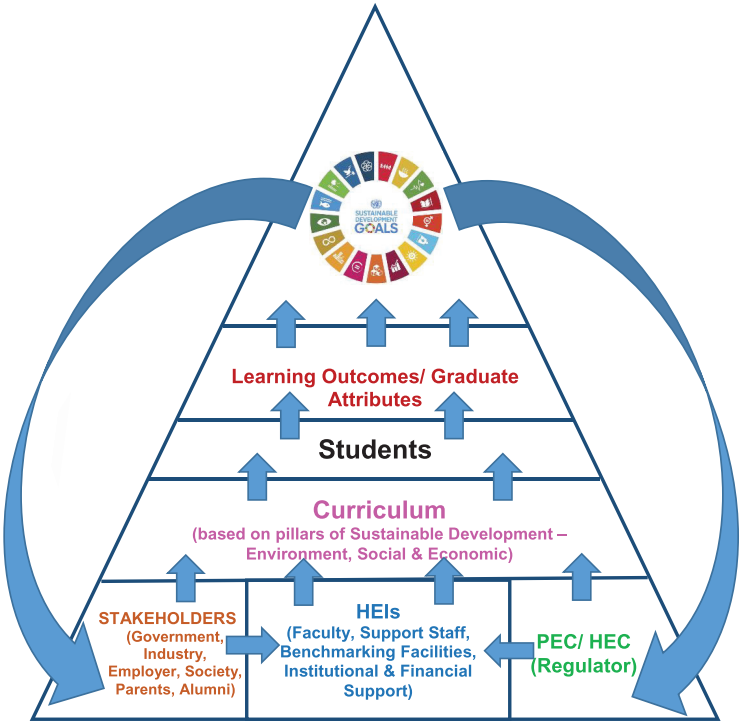
6. Agenda of ECRDC for Metallurgy & Materials, Mining & Petroleum and Gas Engineering Disciplines

- 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. 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 Attributes 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 creativity 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 Bachelor of Engineering Program with UN SDGs

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

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

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

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

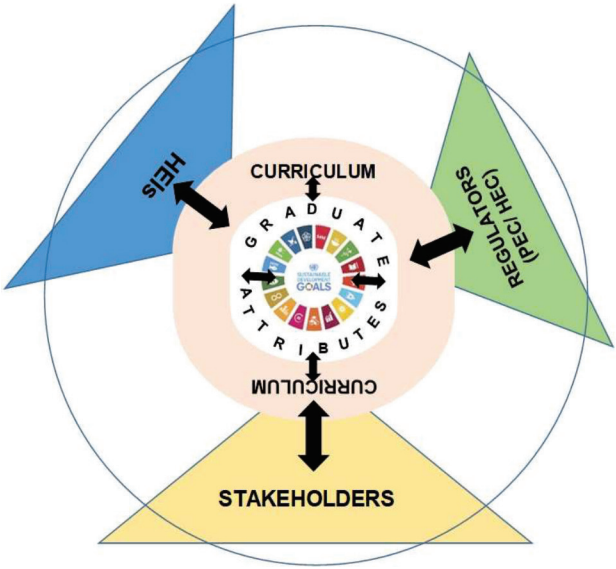


Figure 2: Consideration of UN SDGs in curriculum design

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

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

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

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

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

9. Correlation Matrix PLOs-ECs-WKs-SDGs

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

PLOs	ECs *	WKs	SDGs
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, 9,10, 11, 12, 13, 14 (relevance as per curriculum)
PLO-4 **Investigation:** Breadth and depth of investigation and experimentation	**EC-5** **Evaluation**	**WK-8** **Research literature**	SDG-9
PLO-5 **Tool Usage:** Level of understanding of the appropriateness of technologies and tools	**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 andCollaboration**	(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, 12
PLO-11 **Lifelong Learning:** Duration and manner	**EC-11** **Continuing Professional Development (CPD) and lifelong learning** **EC-12** **Judgement** **EC-13** **Responsibility for decisions**	**WK-8** **Research literature**	SDG- 3, 4, 8, 9, 12, 13

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

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

10. Program Salient Features

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

- **Duration:** 4 Years
- **Number of Semesters:** 8
- **Total Number of Credit Hours**: 130 - 136
    - General Education for Engineering Discipline: Min. 38 Credit Hours
    - Engineering Domain: Min. 72 Credit Hours
    - FYDP/ Capstone Project: 06 Credit Hours
    - Multidisciplinary Engineering Courses: Min. 06 Credit Hours
    - 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 Mining 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 Occupational Health and Safety (Mandatory 01 credit hours)	6
WK-4/ WK-5/ WK-6/ WK-7/ WK-8/ WK-9	Final Year Design Project (FYDP)/ Capstone	Integration of innovative, creative, technical, management and presentation skills of a graduate towards final year.		6

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

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

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

*** PEC ECRDC designed courses.

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

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

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

A final year design project (FYDP) is the confluence of an engineering program. Undertaking a final year design project is a compulsory requirement. It should mainly comprise literature search, individual analysis, modeling and simulation, AI (Artificial Intelligence) and computational data analytics, design of infrastructure, software, firmware and Algorithm Engineering / Informatics related to the program to demonstrate a functional concept including rapid prototyping, where applicable.

The FYDP shall include complex engineering problems and design systems, components or processes integrating core areas and meeting specific needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

A project of this nature should invariably lead to an integration of the knowledge and practical skills as mandated in the program outcomes. In this context, projects of multidisciplinary nature should be encouraged.

The FYDP should span over two consecutive semesters, i.e. semester 7 & 8, totaling 6-credit hours and should be fully supervised, assessed and reflected in the transcripts under a prescribed mechanism to prepare for joining industry after graduation.

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

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

Presentation and Communication Skills: Special focus should be given to inculcate communication and presentation skills amongst the graduates through

individual and group presentations, technical writing and discussions, throughout the program as a regular feature.

This Curriculum has been designed to guide and facilitate the universities and department to formulate their own programs according to the industrial needs, emerging trends and recent developments in the field of Mining 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 Mining Engineering Curriculum

Knowledge Profile (WK-1 to WK-9)	Knowledge Area	Subject Area	Name of Course	Th	Lab	Cr. Hrs.	Total Credits
General Education/ Non-Engineering Domain							
WK-1/ WK-5/ WK-7/ WK-9	**Humanities**	English	Functional English **	3	0	3	**6**
			Expository Writing **	3	0	3	
		Culture	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	
	Management Sciences	Professional Practice	Entrepreneurship **	2	0	2	**4**
			Project Management ***	2	0	2	
	Computer Sciences	Basic Computing	Applications of ICT **	2	1	3	**3**
WK-2/ WK-1	**Natural Sciences**	Mathematics	Calculus & Analytical Geometry	3	0	3	**12**
			Linear Algebra	3	0	3	
			Differential Equations	3	0	3	
			Numerical Analysis	3	0	3	
		Applied Science	Applied Chemistry	2	1	3	**3**
Total (General Education/ Non-Engineering Domain)				**36**	**2**	**38**	**38**

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

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

*** PEC ECRDC designed courses.

Knowledge Profile (WK-1 to WK-9)	Knowledge Area	Sub Area	Title of Course	Th	Lab	Cr. Hrs.	Total
Engineering Domain							
WK-2/ WK-4/ WK-5/ WK-6	**Advanced Computer and Information Sciences**	ICT/AI/ Data Science/ Programming	Introduction to Computing and Programming	2	1	1	**6**
			Applied AI & Machine Learning	2	1	3	
WK-2/ WK-3	**Engineering Foundation**		Mining Engineering Fundamentals	3	0	3	**22**
			Mine Surveying	3	1	4	
			Engineering Mechanics	3	1	4	
			Physical Geology	3	1	4	
			Applied Thermodynamics	2	1	3	
			Fluid Mechanics	3	1	4	
WK-1/ WK-4	**Major Based Core (Breadth)**		Underground Mine Design	3	0	3	**22**
			Explosive and Blasting Engineering	3	0	3	
			Ore Reserve Estimation	3	1	4	
			Surface Mine Design	3	0	3	
			Mine Hazards and Safety	2	0	2	
			Mine Design Lab	0	1	1	
			Technical Elective- I	3	0	3	
			Technical Elective- II	3	0	3	
WK-5/ WK-6	**Major Based Core (Depth)**		Mineral Processing- I	3	1	4	**22**
			Mineral Processing- II	3	1	4	
			Mine Ventilation	3	0	3	
			Mine Ventilation and Safety Lab	0	1	1	
			Rock Mechanics	3	1	4	
			Mine Power, Drainage and Material Handling	3	0	3	
			Technical Elective- III	3	0	3	

WK-1/ WK-2/ WK-3/ WK-4	**Multi-Disciplinary Engg Courses**		Mining Laws and Policies	3	0	3	**7**
			Environmental Aspects of Mining	3	0	3	
			Occupation, Health & Safety	1	0	1	
	Final Year Design Project (FYDP)		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**	
WK-6/ WK-7	**First Aid and Survey camp**	Non- Credit					
	Optional (Flexible Engineering/ Non-Engg Subjects)		Probability and Statistics	3	0	3	**13**
			Applied Electricity	2	1	3	
			Engineering Drawing & Graphics	1	2	3	
		Maximum Four (04) credit hour course (s) duly approved by HEI's Statutory Bodies may be offered under flexible Engineering/ Non-Engineering Category.		4	0	4	
			Total (Flexible Domain)	**10**	**3**	**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 Mining Engineering Curriculum

1st Year				
First Semester				
Sr. No	**Course Title**	**(Credit Hours)**		**Total Credit Hours**
		Theory	**Lab**	
1.	Linear Algebra	3	0	3
2.	Applied Chemistry	2	1	3
3.	Functional English	3	0	3
4.	Ideology and Constitution of Pakistan	2	0	2
5.	Islamic Studies/Ethics	2	0	2
6.	Arts and Humanities Elective *	2	0	2
7.	Mining Engineering Fundamentals	3	0	3
	Total	**17**	**1**	**18**

Second Semester				
Sr. No	**Course Title**	**(Credit Hours)**		**Total Credit Hours**
		Theory	**Lab**	
1.	Calculus & Analytical Geometry	3	0	3
2.	Application of ICT	2	1	3
3.	Engineering Drawing & Graphics	1	2	3
4.	Engineering Mechanics	3	1	4
5.	Physical Geology	3	1	4
	Total	**12**	**5**	**17**

2nd Year				
Third Semester				
Sr. No	**Course Title**	**(Credit Hours)**		**Total Credit Hours**
		Theory	**Lab**	
1.	Differential Equations	3	0	3
2.	Social Sciences Elective **	2	0	2
3.	Introduction to Computing and Programming	2	1	3
4.	Applied Thermodynamics	2	1	3
5.	Fluid Mechanics	3	1	4
6.	Applied Electricity	2	1	3
	Total	**14**	**4**	**18**

Fourth Semester				
Sr. No	**Course Title**	**(Credit Hours)**		**Total Credit Hours**
		Theory	**Lab**	
1.	Numerical Analysis	3	0	3
2.	Civic and Community Engagement	2	0	2
3.	Mine Surveying	3	1	4
4.	Explosive and Blasting Engineering	3	0	3
5.	Probability and Statistics	3	0	3
6.	Technical Elective - I ***	3	0	3
	Total	**17**	**1**	**18**

3rd Year				
Fifth Semester				
Sr. No	**Course Title**	**(Credit Hours)**		**Total Credit Hours**
		Theory	**Lab**	
1.	Expository Writing	3	0	3
2.	Project Management	2	0	2
3.	Applied AI & Machine Learning	2	1	3
4.	Mineral Processing -I	3	1	4
5.	Occupational, Health & Safety	1	0	1
6.	Rock Mechanics	3	1	4
	Total	**14**	**3**	**17**

Sixth Semester				
Sr. No	**Course Title**	**(Credit Hours)**		**Total Credit Hours**
		Theory	**Lab**	
1.	Underground Mine Design	3	0	3
2.	Surface Mine Design	3	0	3
3.	Mineral Processing -II	3	1	4
4.	Mine Design Lab	0	1	1
5.	Ore Reserves Estimation	3	1	4
6.	Technical Elective -II ***	3	0	3
	Total	**15**	**3**	**18**

4th Year				
Seventh Semester				
Sr. No	**Course Title**	**(Credit Hours)**		**Total Credit Hours**
		Theory	**Lab**	
1.	Entrepreneurship	2	0	2
2.	Mine Hazards and Safety	2	0	2
3.	Mine Ventilation	3	0	3
4.	Mine Ventilation and Safety Lab	0	1	1
5.	Mine Power, Drainage and Material Handling	3	0	3
6.	FYDP (Part -I)	0	3	3
	Total	**10**	**4**	**14**

Eighth Semester				
Sr. No	**Course Title**	**(Credit Hours)**		**Total Credit Hours**
		Theory	**Lab**	
1.	Mining Laws and Policies	3	0	3
2.	Technical Elective - III ****	3	0	3
3.	Environmental Aspects of Mining	3	0	3
4.	Flexible Course	4	0	4
5.	FYDP (Part -II)	0	3	3
	Total	**13**	**3**	**16**

* 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 Psychology • Critical Thinking • Human Resource Management • Organizational Behavior • Engineering Law • Engineering Economics • Applied Psychology • Engineering Management • Financial Management • Marketing Management • Leadership and Personal Grooming • Any other relevant course decided by the HEI as per requirement.

*** List of Technical Electives -I & II	**** List of Technical Electives -III
• Industrial Minerals • Gemstone Mining and Gemmology • Coal Technology • Minerals marketing/ utilization • Structural Geology • Operations research • Mine system analysis • Cement Technology • Extractive metallurgy • Drilling Technology • Geo and Minerals Surface Chemistry • Mineralogy and Petrology • Mine Management • Engineering Geology and Soil Mechanics • Mine Automation and Digitization • Mineral Exploration and Geostatistics • Introduction to GIS and Remote Sensing • Any other relevant course decided by the HEI as per requirement.	• Tunnel Engineering • Rock Engineering • Sustainable Mining • Dimension Stone Mining • Coal Mining • Strata Control / Ground Control Engineering • Mining and Processing of Rare Earth Elements • Placer Mining and Processing • Any other relevant course decided by the HEI as per requirement.

13. Program Specific Labs

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

- Rock Mechanics
- Minerals Processing
- Mine Ventilation and Mine Safety
- Mine Surveying
- Geology
- Mine Design Lab
- Computer 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 CONTENT

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

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

2. **Comprehension and Analysis:**
   - Understanding purpose, audience and context.
   - Contextual interpretation (tones, biases, stereotypes, assumptions, inferences, etc.).
   - Reading strategies (skimming, scanning, SQ4R, critical reading, etc.).
   - Active listening (overcoming listening barriers, focused listening, etc.).
3. **Effective Communication:**
   - Principles of communication (clarity, coherence, conciseness, courteousness, correctness, etc.).
   - Structuring documents (introduction, body, conclusion and formatting).
   - Inclusivity in communication (gender-neutral language, stereotypes, cross-cultural communication, etc.).
   - Public speaking (overcoming stage fright, voice modulation and body language).
   - Presentation skills (organization content, visual aids and engaging the audience).
   - Informal communication (small talk, networking and conversational skills).
   - Professional writing (business e-mails, memos, reports, formal letters, etc.).

PRACTICAL REQUIREMENT

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

SUGGESTED INSTRUCTIONAL/READING MATERIALS

1. "Understanding and Using English Grammar" by Betty Schrampfer Azar.
2. "English Grammar in Use" by Raymond Murphy.
3. "The Blue Book of Grammar and Punctuation" by Jane Straus.

4. "English for Specific Purposes: A Learning-Centered Approach" by Tom Hutchinson and Alan Waters.
5. "Cambridge English for Job-hunting" by Colm Downes.
6. "Practical English Usage" by Michael Swan.
7. "Reading Literature and Writing Argument" by Missy James and Alan P. Merickel.
8. "Improving Reading: Strategies, Resources, and Common Core Connections" by Jerry Johns and Susan Lenski.
9. "Comprehension: A Paradigm for Cognition" by Walter Kintsch.
10. "Communication Skills for Business Professionals" by J.P Verma and Meenakshi Raman.

EXPOSITORY WRITING

UGE Policy V1.1: General Education Course

Credits: 3+0
Pre-Requisite: Functional English

DESCRIPTION

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

COURSE LEARNING OUTCOMES

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

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

COURSE CONTENT

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 APPLICATION AND CAPSTONE PROJECT

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

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

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

ISLAMIC STUDIES

UGE Policy V1.1: General Education Course

Credits: 2+0
Pre-Requisite: Nil

DESCRIPTION

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

COURSE LEARNING OUTCOMES

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

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

COURSE CONTENT

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

- The Rashidun Caliphate and expansion of Islamic rule.
- Muslims contributions to philosophy, science, medicine, mathematics, and culture.

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

SUGGESTED INSTRUCTIONAL/READING MATERIALS

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

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

IDEOLOGY AND CONSTITUTION OF PAKISTAN

UGE Policy V1.1: General Education Course

Credits: 2+0
Pre-Requisite: Nil

DESCRIPTION

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

COURSE LEARNING OUTCOMES

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

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

COURSE CONTENT

1. Introduction to the Ideology of Pakistan:

- Definition and significance of ideology.
- Historical context of the creation of Pakistan (with emphasis on socio-political, religious, and cultural dynamics of British India between 1857 till 1947).
- Contributions of founding fathers of Pakistan in the freedom movement including but not limited to Allama Muhammad Iqbal, Muhammad Ali Jinnah., etc.
- Contributions of women and students in the freedom movement for separate homeland for Muslims of British India.

2. Two-Nation Theory:

- Evolution of the Two-Nation Theory (Urdu-Hindi controversy, Partition of Bengal, Simla Deputation 1906, Allama Iqbal's Presidential Address 1930, Congress Ministries 1937, Lahore Resolution 1940).
- Role of communalism and religious differences.

3. Introduction to the Constitution of Pakistan:

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

4. Constitution and State Structure:

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

5. Fundamental Rights, Principles of Policy and Responsibilities:

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

6. Constitutional Amendments:

- Procedures for amending the Constitution.
- Notable constitutional amendments and their implications.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "The Idea of Pakistan" by Stephen P. Cohen.
2. "Ideology of Pakistan" by Javed Iqbal.
3. "The Struggle for Pakistan" by I.H. Qureshi.
4. "Pakistan the Formative Phase" by Khalid Bin Sayeed.
5. "Pakistan: Political Roots and Development" by Safdar Mahmood.
6. "Ideology of Pakistan" by Sharif-ul-Mujahid.
7. "The Struggle for Pakistan: A Muslim Homeland and Global Politics" by Ayesha Jalal.

8. “Jinnah, Pakistan and Islamic Identity: The Search for Saladin” by Akbar S. Ahmed.
9. “The Making of Pakistan: A Study in Nationalism” by K.K. Aziz.
10. “Pakistan: A New History” by Ian Talbot.
11. “Pakistan in the Twentieth Century: A Political History” by Lawrence Ziring.
12. “The Constitution of Pakistan 1973”. Original.
13. “Constitutional and Political Development of Pakistan” by Hamid Khan.
14. “The Parliament of Pakistan” by Mahboob Hussain.
15. “Constitutional Development in Pakistan “ by G.W. Choudhury.
16. “Constitution-Making in Pakistan: The Dynamics of Political Order” by G.W. Choudhury.

*** List of Arts and Humanities Electives (2+0)**

- Communication and Presentation Skills
- Beginners Spanish
- Elementary Arabic
- Elementary French
- Elementary Chinese
- History
- Philosophy
- Professional Ethics

COMMUNICATION AND PRESENTATION SKILLS

Credits: 2+0
Pre-Requisite: Nil

DESCRIPTION

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

COURSE LEARNING OUTCOME

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

1. Write clearly, concisely, and grammatically correctly in various forms, avoiding errors.
2. Read critically to understand information better and improve vocabulary.
3. Deliver engaging presentations with effective communication and visuals.
4. Adapt communication style to audience and context, demonstrating active listening.

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. Pronounce and read Chinese characters accurately using Hanyu Pinyin.
2. Recognize and write approximately 260 basic Chinese characters, applying them in simple communication.
3. Create 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. Explain the epistemological nature of history, including its methods of knowledge production and the challenges it faces.
5. Identify and categorize different forms of historical narratives based on their focus, methodology, and purpose.

COURSE OUTLINE

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

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

COURSE OUTLINE

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

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 OUTCOMES

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

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

COURSE OUTLINE

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

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

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 CONTENT

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 Psychology • Critical Thinking • Human Resource Management • Organizational Behavior • Engineering Law • Engineering Economics • Applied Psychology • Engineering Management • Financial Management • Marketing Management • Leadership and Personal Grooming

SOCIOLOGY FOR ENGINEERS

Credits: 2+0
Pre-Requisite: Nil

DESCRIPTION

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

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**
  Extenttowhichdevelopmentintendstosensitizesocietalandunder-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

1. Principles of sociology and psychology with emphasis on the individual and his/her reciprocal interaction with groups,
2. 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,
3. 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,
4. 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. Explain the importance of asking questions, actively listening, and challenging assumptions.
4. Describe common creative thinking techniques like brainstorming, mind mapping, and De Bono's thinking hats.List and explain root cause analysis techniques like the 5 Whys and Ishikawa Diagram.
5. Describe strategies for effectively presenting recommendations to decision-makers and stakeholders

COURSE CONTENT/COURSE OUTLINE

Course Overview

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

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

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

COURSE CONTENT/COURSE OUTLINE

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

- Types of training
- Technique of training
- Project Description and discussion
- Compensations
- Managing compensation
- Types of compensation
- Rewarding performance
- Pay for Performance
- Designing and administering benefits
- Types of benefits
- Employee relations

SUGGESTED INSTRUCTIONAL/READING MATERIALS

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

ORGANIZATIONAL BEHAVIOUR

Credits: 2+0
Pre-Requisite: Nil

DESCRIPTION

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

COURSE LEARNING OUTCOMES

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

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

COURSE CONTENT/COURSE OUTLINE

- Foundations of Individual Behaviour:
- Biographical Characteristics, Ability, Learning
- Organizational behaviour from Islamic and indigenous perspective
- Understanding human psychology through the lenses of Quran and Sunnah
- Attitudes and Job Satisfaction
- Types of attitudes
- Types of behaviours
- Perception and Individual Decision Making
- Why perception is important
- Types of decision making
- Biases and errors in decision making
- Motivation concept

- Content theories of Motivational
- Process theories of motivation
- Motivation: from concept to application
- Applying motivation concepts for designing reward system

SUGGESTED INSTRUCTIONAL/READING MATERIALS

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

ENGINEERING LAW

Credits: 2+0
Pre-Requisite: Nil

COURSE LEARNING OUTCOMES

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

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

COURSE CONTENT/COURSE OUTLINE

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

SUGGESTED INSTRUCTIONAL/READING MATERIALS

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

ENGINEERING ECONOMICS

Credits: 2+0
Pre-Requisite: 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

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

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

COURSE CONTENT/COURSE OUTLINE

1. Introduction
   - Engineering Costs
   - Estimation Models & Cash Flow Diagram
   - Life cycle cost
2. Time value of Money
   - Time value of money, equivalence, use of spread sheet, simple and compound interest
   - Uniform series & Arithmetic & geometric gradient
   - Nominal & effective, continuous compounding Economic criteria,
   - Present Worth, future worth and annuity
3. Rate of Return
   - Minimum acceptable rate of return(MARR),
   - Internal rate of return, External rate of return
   - Choosing the best alternative
   - Incremental Analysis
4. Benefits and Cost ratio and Payback period
   - Benefit and cost ratio (B/C Ratio), discounted benefit and cost ratio
   - Simple payback period, discounted payback period
   - Sensitivity & breakeven analysis
   - Principle of comparative advantage

5. Depreciation
   - Depreciation
   - Depreciation using Unit of Production
   - Depreciation using straight line method
   - Depreciation using Depletion
6. Taxes
   - Income Taxes, After tax RoR
   - Replacement analysis
   - Design life, salvage value
   - Up gradation Vs replacement
7. Risk and Uncertainty
   - Estimation of future events
   - Monte Carlo Simulation
   - Bayes theorem
8. Concepts of Imports and Exports
   - Basic concepts of import and export
   - Dumping and anti-dumping and related laws
9. Teaching Methodology
   - Lecturing
   - Written Assignments
   - Presentation

SUGGESTED INSTRUCTIONAL/READING MATERIALS

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

APPLIED PSYCHOLOGY

Credit: 2+1
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: 2+0
Pre-Requisites: Nil

DESCRIPTION

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

COURSE LEARNING OUTCOMES

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

COURSE OUTLINE

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

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

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

FINANCIAL MANAGEMENT

Credit: 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 OUTLINE

Risk and return (Required rate)

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

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

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

Cash Operating / Conversion Cycle

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

Management of Marketable Securities

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

Receivables Management

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

Management of Receipts and Disbursements

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

Generic Current Assets' Management

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

Management of Current Liabilities

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

Leverage and Capital Structure

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

Payout Policy

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

Long-term Debt Management

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

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

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

MARKETING MANAGEMENT

Credit: 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 OUTLINE

- Defining Marketing For The 21st Century. Importance and scope of Marketing.
- Discussion on Course Outline:
- Some fundamental Marketing Concepts, How Marketing Management changed. How does the Marketing affect customer Value? Discussion on Project Outline
- Identifying Market Segments and Targets. Different levels of market segmentation & requirements of effective segmentation? How companies divide a market into segments?
- Creating and delivering Customer Value, satisfaction and loyalty. What is the lifetime value of customers and how can marketers maximize it? How can companies cultivate strong customer relationship? How can companies both attract and retain customers?
- Analyzing Consumer Markets & Globalization How do consumer characteristics influence buying behavior & major psychological processes influence consumer Reponses to the marketing program?

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

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

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

LEADERSHIP AND PERSONAL GROOMING

Credit: 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 OUTLINE

Fundamentals of Leadership and Servant Leadership

- What is leadership; Leadership Traits; Servant Leadership

Foundations of Community Development

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

Social Capital, Community Building and Community Development Practice

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

Community development assessment,

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

Building Powerful Community Organizations

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

Marketing your Organization

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

Mobilizing Resources: Raising Money

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

Measuring Progress

- Community development indicators, Best practices & Benchmarking

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

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

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 CONTENT

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 CONTENT

- **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 CONTENT

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 AND ANALYTICAL GEOMETRY

Credit: 3+0
Pre-Requisites: Nil

COURSE LEARNING OUTCOMES

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

COURSE OUTLINE

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

- **Integration:**
  a. Integrals and Properties of Integrals
  b. Techniques of Integration
  c. Integration by Parts
  d. Definite Integrals
  e. Integration of Trigonometric
  f. Exponential and Inverse Functions
  g. Integration by Partial Fractions
  h. Reduction Rules
- **Applications of Integration:**
  a. Applications of Integration
  b. Area under the curve
  c. Area between curves
  d. Solids of Revolution
  e. Volume of Solids of revolution by disk
  f. washer, Cylindrical shell & Cross Section Methods
  g. Center of Pressure and Depth of Center of Pressure
  h. Center of mass
  i. Arc length
- **Improper Integrals:**
  a. Improper Integral
  b. Integrals and Singularities
  c. Convergence of improper integrals
- **Infinite Sequence and Series:**
  a. Sequence and Infinite Series
  b. Convergence and Divergence of sequences and series
  c. Positive Term Series
  d. Integral Test
  e. Basic Comparison Test
  f. Limit Comparison Test
  g. Ratio and Root tests
  h. Alternating series
  i. Absolute and Conditional Convergence
- **Power and Taylor Series:**
  a. Power series
  b. Maclaurin and Taylor Series and its Applications

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

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

LINEAR ALGEBRA

Credit: 3+0
Pre-Requisites: Nil

DESCRIPTION

Linear Algebra" provides students with a solid foundation in mathematical concepts essential for engineering applications. The course covers topics such as linear equations, vector spaces, transformations, eigenvalues, eigenvectors, linear programming, and applications in dynamical systems. Emphasis is placed on understanding the theoretical principles and applying them to solve real-world engineering problems.

COURSE LEARNING OUTCOMES

The knowledge units in this area collectively encompass the following:

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

COURSE OUTLINE

- **System of Linear Equations and Applications**
  a. Overview of linear system of equations, Cases of unique solution, No solution and infinite solutions,
  b. Echelon form, Gauss elimination method, Inversion of matrix in the context of solution of system of equations, LU factorization, Row space and column space
  c. Relevant engineering case studies such as Network analysis, Traffic Flows, Balancing chemical reaction, Leontief Input-output model, Finding max stress in compound cylinder, Applications of linear systems in force balancing of structures, Markov process
- **Vector Spaces and Transformations**
  a. Vector Spaces: Real vector spaces, Subspaces, Basis and dimension, Rank, Nullity
  b. Gram-Schmidt process for finding orthonormal basis
  c. Linear Transformation, Kernel of Transformation, Range of Transformation, Matrix of Transformation,
  d. Applications: Cryptography, Coding and decoding, Breaking of codes, Robotic Applications of linear transformations
- **Eigenvalues and Eigen Vectors**
  a. Eigenvalues, Eigenvectors, Similar matrices, Diagonalization,
  b. Quadratic forms, Positive definite Matrices, Singular Value Decomposition, Inner product Spaces
  c. Applications of linear Algebra: Constructing curves and surfaces, Computer graphics, Genetics

- **Linear Programming**
  a. Solution Introduction to linear programming, Optimization, Graphical method, Simplex method, Optimization problems in engineering and economics
  b. Dual simplex methods, Duality theory, Primal and dual problems, transportation models, north-west corner, least-cost and Vogel's approximations methods,
  c. Assignment model, the transshipment model and other relevant engineering case studies
- **Application of Linear Algebra in Dynamical Systems**
  a. Numerical System of linear ODEs, Eigenvalue problems, Homogeneous and nonhomogeneous system of ODE.
  b. Dynamical systems, Population dynamics, Prey-Predator models, Stability analysis

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

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

DIFFERENTIAL EQUATIONS

Credit: 3+0
Pre-Requisites: Nil

DESCRIPTION

Differential Equations" is a foundational course in engineering focusing on mathematical models and analytical methods to solve differential equations encountered in engineering applications. Topics include first-order differential equations, analytical methods for first and second-order ODEs, series solutions, Laplace transforms, and partial differential equations. Emphasis is placed on formulating and solving real-world engineering problems using differential equation techniques.

COURSE LEARNING OUTCOMES

The knowledge units in this area collectively encompass the following:

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

COURSE OUTLINE

Basic Concepts and Modelling

- Linear Differential equations, Non-Linear, Differential equations, Solutions of differential equations, General solutions, Particular solutions, Initial and boundary value problems, Degree and order of ODEs
- Formulation of first-order ODEs: Case studies related to finding age of fossils, Mixing problems and free fall motion, Finding temperature of a building, RL, RC circuits, Airplane take-off problem, Population dynamics and logistic equations etc.

Analytical Methods of Solution for First-order ODEs

- Variable separable method, Reduction to variable separable form, Homogeneous equations, Differential equations reducible to homogeneous form, Solution of the related ODE models by these methods
- Exact equations, Integrating factors, Linear equations and related examples, Bernoulli's equations, Orthogonal trajectories and solution of the related ODE models by these methods

Mathematical Models Based on Second-order ODEs

- Formulation of a single RLC circuit, Spring mass systems, Earthquake model of a single story building
- Bungee Jumper model, Bridge collapse problem etc.

Analytical Methods of Solution for Second-order ODEs

- Homogeneous linear ODEs, Method of reduction order , Wronskain determinant to check independence of the solution, and related examples
- Cauchy-Euler equations and related examples, Non-homogeneous linear ODEs, Method of undetermined coefficients
- Method of variation of parameters and related example
- Analytical solution of the related ODE models by these methods

Series Solution for Second-order ODEs

- Series solution of ODEs and convergence tests
- Series solution of Legendre equation, Frobenious method of solution for Bessel equation and related applications

Laplace Transform

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

Partial Differential Equations

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

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Advanced Engineering Mathematics by Erwin Kreyszig, John Wiley & Sons Inc. Latest Edition.
2. Differential Equation with Boundary Value problems by D. G. Zill, M. R Cullen Latest Edition, Brooks/Cole Publishers.
3. A First Course on Differential Equations with Modelling Applications by D. G. Zill, Latest Edition, Brooks/Cole Publishers.
4. An Introduction to Mathematical Modelling by Bender, E.A., Latest Edition, Wiley, New York.

NUMERICAL ANALYSIS

Credit: 3+0
Pre-Requisites: Nil

COURSE LEARNING OUTCOMES

The knowledge units in this area collectively encompass the following:

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

COURSE OUTLINE

- **Error Analysis and Interpolation**
  a. Error analysis, Types of error, Sources of error, Norms of vectors and matrices, Computer arithmetic, Condition number of a matrix, Significant digits and loss of significant digits, Floating point arithmetic, Binary and decimal representation, Single and double precision
  b. Interpolation: Newton forward and backward difference formula for interpolation, Central difference interpolation formulae, Lagrange's interpolation, Error in interpolation, Linear least square approximation, Interpolation versus least square approximation, Relevant engineering case studies
- **Numerical Differentiation and Integration**
  a. Derivation of numerical differentiation of first order and second order derivatives using two points, three points, and five points formulas along with its application in engineering, Relevant case studies
  b. Numerical integration: Trapezoidal rule, Simpson's rules, Composite Trapezoidal Simpson Rules and Romberg integration, Applications of numerical in engineering, Relevant case studies
- **Methods of solution a system of Linear Equations**
  a. Solution of system of linear algebraic equations, Gauss elimination method
  b. LU factorization, Tridiagonal solver
  c. Applications of these methods in engineering disciplines, Relevant case studies

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

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

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

- **Numerical Methods for Computing Eigenvalues**

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

- **Numerical Optimization**

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

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Numerical Analysis: By Richard L. Burden, J. Douglas Faires, Latest Edition
2. Numerical methods for scientist and engineers by R.W. Hamming (Latest Edition)
3. Numerical methods for Engineers by Steven C. Chapra and R. P. Canale (Latest Edition)

APPLIED CHEMISTRY

Credit: 2+1
Pre-Requisites: Nil

COURSE LEARNING OUTCOMES

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

1. Know Reaction mechanism and industrial applications of organic compounds and their reactions.
2. Understand chemical process industry, Industrial Chemical Analysis and primary raw materials used in various industries.
3. Infer the knowledge of synthesis and basic reactions of reagents in mineral separation processes
4. Learn Synthesis characterization and applications of cement and steel

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 mineral process industry and primary raw material, Industrial Pollution Prevention, Industrial mineral Analysis, Chemical Explosives, Synthetic reagents, minerals surface chemistry, corrosion, chemical analyses of materials, chemistry of cement and chemistry of steel. Chemical manufacturing processes and production methods

COURSE OUTLINE (PRACTICALS)

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

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

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. Minerals surface chemistry
5. Gary Wulfsberg, Foundations of Inorganic Chemistry, University Science Books, 2017 David Klein, Organic Chemistry , Wiley, 2017

14.2 Engineering Domain

INTRODUCTION TO COMPUTING AND PROGRAMMING

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

Introduction to programming basics (what it is and how it works), binary computation, problem-solving methods and algorithm development. Includes procedural and data abstractions, program design, debugging, testing, and documentation. Covers data types, control structures, functions.

COURSE LEARNING OUTCOMES

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

1. Differentiate between the programming basics (operations, control structures, data types, etc.)
2. Evaluate python tools and libraries used in developing programming-related projects.
3. Analyze the application of programming in the field of Mining engineering.

COURSE CONTENTS

1. **Introduction**
   - Computers and Programming in Engineering
   - Basic principles of computing
2. **Introduction to Python**
   - Python IDEs
   - Using the Python interpreter
   - Introduction to binary computation
   - Input / Output
3. **Data types**
   - Lists
   - Dictionary
   - Tuple
4. **Tuple properties and Methods**
5. **List Properties and Methods**
6. **Dictionary Properties and Methods**
7. **If, Elif Conditional statements**
8. **For Loops**
9. **While Loops**

10. **Introduction to Object Oriented Programming**
11. **Computer Applications in Mining**
12. **Case study as a Project**

PRACTICAL REQUIREMENTS

- Installation of Anaconda, Setting Anaconda Environment and IDEs and Python Libraries
- Introduction to python data types and data structures
- Application of computer programming in earth sciences and mining engineering
- Creating Lists and Dictionaries and applying properties associated with – Lists – Dictionary -- Tuple
- Creating Lists and Dictionaries and applying methods associated with – Lists – Dictionary -- Tuple
- Applying conditional statements in programming
- Applying For Loops in computer programming
- Applying While Loops in computer programming
- Applying logical operators during computer programming
- Introduction to Modelling and Optimization
- Develop computing code for Project -I
- Data Analysis PCA hands on case study
- Introduction to functions
- Develop computing code for Project -II

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Starting Out with Python plus MyLabProgramming with Pearson eText by Tony Gaddis
2. "Introduction to Computers" by Peter Norton
3. "Computing Essentials" by Timothy O'Leary and Linda O'Leary

APPLIED AI AND MACHINE LEARNING

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

This course aims to enhance expertise in Applied AI and Machine Learning through a comprehensive course covering fundamental concepts like SVM, Softmax loss, and Stochastic Gradient Descent, while delving into advanced topics including Computer Vision, Deep Learning, and ML Explainability for a well-rounded understanding of cutting-edge technologies

COURSE LEARNING OUTCOMES

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

1. Fundamental Understanding of Machine Learning Techniques such as Softmax loss, and Stochastic Gradient Descent Identify uses of various ICT platforms and tools for different purposes.
2. Construct neural network architectures for specific tasks, while also understanding the nuances of enhancing model performance through various techniques Understand the ethical and legal considerations in use of ICT platforms and tools
3. Explain and interpret machine learning models effectively.

COURSE CONTENT

1. Introduction to Machine Learning
2. SVM and Softmax loss
3. Stochastic Gradient Descent
4. Computer Vision Basics
5. Image analysis
6. Feature extraction and processing
7. Shallow neural network
8. Introduction to Deep learning
9. Back propagation in neural networks
10. Dropout, Batch normalization and optimization
11. ML Explainability

Lab: The contents of the lab course will be based on the theory course

PRACTICAL REQUIREMENTS

Hands on experience using various essential software: Python for programming, Jupyter Notebook for interactive coding, and VS Code or PyCharm for development. Key libraries e.g. NumPy, Pandas, Matplotlib, Scikit-learn, TensorFlow, Keras, and PyTorch. Various other software for managing environments, databases management, for reinforcement learning for the operating system due to better compatibility with AI tool

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Machine learning" by Tom Mitchell
2. "Pattern Recognition and Machine Learning" by Christopher M. Bishop
3. "Deep learning" by Good Fellow
4. Google AI Kaggle Learn online course
5. CS229 lecture note (https://cs229.sta nford.edu/main_notes.pdf)

MINING ENGINEERING FUNDAMENTALS

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

This course offers a foundational overview of key operations in mining engineering, encompassing both production and auxiliary aspects. Subjects covered include various stages in a mine's lifecycle, evaluation of resources, planning and design of mines, methods for surface and underground mining, techniques for drilling and blasting, systems for rock support, transportation of materials, mineral processing, ventilation in mines, safety protocols, environmental considerations, and future trends in mining. Additionally, the course aims to impart an understanding of the significance of mining in Pakistan and globally, as well as familiarize students with the operational dynamics of the mining industry.

COURSE LEARNING OUTCOMES

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

1. Explain how mining is carried out and why.
2. Identify mining systems (both underground and surface mines)
3. Comparison of Mining practice in Pakistan and other countries.

COURSE CONTENT

1. **An introduction to the field of mining engineering and its economic importance.**
   - Definition and significance of mining
   - Historical overview of mining industry
   - Role of mining in the global economy (Pakistan Vs global)
   - Mining terminology and concepts
2. **Mining Terminology**
3. **Overview and extraction of minerals in Pakistan.**
4. **Governmental Oversight in the Mining Industry: Federal and Provincial Roles**
5. **Mine Life Stages**
   - Prospecting
   - Exploration
   - Development
   - Exploitation
   - Reclamation

6. **Unit Operations of Mining**
    - Production Operations
    - Auxiliary Operations
7. **Mining Methods**
    - Surface mining methods
    - Underground mining methods
    - Selection criteria for mining methods
8. **Mine Supports.**
9. **Mine Ventilation**
10. **Mineral Dressing**

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Introductory Mining Engineering" By Howard L. Hartman, Jan M. Mutmansky
2. "SME Mining Engineering Handbook", By Peter Darling
3. "Wills' Mineral Processing Technology: An Introduction to the Practical Aspects of Ore Treatment and Mineral Recovery" by Barry A. Wills and James Finch

MINE SURVEYING

Credits: 3 + 1
Pre-Requisite: Nil

DESCRIPTION

The course provides students with a comprehensive understanding of the principles, techniques, and applications of surveying in the mining, geotechnical, and civil industry. It includes the use of traditional and advanced surveying tools and technologies. Through a combination of theoretical knowledge and practical exercises, students will develop the skills required to accurately and efficiently survey mining sites, contributing to safe and optimized mining operations.

COURSE LEARNING OUTCOMES

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

1. Understand the fundamental principles of mine surveying, including measurement techniques, instrumentation, and data analysis.
2. Apply mathematical and computational methods to solve surveying problems encountered in mining operations, such as calculating volumes, designing mine layouts, and establishing control points.
3. Interpret and utilize mine plans, diagrams, and surveys for efficient mine planning, development, and safety management.
4. Demonstrate knowledge of industry standards and best practices in mine surveying to ensure compliance with safety and environmental requirements.

COURSE CONTENTS

Introduction to Mine Surveying

- Definitions, uses & types of surveys, survey measurements, errors and adjustments.
- Role and importance of mine surveying in mining engineering
- Historical development and advancements in mine surveying

Surveying Measurement and Calculation Techniques

- Distance measurement methods (taping, EDM, stadia surveying etc.)
- Angle measurements and horizontal control (compass, theodolite, total station, etc.)
- Vertical control and leveling techniques
- Introduction to GPS/D-GPS and Drone-based Surveying

Surveying Operation & Adjustments

- Traversing and adjustments
- Triangulation, adjustment of triangulation network,
- Construction & use of optical alidade,

Underground & Surface Mine Surveying

- Challenges and techniques specific to underground mine surveying
- Tunnel surveying
- Surface mine mapping
- Volumetric calculations for open-pit mines

Data Analysis and Interpretation

- Data validation and quality control
- Statistical methods for survey data analysis
- Creation of maps using modern tools

PRACTICAL REQUIREMENTS

1. Surveying Instruments and Technologies

- Introduction to surveying instruments (theodolites, total stations, GPS, etc.)
- Applications of laser scanning and drone technology in mine surveying
- Hands-on training with surveying instruments

2. Surveying Operation & Adjustments

- Distance Measurement
- Leveling & Vertical Control
- Angle Measurement & Horizontal Control
- Traversing (Plane Table, Transit-tape, etc.)
- Triangulation
- Adjustment of traverse and triangulation network,
- construction & use of optical alidade,
- precise measurement of baseline,
- location of details and area measurement, determination of meridian by astronomical observation, topographic maps

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Elementary Surveying" by Charles D. Ghilani and Paul R. Wolf
2. "Surveying" by Davis and Foot
3. "Surveying and Levelling" by Kanetker Vol.1&2
4. "Fundamentals of Capturing and Processing Drone Imagery and Data" by Amy Frazier and Kunwar Singh

ENGINEERING MECHANICS

Credits: 3+1
Pre-Requisite: Nil

DESCRIPTION

This course introduces the fundamental principles of mechanics and their application to problems encountered in engineering. Students will gain a strong understanding of statics, dynamics, and mechanics of materials, enabling them to analyze forces, stresses, strains, and deformations in various engineering structures and equipment.

COURSE LEARNING OUTCOMES

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

1. Define fundamental concepts in statics and dynamics, including force, moment, equilibrium, velocity, and acceleration.
2. Apply equilibrium principles to solve engineering problems involving forces, moments, and free body diagrams across various engineering contexts.
3. Solve static and dynamic problems related to structures, demonstrating an understanding of their behavior under different loading conditions.
4. Evaluate the impact of friction on engineering systems' design and performance, utilizing basic numerical methods and engineering software for structural analysis.

COURSE CONTENT

1. **Introduction to Engineering Mechanics**
   - Basic concepts and principles
   - Units and dimensions
   - Vector algebra/analysis.
2. **Statics**
   - Force systems and equilibrium of rigid bodies.
   - Free body diagrams and equilibrium analysis of 2D and 3D structures
   - Trusses and frames
3. **Dynamics**
   - Kinematics: motion description, displacement, velocity, acceleration
   - Kinetics: Newton's laws of motion, work and energy, impulse and momentum
4. **Mechanics of Materials**
   - Stress and strain analysis.
   - Mechanical properties of materials (elasticity, plasticity, yield strength, ultimate strength)

- Axial loading and torsion
- Bending and shear forces in beams
- Laws of friction

5. Structural Analysis

- Analysis of trusses and frames
- Deflection of beams
- Stability of structures
- Applications of numerical methods to solve engineering mechanics problems.

PRACTICAL REQUIREMENTS

- Verification of the link polygon for various uni-planer forces.
- Determination of tension in various parts of a hanging cord.
- Verification of the principle of moments on a bent lever.
- Calculation of supporting reactions in a simply supported beam, forces developed in various parts of a simple roof truss, forces developed in various parts of a wall crane.
- Calculation of moment of inertia of a flywheel by falling-weight method.
- Calculation of moment of inertia of a wheel (by rolling it down an inclined plane).
- Calculation of coefficient of friction between two materials on an inclined plane.
- Calculation of the coefficient of friction between the given belts and the cast iron pulley.
- Calculation of efficiency and to draw load efficiency curve for a screw jack.
- Drawing load-efficiency curve for a simple lifting grab.
- Drawing load-efficiency curve for a worm and worm wheel (helical block).
- Drawing load-efficiency curve for a Weston's differential pulley block.
- Drawing load-efficiency curve for a wheel and axle.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Mechanics of Materials" by R. C. Hibbeler
2. "Engineering Mechanics" by Timoshoko & Young
3. "Mechanics" by Q.K Ghori.

PHYSICAL GEOLOGY

Credits: 3 +1
Pre-Requisite: Nil

DESCRIPTION

Physical geology is the study of the Earth system, minerals, rocks, structural geology, plate tectonics, geologic time, geological processes, and landforms. This course is designed to give a basic understanding of geology and geological techniques for both geology and non-geology majors.

COURSE LEARNING OUTCOMES

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

1. Read and interpret geological maps and physical features of earth.
2. Identify minerals and rocks using appropriate terminologies.
3. Identify mineral resources and their uses

COURSE CONTENT

1. Introduction to Geology, Origin of the Earth
2. Geologic Time
3. Continental Drift, Plate Tectonics
4. Plate Tectonics
5. Minerals
6. Minerals, Igneous Rocks
7. Igneous, Rocks, Volcanoes
8. Volcanoes, Sediments and Sedimentary Rocks
9. Sedimentary Rocks, Metamorphic Rocks
10. Metamorphic Rocks, Cartography and Maps
11. Geologic Structures, Earthquake
12. Weathering, Soils, Mass Wasting
13. Earthquake, Weathering and Erosion
14. Groundwater and Surface Water
15. Wind and Desert
16. Shorelines and Glaciers

PRACTICAL REQUIREMENTS

1. Thin section preparation

2. Thin section investigation using Polarizing Microscope
3. Mineral properties
4. Minerals Identification
5. Igneous Rocks and its Identification
6. Sedimentary Rocks and its Identification
7. Metamorphic Rocks and its Identification
8. Crystallography and crystal systems
9. Topographic maps and Contours
10. Geologic Maps
11. Geologic Structures
12. Earthquake and Landslides
13. Groundwater

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Understanding Earth" by Grotzinger, John, and Jordan, Thomas H
2. "A Textbook of Geology" by Santosh Kumar Grag

APPLIED THERMODYNAMICS

Credit: 2+1
Pre-Requisite: Nil

DESCRIPTION

This Course has been designed to develop the understanding of the applications of thermodynamics and different types of equipment in mining (e.g. air compressor, heat engine etc). It will focus on various laws of thermodynamics and its properties, and ideal gas behavior. Thermodynamics applications in heat engines, refrigeration, compressors and power generation. Emphasis is on understanding real-world thermodynamic processes, its efficiency, and sustainability in mining machines.

COURSE LEARNING OUTCOMES

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

1. Explain basic ideas, concepts and laws of Thermodynamics.
2. Discuss the fundamentals and applications of different equipment's (air compressor, I.C engine, refrigerator etc.)
3. Solve problems related to thermodynamics

COURSE CONTENT

1. Basics/Introduction: Basic thermodynamics, system, thermodynamic equilibrium, state, property, process, cycle, heat, work, concept of reversibility and irreversibility, perfect gas laws and characteristics equation, work done during thermodynamics process, first law of thermodynamics and its applications, constant pressure process, constant volume process, isothermal and adiabatic process, internal energy, and enthalpy point and second law of thermodynamics and its applications.

2. Engines: Engine classification, four and two stroke engines, working process, cooling system, lubricating system, fuel system and ignition system of engines.

3. Air compressors: Air compressors and their types, constructional details of reciprocating and rotary compressors, uses of compressed air, calculation for power requirement of reciprocating compressors.

4. Boilers: Boilers, types and uses, accessories and auxiliaries of boilers, controls on boilers.

5. Refrigeration and air conditioning: Refrigeration and air conditioning; principles of vapor compression system. Cop of refrigeration plant, psychometric properties of air.

PRACTICAL REQUIREMENTS

- Introduction to engines: Introduction to two-stroke and four stroke engines, introduction to petrol and diesel engine, fuel system of a four-stroke engine, ignition system of a four-stroke engine, cooling system of a four-stroke engine,
- Lubrication system: lubrication system of a four-stroke engine, basic vapor compression cycle, two-stage reciprocating air compressor.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Applied thermodynamics for Engineering Technologist" by T.D. Eastop and A. McConkey
2. "Thermodynamics Applied to Heat Engines" by E.H. Lewitt

FLUID MECHANICS

Credit: 3+1
Pre-Requisite: Nil

DESCRIPTION

This course is designed to introduce fluid mechanics and establish its relevance in Mining Engineering by studying distinctive characteristics of fluid. Introduction to fluid principles and monitoring laws for efficient utilization of different fluids in the mining and mineral processing industry.

COURSE LEARNING OUTCOMES

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

1. Explain the basic concept and principles of fluid statics and kinematics.
2. Solve hydrostatic problems by applying relevant principles.
3. Solve hydro kinematics problems by applying relevant principles.

COURSE CONTENT

1. Physical properties of fluids: Density specific weight, specific volume, specific gravity, surface tension, and compressibility.
2. Viscosity: Newton's equation of viscosity, units of viscosity, measurement of viscosity, dissipation of energy in lubricated bearings.
3. Fluid statics: Pressure, pressure-specific weight and height relationship.
4. Units of pressure: Absolute and gauge pressure.
5. Measurement of pressure: Bourden gauge, manometers and differential manometers, forces on submerged plane and curved surface and their application.
6. Flow types: Basic concepts about 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, impersemomentum equation.
7. Flow measurements: Measurements of velocity, pitot tube, measurement of discharge, venturimeter, orifices, notches and weirs.
8. Steady flow through pipes: Darcy weisbach equation for flow in pipes, chery's manning and kutter's formula. losses in pipelines, hydraulic and energy gradients, transmission of energy through pipes, uniform flow through open channels (Chezy's and Manning's formula) economical cross-section (rectangular and trapezoidal), use of pumps and their characteristics.

PRACTICAL REQUIREMENTS

1. Study of hydraulic bench,
2. Study the operation of hydraulic bench,
3. Study of the characteristics of flow over a rectangular notch,

4. Investigation of the validity of Bernoulli's equation as applied to flow of water in a tampering circular duct,
5. Measurement of coefficient of velocity "Cv" of small orifice by jet distance method or coordinates methods,
6. Finding the coefficient of velocity "Cv" coefficient of discharge "Cd" and coefficient of contraction "Cc" by energy method,
7. Study of characteristics of flow over a triangular notch,
8. Determination of co-efficient of discharge of given Venturi meter

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Fluid Mechanics" by Frank. M. White
2. "A Textbook of Fluid Mechanics and Hydraulic Machines" by R K Bansal
3. "Fox and McDonald's Introduction to Fluid Mechanics" by Philip J. Pritchard, John W. Mitchell
4. "Basics of Fluid Mechanics" by Genick Bar-Meir

UNDERGROUND MINE DESIGN

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

This course is designed for introducing students to the principles and methodologies essential for planning, designing, and operating underground mines. Topics covered include geological and geotechnical considerations, mine layout and infrastructure design, underground mining methods and their selection, equipment selection, safety protocols, environmental management, and economic analysis. Through a combination of theoretical learning, practical exercises, and case studies, students gain the knowledge and skills necessary to tackle the complexities of underground mining projects and address industry challenges effectively.

COURSE LEARNING OUTCOMES

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

1. To select a mining method based on geologic conditions.
2. Perform mine layout for a given deposit.
3. To select equipment and services determination for a target underground production rate with safety and economically.

COURSE CONTENT

1. **Introduction**
   - Objectives of underground Mine design and planning
   - Design Process in Engineering
   - Design and Planning as Complementary Partners
   - Safety and Economy as Opposing Partners in underground mining
2. **Factors to be considered for Mine design**
   - Climatic and Physiographic Data
   - Geological Data
   - Geomechanical and Geochemical Data
   - Economic Data
   - Corporate Policy
   - Environmental and Mining Laws of the Country
3. **Geological and Economic Considerations**
   - Geological mapping and interpretation
   - Ore body characterization and modeling
   - Structural geology and its implications for mining
   - Reserves and production rate

4. **Designing strategies**
   - Mining Planning and Layout
   - Classification of Underground Mining Methods
   - Selection of Mining Method
   - Determination of access points and mine layout
   - Equipment selection
   - Short- and long-term mining planning
5. **Integrated Design**
   - Design of Mine Pillars
   - Designing Pillars and Planning Extraction Sequences
   - Application of Rock Mass Classification to Pillar Design
   - Integrated Design Procedure for the Design of Room and Pillar Mine Workings
   - Mechanisms of Instability in Underground Excavations
   - Design and Analysis of Underground Excavations
   - Geotechnical Considerations and support applications in mine stabilization
6. **Shaft Sinking**
   - Factors Affecting the Design of Shaft
   - Methods of Shaft Sinking
   - Lining of Shafts
7. **Mine operations strategies**
   - Underground operations
   - Surface operations
   - Project risk assessment
   - Emergency preparedness and response
   - Production scheduling
   - Sustainability
8. **Environmental impacts of underground mining and remedial measures**
9. **Case Studies**
   - Analysis of real-world underground mining projects

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Underground Mine Planning" by Jim Dowling
2. "Mine Design, Planning and Sustainable Exploitation in the Digital Age" by A.J.S. (Sam) Spearing, Liqiang Ma, Cong-An Ma
3. "Underground Mining Methods: Engineering Fundamentals and International Case Studies" by William A Hustrulid and Richard L Bullock
4. "Rock Mechanics for Underground Mining" by B.H.G. Brady and E.T. Brown
5. "SME Underground Mining Handbook" by Peter Darling

EXPLOSIVES AND BLASTING ENGINEERING

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

This course explores rock fragmentation through blasting in surface and underground mining, covering explosive-rock interactions, fracture mechanisms, and design principles. It addresses choice of explosives, initiation methods, safety, and environmental concerns. Additionally, it delves into mine process optimization considering fragmentation's impact on mineral extraction downstream.

COURSE LEARNING OUTCOMES

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

1. Understand the significance of rock fragmentation through blasting in mining operations and its influence on downstream processes.
2. Identify and classify various types of commercial explosives and accessories and their specific applications.
3. Apply appropriate techniques to assess fracturing caused by explosive charges under varying rock conditions and expected performance criteria.
4. Design safe and efficient blasting operations, considering blast outcomes, environmental impacts, and legislative requirements, and effectively communicate these plans within a team setting.

COURSE CONTENT

1. **Introduction to Explosives**
   - Chemical composition and properties of explosives
   - Definition and classification of explosives
   - Types of explosive reactions (deflagration vs. detonation)
   - Applications of explosives in different industries
2. **Explosive properties and initiation systems**
   - Types, properties, selection and charging techniques
   - Initiation systems, blasting accessories and their applications
3. **Explosive rock breakage**
   - The Role of Blasting
   - Detonation and explosive performance
   - Explosive rock interaction, fracture and fragmentation mechanisms
   - Introduction to damage and fragmentation modelling techniques

4. **Blast design concepts**
   - Rock mass characterization for blasting
   - Design principles and practices (Bench and underground)
   - Management of fragmentation and blast damage
   - Environmental impacts and management (Fly rock, gasses, vibration, air blast, and sound)
   - Relevant legislation and standards (Transportation, handling, storage, etc.)
5. **Mine process optimization**
   - Role of Blasting in the mining value chain
   - Implementation of integrated optimization methods such as Mine to Mill
   - Blast movement and grade control to enhance value and recovery
6. **Commercial explosives in Pakistan**
   - Wah Nobel explosives
   - Biafo Explosives
   - Chiniot safety fuse manufacturing company
7. **Future trends and advancements in the field**

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Rock Blasting and Explosives Engineering" by Per-Anders Persson, Roger Holmberg, Jaimin Lee
2. "Applied Explosive Technology for Construction and Mining by Stig O. Olofsson
3. "SME Mining Engineering Handbook" by Peter Darling
4. "Cost estimation handbook for the Australian mining industry" by Michael Noakes, Terry Lanz
5. "Performance of Explosives and New Developments" by Vinay Kumar Singh, Bibhu Mohanty

ORE RESERVE ESTIMATION

Credit: 3 +1
Prerequisites: Nil

DESCRIPTION

This course provides fundamental knowledge in mineral resource estimation, covering geological data analysis, statistical techniques, and modeling principles crucial for assessing deposits' size, grade, and distribution.

COURSE LEARNING OUTCOMES

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

1. Describe various steps of mineral resource estimation.
2. Differentiate between statistics and geostatistics.
3. Compare and contrast various aspects of linear geostatistical techniques for resource estimation of recoverable reserves.

COURSE CONTENT

1. **Introduction to Mineral Resource Estimation**
   - Introduction to Mineral Exploration
   - Overview of ore reserve estimation
   - SME/JORC/CIM Guidelines, Resource and Reserve Classification, Resource estimation methodology and reporting
2. **Mineral Resource Estimation**
   - Data Collection and Sampling Techniques
   - Geologic interpretation Modelling and interpretation.
   - Compositing, grade distribution,
3. **Introduction to Statistics**
   - Mean, Variance, St Deviation, frequency distributions, discrete and continuous
   - Univariate and multivariate data sets, Covariance, Correlation
   - Distribution types, parameters, and confidence intervals
   - Declustering
4. **Traditional Resource Estimation**
   - Polygonal Estimation
   - Triangulation
   - Cross Sectional Method, Inverse distance weighting

5. **Geostatistical Techniques**
   - Geostatistics vs classical statistics, why geostatistics?
6. **Spatial Structural Analysis:**
   - *Spatial Statistics*: h-scatter plots, Semi- variance, Variogram, Semi-variogram, Variogram calculation, Variogram modelling, Linear, Spherical, exponential and Gaussian model, Stationarity, Geometric and Zonal anisotropies
7. **Linear Geostatistical Estimation:**
   - Kriging, Best Linear Unbiased estimator- Ordinary Kriging
   - Kriging variance, Uncertainty of estimated variable
   - Variogram parameters and Kriging

PRACTICAL REQUIREMENTS

1. Introduction to Geological Modeling and Resource Estimation Software
2. Geological interpretation of data for mineral resource estimation
3. Determine Mean, Median, Mode of sample data set, grade analysis of univariate geochemical samples.
4. Determine Variance, scatter plots, covariance, and h-scatter plots of data sets.
5. Multivariate Regression for modeling trend in data
6. Experimental variogram of a given data set, model a variogram using MS Excel
7. Solve Ordinary Kriging sets of equation using MS Excel
8. Analyze Kriging estimates.
9. Using SGEMS for Mineral Resource Estimation

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Introduction to Geostatistics" by Isaaks and Srivastava
2. "Applied Mineral inventory Estimation" by Sinclair A.J. & Blackwell G. H.

SURFACE MINE DESIGN

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

Surface Mine Design course equips students with knowledge and skills in planning and designing surface mining operations. It covers principles of mine planning, geological factors, equipment selection, environmental impact assessment, safety protocols, and economic evaluations. Through theory and practice, students gain a comprehensive understanding of surface mine design and management complexities.

COURSE LEARNING OUTCOMES

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

1. Explain the significance of fundamental principles like geological considerations, environmental impact, and regulatory requirements in surface mine design.
2. Design geometric pit configurations and pit limits for optimal efficiency and safety.
3. Select appropriate production equipment for surface mining operations based on project requirements and technical specifications.
4. Design haulage systems and mine infrastructure for optimal efficiency.
5. Perform a comprehensive economic evaluation of a surface mine project, including cost estimation, financial analysis, and sensitivity analysis.

COURSE CONTENT

1. **Introduction to Surface Mine Design**
   - Introduction to surface mining methods (open pit, strip mining, quarrying)
   - Mine phases: Pre-cursor to mining, exploitation, post-mining
   - Advantages and limitations of surface mining compared to underground mining.
   - Ore reserves (proven, indicated, and possible reserves)
2. **Mine Geometric Design Principles**
   - Overview of the surface mine design process

- Pit geometric design: pit geometry, bench geometry, safety berms, slope stability analysis, catch bench, bench structural integrity evaluation, haul road design.

3. Pit Limit Optimization

- Block modeling basics.
- Economic block values.
- Pit optimization algorithms, techniques, and software.
- Overview of mine planning and scheduling.

4. Surface Mining Equipment and Operations

- Excavation equipment: shovels, loaders, draglines
- Hauling equipment: trucks, conveyors, etc.
- Auxiliary equipment: dozers, grader, drills, etc.
- Equipment selection, productivity modeling, sizing, fleet optimization, equipment risk modeling

5. Economic Considerations and Sustainability

- Cost estimation and financial analysis
- NPV (Net Present Value), ROI (Return on Investment), and economic feasibility
- Mine closure and reclamation planning
- Sustainable mining practices

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Open Pit Mine Planning and Design" by William A. Hustrulid and Mark Kuchta
2. Lecture Slides: Customized lecture slides covering each topic in the course contents to aid in delivering structured and visually engaging lectures.
3. "SME Mining Engineering Handbook" edited by Peter Darling
4. "Surface Mining" by Bruce A. Kennedy
5. "Performance Handbook" by Caterpillar
6. "Specifications & Applications Handbook" by Komatsu
7. "Geotechnical Considerations in Open Pit Mines" by J. Read and P. Stacey
8. "Equipment Selection for Surface Mining: A Review" by A. Burt and C. Caccetta

MINE HAZARDS AND SAFETY

Credits: 2+0
Pre-Requisite: Nil

DESCRIPTION

This course is designed to familiarize students with the hazards related to mining. Students will be able to know about the types, identification, evaluation, effects and control of mine hazards. Students will learn about types and control of mine accidents. They will also be able to recognize the importance of safety management in mines and will learn about control of spontaneous heating, mine fires, explosions, and understand the procedures of mine rescue.

COURSE LEARNING OUTCOMES

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

1. Identify occupational hazards related to mining and describe principles of accident prevention in mining.
2. Explain the occurrence, effects, and control of mine gases and particulate matter.
3. Analyze causes and prevention of spontaneous combustion, mine fires, and mine explosions.
4. Describe equipment and management of mine rescue operations.

COURSE CONTENT

1. Importance of mine safety
2. Concept of accidents causation phenomenon, principles of accidents prevention,
3. Mine hazards: types, identification, evaluation techniques, and control.
4. Mine gases and Dusts: Sources, types, properties, effects, detection, analysis, and control. Introduction to instruments used for detection and measurement of mine gases and dusts.
5. Occupational diseases in mining: Types, causes, and control.
6. Spontaneous Combustion and Mine Fires: Causes, effects and control of spontaneous combustion and underground mine fires, firefighting equipment, and procedures.
7. Mine explosions, occurrence and consequences of firedamp and coal dust explosions in mines, control of mine explosions.
8. Safety management in mines: concept, principles, and latest approach
9. Mine Rescue: Construction, types and uses of various kinds of mine rescue and breathing apparatuses, organization of recovery and rescue work, opening of sealed areas.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Mine Health and Safety management" by Michael Karmis
2. "Hazard prevention and control in the work environment: airborne dust" by World Health Organization
3. "Western Canada Mine Rescue Manual" by Ministry of Energy and Mines Office of the Chief Inspector of Mines.
4. "Improving safety culture: a Practical guide" by Cooper Dominic.

MINE DESIGN LAB

Credits: 0+1
Pre-Requisite: Nil

DESCRIPTION

The course provides the students with hands-on experience in surface and underground mine design. The course provides practical experience in applying mine design principles to both surface and underground mining scenarios. Students will work on real-world mining design projects, utilizing industry-standard software tools and techniques, to develop proficiency in mine planning, layout, and optimization.

COURSE LEARNING OUTCOMES

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

1. Apply theoretical mine design concepts practically, utilizing software tools for surface and underground layouts.
2. Analyze geological and geotechnical data to identify challenges and ensure safe mining operations.
3. Develop mine plans prioritizing safety, environmental impact, and economic feasibility.
4. Implement optimization techniques to enhance pit configurations, haulage systems, and overall mine infrastructure.

COURSE CONTENT

1. Introduction to Mine Design Principles
2. Familiarization with the software tool
3. Geological Data Interpretation for Mine Design
4. Surface Mine Design Techniques
5. Underground Mine Design Techniques
6. Mine Planning and Scheduling
7. Equipment Selection and Optimization
8. Environmental Considerations in Mine Design
9. Safety and Risk Assessment in Mine Design
10. Cost Estimation and Economic Analysis
11. Case Studies and Project Work

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Software Manual for the software selected.
2. "Open Pit Mine Planning and Design" by William A. Hustrulid and Mark Kuchta

*** List of Technical Electives -I & II
• Industrial Minerals • Gemstone Mining and Gemmology • Coal Technology • Minerals marketing/ Utilization • Structural Geology • Operations research • Mine system analysis • Cement Technology • Extractive metallurgy • Drilling Technology • Geo and Minerals Surface Chemistry • Mineralogy and Petrology • Mine Management • Engineering Geology and Soil Mechanics • Mine Automation and Digitization • Mineral Exploration and Geostatistics • Introduction to GIS and Remote Sensing

INDUSTRIAL MINERALS

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

This course is designed to provide students with a fundamental understanding of the geological occurrence, extraction, processing, and utilization of industrial minerals of the world in general and Pakistan in particular. The course explores the importance of industrial minerals in various sectors including construction, manufacturing, agriculture, and environmental applications. From this course, the students will gain insight into the diverse range of industrial minerals, their properties, and their significance in modern society.

COURSE LEARNING OUTCOMES

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

1. Gain understanding of industrial minerals, their applications, and geographical distribution.
2. Familiarize themselves with global mining practices and the mining sector's involvement in the extraction of industrial minerals, both globally and specifically in Pakistan, emphasizing environmentally sustainable methods.
3. Develop skills to strategize the efficient utilization of Pakistan's industrial minerals.
4. Explore potential marketing avenues for these materials.

COURSE CONTENT

1. **Introduction to Industrial Minerals**
   - Definition and classification of industrial minerals
   - Economic significance and global distribution
   - Historical perspectives and current trends
2. **Geological Formation of Industrial Minerals**
   - Geological processes and environments conducive to industrial mineral formation
   - Types of mineral deposits and their characteristics
   - Exploration techniques and geological mapping
3. **Mining Methods for Industrial Minerals**
   - Surface mining techniques
   - Underground mining methods
   - Dredging and solution mining

4. **Processing Technologies**
   - Crushing, grinding, and screening
   - Physical separation methods
   - Chemical processing techniques
5. **Utilization of Industrial Minerals**
   - Construction and Infrastructure
   - Industrial Minerals in Ceramics and Glass
   - Industrial Minerals in Chemicals and Pharmaceuticals
   - Industrial Minerals in Agriculture and Fertilizers
   - Industrial Minerals in Energy and Environmental Technologies
6. **Sustainability and Environmental Considerations**
   - Environmental regulations and permitting for industrial mineral extraction
   - Rehabilitation and reclamation of mining sites
   - Sustainable practices in mineral resource management
7. **Case Studies and Industry Perspectives**
8. **Current status of industrial minerals of Pakistan and its global comparison**
   - Available deposits
   - Mining
   - Beneficiation
   - Utilization
   - Marketing
9. **Future Trends and Challenges**

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Mineral Resources and Development" by Ganpat Singh Roonwal, K. Shahriar, Hojjatollah Ranjbar
2. "Industrial Minerals & Rocks; Commodities, Markets, and Uses" by Jessica Elzea Kogel
3. Mineral Directory of Pakistan – GSP Quetta.

GEMSTONE MINING AND GEMOLOGY

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

This course is designed to provide the students with basic concepts in gemstone mining. The course will cover identifying gem bearing host rocks, exploration techniques, Mining techniques, challenges, and environmental concerns. Gemstone Mining is an interdisciplinary course designed to provide undergraduate students with a comprehensive understanding of the geological, mining, and economic aspects of gemstone extraction. This course explores the scientific principles, mining techniques, environmental considerations, and market dynamics associated with gemstone mining.

COURSE LEARNING OUTCOMES

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

1. Students will acquire a solid understanding of the geological processes leading to the formation of gemstone deposits.
2. Students will learn the application of mining methods suitable for gemstone extraction from different types of geological formations and will be able to understand environmental issues related gemstones mining.
3. Students will also learn basic gems identification techniques. Gemstone mining activities.

COURSE CONTENT

1. **Geological Formation of Gemstones**
   - Mineralogy and geology of gemstone deposits
   - Formation processes and conditions
   - Identification of gemstone-bearing rocks
2. **Gemstone Exploration and Prospecting**
   - Remote sensing and geological mapping
   - Sampling techniques for gemstone identification
   - Geophysical methods for exploration
   - Gemstones resources of Pakistan
3. **Mining Techniques for Gemstones**
   - Gemstones Mining localities in Pakistan

- Surface mining
- underground mining
- Artisanal and small-scale mining
- Sustainable mining practices

4. Gemstone Extraction

- Gemstone extraction methods

5. Environmental and Social Impacts

- Environmental considerations in gemstone mining
- Social and ethical issues in the gemstone industry
- Responsible mining practices

6. Gemology

- Basic concept of Gems identification
- Techniques used for identification of gemstones
- Gemstone valuation and pricing
- Cutting, polishing, and shaping techniques
- Value addition processes

7. Gemstone Market and Trade

- Global gemstone market trends
- International trade regulations

PRACTICAL REQUIREMENTS

- Case Studies and Field Trips
- Field trips to operational gemstone mines
- Use of gems identification equipment.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Gemstone and Jewelry Resources of Pakistan" by Malkhani, S
2. SMEDA, An overview of Gemstone Sector- Pakistan.
3. "Gemstone & Mineral Data Book" by Walter Schumann
4. "Gemstones of the World" by Walter Schumann
5. "Introduction to Mineralogy" by William D. Nesse
6. "Gemstone Buying Guide" by Renee Newman
7. "Gemstone Manufacturing" by Antoinette Leonard Matlins

COAL TECHNOLOGY

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

The course provides an in-depth exploration of the entire lifecycle of coal, covering its importance in global economies, chemistry, classification, exploration, sampling techniques, analysis methods, preparation, and advanced utilization technologies. Students will gain a comprehensive understanding of coal from extraction to utilization, including environmental and economic considerations.

COURSE LEARNING OUTCOMES

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

1. Explain coal's global importance, origin, classification, and its role in energy production.
2. Apply analytical techniques to assess coal quality based on properties like proximate and ultimate analysis.
3. Demonstrate understanding of coal preparation operations including size reduction, separation, concentration, and dewatering.
4. Evaluate coal utilization technologies considering economic feasibility and environmental impact, including combustion and gasification.

COURSE CONTENT

1. Introduction to Coal

- Importance of coal in world economies and energy production
- Origin, formation, and classification of coal based on rank and properties
- Coal exploration techniques and resource evaluation (including Pakistan-specific examples)
- Exploration protocols and techniques
- Coal resources assessment methods
- Overview of coal reserves in Pakistan

2. Coal Analysis and Characterization

- Common analytical techniques for thermal and coking coal properties (proximate analysis, ultimate analysis, calorific value, ash fusion temperature, etc.)
- Coal reporting basis (air-dried, as-received, etc.) and interpreting results

3. Coal Preparation Principles and Operations

- Introduction to coal preparation and its principles
- Unit operations of coal preparation plants:
- Size reduction & separation (crushing, grinding, screening, classification)
- Concentration (gravity separation, jigging, dense medium washing)
- Dewatering and waste disposal (thickening, filtration)
- Coal preparation plant practices and typical process flowsheets

4. Coal Combustion Technologies and Utilization

- Overview of coal combustion processes
- Gasification, liquefaction, and carbonization
- Production of coke and coal-based chemicals

5. Economic and Environmental Considerations

- Designing coal preparation plants
- Economic feasibility analysis
- Environmental impact assessment

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "The Coal Handbook Towards Cleaner Production" by Dave Osborne
2. "Coal Preparation" by J. W. Leanord & B. C. Hardinge
3. "Coal Energy Systems" by B. G. Miller
4. "An Introduction to Coal Technology" by N. Berkowitz.

MINERALS MARKETING/UTILIZATION

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

The course basically tries to explain industrial Minerals in Pakistan, which are obtained by mining and represents non-metallic, non-fuel raw materials of commercial value. These include limestone, rock salt, phosphate, clays, soapstone etc. The course is a combination of theoretical concepts, practical applications, and industry-specific knowledge.

COURSE LEARNING OUTCOMES

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

1. Demonstrate comprehensive understanding of industrial minerals, including significance, classification, extraction, and distribution.
2. Analyze physical and chemical properties of industrial minerals, adherence to quality standards, and testing methods.
3. Evaluate market dynamics and conduct thorough research to develop effective marketing strategies.
4. Apply understanding of industrial minerals value chain and navigate regulatory environments in marketing.

COURSE CONTENT

1. **Introduction to Industrial Minerals**
   - Overview of industrial minerals and their significance in various industries
   - Classification of industrial minerals
   - Exploration and extraction processes
   - Global distribution and availability of industrial minerals
2. **Characteristics and Properties of Industrial Minerals**
   - Physical and chemical properties of common industrial minerals
   - Quality standards and specifications
   - Mineral testing and analysis methods
3. **Market Analysis and Research**
   - Market trends and dynamics in the industrial minerals sector
   - Conducting market research and feasibility studies
   - Analyzing demand and supply factors

4. **Value Chain in Industrial Minerals**
   - Exploration and mining
   - Processing and beneficiation
   - Distribution and transportation
   - End-user industries
5. **Regulatory Environment**
   - Environmental regulations and sustainability in mining
   - Health and safety regulations
   - Permitting and compliance issues
6. **Marketing Strategies**
   - Developing a marketing strategy for industrial minerals
   - Branding and positioning
7. **International Trade and Export**
   - Export regulations and documentation.
   - Managing international logistics
   - Cross-cultural considerations in marketing
8. **Case Studies**
   - Real-world examples of successful industrial mineral marketing
   - Analysis of marketing challenges and strategies in the industry
9. **Emerging Technologies in Industrial Minerals Marketing**
   - Use of technology in exploration and mining
   - Digital marketing trends in the minerals industry
   - Data analytics for market intelligence
10. **Industry Visits and Guest Lectures**
    - Field trips to mines and processing facilities
    - Guest lectures from industry experts
    - Networking opportunities with professionals in the field
11. **Major topics:**
    - Introduction to industrial minerals
    - Place and value.
    - Industrial minerals and national economy
    - Creation of market through political resources
    - Industrial mineral resources in Pakistan
    - Potential of Pakistani raw materials

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Mineral Resources of Pakistan" by M. Sadiq Malkani
2. "Pakistan's Mineral Resources: A Comprehensive Strategy" by M. S. Mukhtar
3. "Industrial Minerals and Rocks" by Donald D. Carr
4. "Introduction to Industrial Minerals" by C. Michael Hogan
5. "Principles of Marketing" by Philip Kotler and Gary Armstrong
6. "Mineral Economics and Policy" by John E. Tilton
7. "Mining Economics and Strategy" by Ian C. Runge

STRUCTURAL GEOLOGY

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

This course is designed to provide students with a basic understating of the structural geology concepts, formation of rocks, different modes of deformation of rocks, identification and classification of geological structures and their interaction with engineered structures such as underground mines, tunnels, and slopes.

COURSE LEARNING OUTCOMES

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

1. Define and identify primary and secondary structures of sedimentary, igneous, and metamorphic rocks.
2. Explain the importance of structural geology for mining and excavation.
3. Identify different geological structures and measure their orientation in 3D space.
4. Use specialized software for analysis of data collected in the field to establish their impact on engineered structures in rock.

COURSE CONTENT

1. Introduction to structural geology

- Rock formation processes, different modes of deformation, and classification of geological structures
- Importance of structure geology in the design and execution of excavation projects.

2. Field measurements and structural data collection

- Measuring the dip, dip direction (Bruntan Compass) and strike of discontinuities.
- Differentiate between the true dip and apparent dip, identify the slip direction along the fault line.
- Methods and procedures for field data collection.

3. Local and regional geological activities and its association with geological structures

- Plate tectonics and its relation to structural geology
- Types of plate boundaries and associated structures
- Regional vs. local tectonic settings

4. Field Data analysis

- Using numerical codes for analysis of discontinuity orientation data, conduct kinematic analysis to design stable slope angles for road cuts and open pit mines.
- Impact of local, regional and global structures on the excavation projects.
- Using stereonet to draw stereographic projections of discontinuities with known orientation.

5. Expression of geological structures on geological maps

- Understanding symbols of different geological structures and plotting procedure on the geological map.
- Principles of geological mapping
- Topographic maps and their interpretation
- Construction of geological maps and cross-sections

6. Photogrammetry

- Understanding the concept of photogrammetry, drone surveying method and its benefits over traditional land surveying, post processing of drone surveying data.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Structural Geology" by Haakon Fossen
2. "Fundamentals of Structural Geology" By David D. Pollard, Raymond C. Fletcher
3. "Structural geology of Rocks and Regions" by George H. Davis, George Herbert Davis, Stephen J. Reynolds, Chuck Kluth, Charles F. Kluth

OPERATIONS RESEARCH

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

The course provides students with a basic understanding of mathematical modeling for various industrial problems and situations, and optimization techniques to solve complex decision-making problems in various fields related to mineral and other industries. The students will formulate the problems in mathematical form using linear programming, network optimization, and integer programming etc. By the end of the course, students will be equipped with the skills to formulate, analyze, and solve optimization problems efficiently, contributing to informed decision-making processes in diverse industries.

COURSE LEARNING OUTCOMES

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

1. Formulate the real word problems into optimization problems
2. Apply different optimization methods and techniques especially on linear programming problems
3. Interpret and Perform sensitivity analysis for the solutions obtained from different optimization methods and software

COURSE CONTENT

- Introduction to Linear Programming (LP),
- Formulation of simple and complex linear programming problems
- Graphical method of solving L.P. problems,
- Simplex method, Duality and Sensitivity,
- Solving large scale problems using computer,
- Transportation and Assignment Problems,
- Network problems, shortest path, minimum spanning tree, maximum flow problems,
- Case studies

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Operations Research by H. A. Taha, Prentice Hall

MINE SYSTEMS ANALYSIS

Credit Hours: 3+0
Prerequisites: Nil

DESCRIPTION

This course, Mine Systems Analysis, delves into the principles, methodologies, and tools essential for analyzing and optimizing mining systems. Students explore various aspects of mine planning, design, and operations to enhance efficiency, productivity, and safety standards within mining operations.

COURSE LEARNING OUTCOMES

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

1. Understand fundamental concepts underlying mine systems analysis.
2. Apply mathematical and computational techniques to model mining processes.
3. Evaluate performance and efficiency of mining systems using quantitative analysis methods.
4. Demonstrate proficiency in using relevant software tools for mine systems analysis.

COURSE CONTENT

1. Introduction to Mine Systems Analysis

- Overview of mine planning, design, and operations
- Importance of systems analysis in mining engineering

2. Mathematical and Computational Techniques

- Linear and nonlinear optimization methods
- Simulation modeling using discrete-event simulation techniques
- Introduction to data analysis and statistical methods

3. Equipment Selection and Fleet Management

- Principles of equipment selection and fleet optimization
- Application of mathematical models for fleet sizing and selection
- Introduction to mine equipment maintenance strategies

4. Material Handling and Haulage Systems

- Analysis of material handling systems in mining operations
- Design and optimization of haulage systems
- Introduction to conveyor systems and truck haulage modeling

5. Risk Analysis and Safety Management

- Risk assessment techniques in mining engineering
- Introduction to safety management systems and risk mitigation strategies
- Application of reliability engineering principles in mine systems analysis

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Mining Engineering Analysis" by Christopher J. Bise
2. "Principles of Mine Planning" by Jayanta Bhattachary

CEMENT TECHNOLOGY

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

This course provides an in-depth understanding of cement technology, covering the entire process from raw material extraction to the production of cement and its applications. It emphasizes the mining aspects involved in sourcing raw materials, processing techniques, quality control measures, environmental considerations, and the overall role of cement in construction and infrastructure development.

COURSE LEARNING OUTCOMES

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

1. Demonstrate a comprehensive understanding of the mining techniques and processes involved in raw material extraction for cement production.
2. Understand the processes involved in cement production, from crushing to kiln operations, and ensure abilities in quality control procedures.
3. Utilize their knowledge to address challenges and optimize operations within the cement industry, integrating ethical and professional principles.

COURSE CONTENT

1. **Overview of Cement Production**
   - Introduction to cement production processes, types of cement, and their properties
   - Cement manufacturing stages and equipment
2. **Raw Materials Used for Cement Manufacturing**
   - Types and properties of raw materials
   - Exploration and extraction methods
   - Quality control in raw material selection
3. **Quarry Operations, Layout, and Design**
   - Overview of principles of quarry operations and layout considerations
   - Designing quarry infrastructure for efficiency and safety
4. **Equipment and Fleet Selection for Cement Quarry Operations**
   - Types of equipment used in quarry operations.
   - Factors influencing equipment selection.
   - Fleet management and optimization

5. Loading and Haulage of Raw Material

- Loading and haulage of material
- Safety considerations in material transport

6. Raw Mix Design

- Principles of raw material selection, blending, and optimization for raw mix design.

7. Pyroprocessing and Cement Kiln

- Overview of pyroprocessing stages in cement kilns, including preheating, calcination, and clinker formation.

8. Heat transfer and thermodynamics in cement kilns

- Mechanical aspects of cement plants, including coolers, and principles of cement grinding.
- Operation, control, and optimization techniques for cement kilns and grinding processes.

9. Cement Storage and Handling, Material Transport and Conveying

- Storage and handling of facilities for cement in cement plants
- Conveying methods and equipment

10. Production Scheduling and Optimization Procedures of Cement Quarry Operations

- Principles of production scheduling
- Factors influencing production scheduling in cement quarry operations.
- Optimization methodologies in cement quarry operations
- Data analysis techniques for optimization

11. Sustainable Development and Responsible Mining

- Environmental considerations in cement quarry operations
- Sustainable practices in mining and cement production

12. Introduction to Software Tools Related to Mine Planning and Design

- Overview of software tools for mine planning and design
- Applications of software tools in cement quarry operations

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Cement Plant Operations Handbook for Dry Process Plants" by Philip A. Alsop
2. "Cement Engineer's Handbook" by B. Kohlhaas and O. Mayer
3. "Chemistry of Cement and Concrete" by F.M. Lea and C.A. Taylor

EXTRACTIVE METALLURGY

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

The course has the aim to understand the fundamental principles and processes involved in the extraction of metals from their ores. students will learn various techniques used in extractive metallurgy, including pyrometallurgy, hydrometallurgy, and electrometallurgy. Emphasis will be placed on developing a comprehensive understanding of the all physical and chemical processes involved in each stage of metal extraction.

COURSE LEARNING OUTCOMES

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

1. Explain the fundamental principles of extractive metallurgy
2. Describe the extraction process of iron, steel and non-ferrous metals
3. Solve relevant numerical problems.

COURSE CONTENT

- Fundamental of metallurgy: Classification of metals, atomic structures, and chemical bonding, crystal structure and x-ray diffraction.
- Extraction process: Survey of extraction process. The general principles of hydrometallurgy, leaching of various minerals, thermodynamics of pyrometallurgy, roasting sintering, reduction smelting, and oxidation, chlorinating and smelting processes, structures and properties.
- Iron and steel predicting methods: Iron ores and preliminary treatment of iron ores. The blast furnace and its chemistry, steel making processes, bessemer converter, open hearth and electric processes.
- Extraction processes of non-ferrous metals: Ores, preliminary treatment and extraction procedure of common non-ferrous metals including aluminum, copper, zinc, gold, lead, uranium, and silver, properties of metals, uses of different metals in different industries, alloys of different metals and their uses, properties.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Extractive Metallurgy by Joseph Newton
2. Principles of Extractive Metallurgy by Terkel Rosenqvist
3. Extractive Metallurgy of Copper by W.G. Davenport, M. King, M. Schlesinger, and A.K. Biswas

DRILLING TECHNOLOGY

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

This course provides comprehensive insight into the principles and techniques of rock drilling for mineral exploration and mining. Students learn about drilling theories, geological factors influencing drilling, types of drilling equipment, and estimation of drilling parameters. Emphasis is placed on safety protocols and environmental considerations in drilling operations.

COURSE LEARNING OUTCOMES

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

1. Understand drilling theories, geological factors, and equipment used in mineral exploration and mining.
2. Apply knowledge of drilling parameters estimation and equipment selection for efficient mineral extraction.
3. Demonstrate adherence to safety protocols and environmental standards in mineral drilling operations.
4. Analyze geological data to anticipate drilling challenges and optimize strategies for mineral exploration and extraction

COURSE CONTENT

1. Fundamentals of Rock Drilling

- Introduction to drilling theory, principles, and methodologies
- Understanding the mechanics of rock drilling and factors influencing drilling efficiency
- Classification of Drilling Techniques
- Core/Exploratory drilling: Purpose, methods, and equipment used for obtaining core samples
- Non-Core/Production Drilling: Techniques for drilling blast holes, wells, and other non-core applications

2. Geological Considerations in Drilling

- Understanding geological structures and formations to optimize drilling strategies
- Identification of favorable drilling locations based on geological surveys and mapping
- Interpretation of geological data to anticipate drilling challenges and opportunities

3. Drilling Equipment

- Overview of drilling equipment used in mineral exploration and mining operations
- Types of drilling equipment: Wagon drills, Crawler drills, Drifters, DTH, Surface rigs
- Drill Cost Calculations: Methods for estimating drilling costs, including equipment maintenance, fuel consumption, and labor expenses

4. Estimation of Drilling Parameters

- Techniques for estimating the Rate of Penetration (ROP) in different rock formations
- Factors Affecting Drilling
- Rockmass properties: Hardness, abrasiveness, fracture density, and other geological factors influencing drilling performance
- Equipment parameters: Drill bit design, rotation speed, pressure, and other operational variables affecting drilling efficiency

5. Environmental and Safety Considerations in Drilling Operations

- Safety Protocols: Implementation of safety procedures to prevent accidents and injuries during drilling operations.
- Personal protective equipment (PPE) requirements and safety training for drill operators and workers
- Environmental Protection: Assessment of environmental impacts associated with drilling activities. Measures to minimize soil erosion, air, and water pollution, and habitat disturbance

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Drilling Technology Handbook" by C.P. Chugh
2. OGTI (Oil and Gas Training Institute, Islamabad) notes
3. "Applied Drilling Engineering" by Adam T Bourgoyne Jr., Martin E. Chenevert,
4. Drilling Engineering Workbook, A distributed learning course
5. "Petroleum Exploration Handbook" by Moody
6. "The Petroleum Handbook" compiled by members of the staff of companies of the Royal Dutch/Shell group
7. "High Technology in Drilling and Exploration" by C.P.Chugh
8. "Drilling and Drilling Fluids" by G.U.Chilingarian
9. "Mining Engineering Handbook" by PEELE
10. "Drilling Fluids Technology" by EXXON COMPANY USA

GEO AND MINERALS SURFACE CHEMISTRY

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

The course covers geochemistry and mineral surface chemistry, studying the composition, distribution, and transformation of Earth materials. It explores how these processes shape the Earth's surface and interior over time. Emphasis is on understanding mineral behavior and applying geochemical principles to address challenges in mining, environmental remediation, and mineral processing.

COURSE LEARNING OUTCOMES

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

1. Understand the principles of geochemistry and minerals surface chemistry and their applications in mining engineering.
2. Analyze and interpret geochemical data to evaluate mineral reactions, transport mechanisms, and environmental impacts.
3. Apply knowledge of geochemistry and minerals surface chemistry to design effective strategies for mineral extraction, processing, and environmental management.

COURSE CONTENT

- Introduction to Geochemistry and Minerals Surface Chemistry
- Thermodynamics of Mineral Reactions
- Kinetics of Mineral Reactions
- Surface Chemistry of Minerals
- Mineral-Water Interactions
- Mineral Surfaces and Adsorption Phenomena
- Environmental Geochemistry in Mining
- Surface chemistry in flotation, agglomeration, flocculation, and coagulation
- Geochemical Modeling and Applications

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Introduction to Geochemical Modeling" by Elizabeth A. Johnson
2. "Surface Chemistry of Froth Flotation" by S. Ramachandra Rao
3. "Geochemistry: An Introduction" by Francis Albarede
4. "GEOCHEMISTRY, Pathways and Processes" by McSween, Richardson and Uhle
5. "Understanding mineral deposits" by Kula Misra

MINERALOGY AND PETROLOGY

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

This course provides an in-depth exploration of mineral composition, structure, and classification, alongside the formation, identification, and properties of rocks. It includes crystallography, mineralogical identification techniques, igneous, sedimentary, and metamorphic rock formation processes, and the interpretation of rock textures and structures. Through lectures, the students will develop skills in mineral and rock identification through physical, optical and microscopic analysis.

COURSE LEARNING OUTCOMES

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

1. Understand basic crystallography for mineral identification.
2. Classify and relate minerals to appropriate groups (e.g. chemicals, geological, and silicates).
3. Identify minerals on the basis of physical and optical properties.
4. Compare various rocks based on its nature and composition

COURSE CONTENT

1. Crystallography

- Introduction to crystallography and crystal chemistry.
- Characteristics and systematic classification of crystal systems.

2. Mineralogy

- Study of physical, chemical and optical properties of minerals,
- Classification of minerals and study of common rock forming, ore forming and industrial minerals.
- Identification of minerals with the help of their physical properties.
- Megascopic and microscopic study of common minerals and ores.

3. Petrology

- The nature, composition and classification of igneous, sedimentary and metamorphic rocks.
- Megascopic and microscopic study of common igneous, sedimentary and metamorphic rocks.
- Textural and physical properties of rocks (porosity, permeability, hardness, strength etc.) relevant to engineering problems.

PRACTICAL REQUIREMENTS

Hands-on mineral and rock identification, examining their crystallography.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Mineralogy: An Introduction to Minerals, Rocks, and Mineral Deposits" by Martin Okrusch, Hartwig E. Frimmel.
2. "Essentials of Igneous and Metamorphic Petrology" by B. Ronald Frost, Carol D. Frost.
3. "Sedimentary petrology: An introduction to the Origin of Sedimentary Rocks" by Maurice E. Tucker
4. "Earth Materials: Introduction to Mineralogy and Petrology" by Cornelis Klein, Anthony Philpotts

MINE MANAGEMENT

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

This course provides an introduction to the principles, responsibilities, and tasks of mine management in the context of mining engineering. It covers management philosophies, strategic planning, human resource management, reporting, sales and marketing, purchasing and inventory, and budgeting specific to mining operations.

COURSE LEARNING OUTCOMES

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

1. Understand the basic principles of human and project management.
2. Interpret information and communicate knowledge, ideas, and procedures.
3. Apply management principles to control engineering costs, and plan and schedule operations at maximum labor productivity.
4. Analyze and design complex systems and operations using both qualitative and quantitative tools.

COURSE CONTENT

1. **Management:** Definition and Essential elements of Management.
2. **From Scientific Management to Human Resource Management:** Principles and Characteristics of different Management theories.
3. **Mine Management:** Mine Engineer as Project Manager, Management tasks and responsibilities.
4. **Mine Organization:** Duties and Characteristics of functional Organization.
5. **Underground Mine Management and Surface Mine Management** – Matrix and Mixed Organization.
   - Effective Management: by objectives
   - EM by Productivity
   - EM by communication
   - EM by technical Staff
   - EM by safety and Training
6. **Project Planning and control:** Strategic Planning, project Network analysis
7. **Human and Performance**: Recruiting selection, training, development, compensation.

8. **Material Resource:** Measurement, Material Management, Market Management, Reserve/Sampling Calculations, Pricing.
9. **Project Budgeting:** Budgets and Controls, Budgeting Methods.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Mine Management" by SLOAN
2. "Project Management" by J.R. Meredith and S.J. Mantel
3. "Modern Management in the Global Mining Industry" by Robin G. Adams
4. "Engineering Management" by Faridoon Mazda
5. "SME Mining Engineering Handbook" by A.B. Cummins and I.A. Given.

ENGINEERING GEOLOGY AND SOIL MECHANICS

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

Engineering Geology and Soil Mechanics is a foundational course designed for undergraduate students pursuing BSc Mining Engineering. This course integrates principles from geology and soil mechanics, providing students with essential knowledge to analyze and address geological and geotechnical challenges in mining projects. Students will explore topics such as geological site characterization, soil mechanics principles, rock mechanics, and their practical applications in mining engineering.

COURSE LEARNING OUTCOMES

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

1. Recognize various rock and soil types and assess their engineering implications.
2. Evaluate geological structures' impact on mining and excavation endeavors.
3. Employ engineering geology principles to mitigate geological hazards in mining.
4. Apply soil mechanics to analyze and resolve soil-related challenges in mining operations.

COURSE CONTENT

1. Introduction to Engineering Geology

- Definition and scope of engineering geology in the context of mining.
- The role of engineering geology in site characterization and exploration.
- Geological processes, rock types, and their engineering significance.
- Soil formation, types, classification systems, and their influence on mining activities.
- Introduction to geological maps and engineering drawings

2. Geological Structures and Mining Operations

- Principles of geological structures and their impact on mining activities.
- Geological considerations for excavation design and stability assessments.

3. Soil Mechanics Fundamentals

- Basic soil properties: grain size, consistency, and classification.
- Soil behavior under different loading conditions and its significance in mining

4. Geotechnical Applications in Mining Structures

- Application of geotechnical principles in the design of open pits and underground excavations.
- Stability assessments and reinforcement strategies for mining structures.

5. Soil Behavior and Engineering Applications

- Soil-structure interaction and its impact on foundation design.
- Settlement analysis and considerations in foundation design for mining structures.
- Interpretation of laboratory test results for engineering design and decision-making.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Engineering Geology" by F.G. Bell
2. "Principles of Geotechnical Engineering" by Braja M. Das
3. "General & Engineering Geology" by Bopche and Agarwal
4. "Soil Mechanics and Foundations" by Muni Budhu
5. "Soil Mechanics" by Craig

MINE AUTOMATION AND DIGITIZATION

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

Mine Digitization and Automation is an advanced course tailored for undergraduate students pursuing BSc in Mining Engineering. This course focuses on the integration of digital technologies and automation in mining operations. Students will gain a comprehensive understanding of mine digitization, data analytics, and the application of automation systems to enhance safety, efficiency, and productivity in mining processes.

COURSE LEARNING OUTCOMES

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

1. Understand the foundational principles of mine digitization and recognize its importance in contemporary mining practices.
2. Describe the functionalities and applications of essential technologies utilized in mine digitization and automation, such as sensors, drones, and autonomous vehicles.
3. Analyze and interpret data collected from mining operations using relevant software tools for optimization and decision-making.
4. Evaluate the impact of automation systems on improving safety protocols and operational efficiency across various facets of mining activities.

COURSE CONTENT

1. Introduction to Mine Digitization and Automation

- Definition and scope of mine digitization in the mining industry.
- Overview of key technologies (sensors, data analytics, automation systems).
- Impact of digitization and automation on the mining industry (productivity, safety, sustainability).
- Ethical considerations and challenges associated with automation in mining.

2. Data Acquisition and Management

- Sensor technologies and data collection methods in mining operations.
- Data communication protocols and infrastructure (wired, wireless, cloud-based).
- Data management systems (SCADA, databases) and their functionalities.
- Big data analytics in mining: principles, applications, and tools..

- Hands-on session: Utilizing software for data visualization and basic analysis

3. Automation Systems in Mining

- Principles of mine automation and its role in improving safety and efficiency.
- Types of automation (fixed, mobile, autonomous).
- Automated drilling, blasting, and loading technologies.
- Autonomous haulage systems (trucks, conveyors) and their operational principles.
- Remote operation centers and telepresence applications in mining.
- Case studies: Analyzing successful implementations of automation technologies in different mining environments.

4. Designing Mine Automation Strategies

- Strategies for designing and implementing automation in various mining processes.
- Considerations for human-machine interaction and collaboration.
- Integration of automation technologies with existing mining infrastructure.
- Systems engineering principles for designing and implementing automated systems.
- Safety considerations and risk assessment for automated mining operations.
- Maintenance and support strategies for automated equipment.

5. Internet of Things (IoT) in Mining

- Integration of IoT devices in mining operations.
- Real-time monitoring and control using IoT for enhanced decision-making.

6. Remote Sensing and GIS Applications

- Principles of remote sensing and GIS in mine digitization.
- Applications for geological mapping, monitoring, and resource management.

7. Emerging Technologies in Mine Digitization

- Emerging technologies in mining (artificial intelligence, machine learning, robotics).
- The impact of digitization and automation on future workforce skills and training needs.
- Sustainability considerations in the context of mine digitization and automation.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Industry 4.0: The Industrial Internet of Things" by Alasdair Gilchrist
2. "Artificial Intelligence: A Modern Approach" by Stuart Russell and Peter Norvig
3. "Introduction to Autonomous Robots: Mechanisms, Sensors, Actuators, and Algorithms" by Nikolaus Correll, Bradley Hayes

MINERAL EXPLORATION AND GEOSTATISTICS

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

This course delves into the processes of mineral deposit formation, geological data gathering, and exploration techniques. Students will gain insights into exploration geophysics, geochemistry, sampling methods, and ore reserve estimation using classical and geostatistical approaches. The course includes practical exercises in sampling, reserve estimation methods, and geophysical surveys.

COURSE LEARNING OUTCOMES

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

1. Interpret geological, geophysical, and geochemical data for effective mineral exploration.
2. Estimate mineral reserves using classical methods and geostatistics in exploration projects.
3. Apply various exploration techniques (geological, geophysical, geochemical) for mineral exploration.
4. Communicate technical concepts related to mineral exploration effectively through reports and presentations

COURSE CONTENT

1. Introduction to Mineral Deposits

- Processes of mineral deposit formation (hydrothermal, magmatic, etc.).
- Classification of mineral deposits based on geology and commodity.
- Exploration strategies and target generation.
- Geological data gathering and presentation (maps, sections, logs).

2. Exploration Techniques

- Geophysical methods for mineral exploration (gravity, magnetic, resistivity, seismic).
- Principles and applications of each geophysical technique.
- Geochemical exploration methods and data interpretation.
- Principles and techniques of various sampling methods.
- Drilling methods (core drilling, percussion drilling) and sample collection.

3. Resource Estimation Methods

- Classical reserve estimation methods (polygonal, triangular, etc.).
- Introduction to geostatistics for resource estimation.

- Spatial variability of mineral deposits and variogram analysis.
- Geostatistical estimation methods (kriging, conditional simulation).

4. Applications and Software

- Introduction to geostatistical software for data analysis and resource estimation.
- Hands-on exercises using software to perform variography, kriging, and resource modeling.
- Considerations for resource classification and reporting (JORC Code, NI 43-101).
- Case studies: Applying exploration techniques and geostatistics to real-world scenarios.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Introduction to Mineral Exploration" by Anthony Evans
2. "Techniques in Mineral Exploration" by J.H Reedman.
3. "Practical Geo Statistics" by Isobel Clark, 1979.
4. "Mineral Exploration" by Kearry.
5. "Economic Mineral Deposits" by Bateman.
6. "Mining Geology" by Peters and McKinstry.
7. "Exploration and Mining Geology" by W.C. Peters
8. "TLR on Mineral Exploration" by Abid S. H.

INTRODUCTION TO GIS AND REMOTE SENSING

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

Introduction to GIS and Remote Sensing is a foundational course designed for undergraduate students pursuing BSc in Mining Engineering. The course provides an in-depth understanding of Geographic Information Systems (GIS) and Remote Sensing principles. Students will explore GIS functionalities, data models, coordinate systems, and spatial analysis techniques. The remote sensing component covers the basics, data acquisition, image analysis, and practical applications using relevant software.

COURSE LEARNING OUTCOMES

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

1. Understand the fundamental principles and concepts underlying Geographic Information Systems (GIS) and remote sensing technologies.
2. Apply coordinate systems and GIS techniques effectively to ensure precise analysis and interpretation of spatial data.
3. Utilize GIS software tools for managing, analyzing, and visualizing geospatial data to address engineering challenges and make informed decisions.
4. Demonstrate advanced skills in map design and data transformation techniques to communicate spatial information effectively.

COURSE CONTENT

1. GIS - Introduction and Fundamentals

- Concepts and principles of GIS: spatial data, applications in engineering.
- Functional subsystems of a GIS: data acquisition, management, analysis, and visualization.
- Spatial data models: raster, vector, and attribute data.
- Coordinate systems basics: understanding geographic location and projections.

2. Spatial Data Analysis and Visualization

- Discrete geo-referencing and Global Positioning Systems (GPS).
- Projections, transformations, and their applications.
- Maps as representations of the world.
- Data transformation and visualization techniques.

3. Spatial Data Analysis and Visualization

- Layers, projections, and overlay analysis.
- Spatial analysis and neighborhood functions.
- Visualization methods for spatial data: maps, charts, and graphs.
- Introduction to network analysis and its applications in engineering.

4. Introduction to Remote Sensing

- Fundamentals of remote sensing: principles, electromagnetic spectrum, and data acquisition.
- Sensor systems and platforms used for remote sensing applications.
- Digital image processing: preprocessing, enhancement, and classification techniques.
- Applications of remote sensing in engineering: environmental monitoring, resource mapping, and infrastructure development.

5. Practical Applications and Case Studies

- Digital Image Processing in Remote Sensing.
- Introduction to popular GIS and remote sensing software packages (e.g., ArcGIS, ERDAS Imagine).
- Hands-on tutorials: Data processing, image analysis, and integration with GIS for spatial analysis.
- Project work: Utilizing GIS and remote sensing data to solve an engineering problem relevant to the chosen field (e.g., civil, environmental).

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Introduction to Geographic Information Systems" by Kang-Tsung Chang
2. "Geographic Information Systems and Science" by Paul A. Longley, Michael F. Goodchild, David J. Maguire, and David W. Rhind
3. "Remote Sensing and Image Interpretation" by Thomas Lillesand, Ralph W. Kiefer, and Jonathan Chipman
4. "Mastering ArcGIS" by Maribeth H. Price

MINERAL PROCESSING – I

Credits: 3 +1
Pre-Requisite: Nil

DESCRIPTION

The course has been designed to equip mining engineering students with the knowledge and skills required for efficient minerals beneficiation. The course focuses on the fundamental principles and techniques involved in mineral processing, including mineral liberation, comminution, screening and classification. The students will develop a deep understanding of mineral liberation and particles separation.

COURSE LEARNING OUTCOMES

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

1. Explain various mineral processing terminologies and theories involved in the unit operations like comminution, classification and screening.
2. Describe various equipment involved in comminution, screening and classification.
3. Solve different problems related to mass, water and component balancing, particle size analysis, comminution, classification and screening.

COURSE CONTENT

- **Introduction:** Economic justification and scope of mineral processing, metallic ores processing, grade and recovery phenomenon, efficiency of mineral processing operation, liberation and concentration. Steps involved in the mineral processing operations.
- **Comminution:** Comminution theories, comminution circuit, crushing and grinding, types of crushers and mills
- **Laboratory sizing and industrial screening:** Laboratory sizing, wet and dry sieve analysis, size distribution, sub-sieve techniques, movement of solid in fluids, stokes law, industrial screening, performance of screens, screen types, screening surfaces.
- **Classification:** Principal of classification, free and hindered settling, stokes law with examples, hydraulic and mechanical classifiers, principles of aero and hydraulic cyclones.
- **Gravity concentration:** Principles of gravity concentration, gravity separators, jigging, Humphrey's spirals, flowing film concentration, tabling, concentration criteria,
- ***Material Balancing:*** Mass, water and component balancing around various mineral processing unit operations.

PRACTICAL REQUIREMENTS

1. Determination of reduction ratio of primary crushers,
2. Reduction ratio of secondary crushers,
3. Particle size analysis test by sieves,
4. Particle size analysis test by sub-sieving techniques, sedimentation and elutriation,
5. Grindability of mills, ball mills and rod mills,
6. Work index of mills,
7. Methods of representative sampling from bulk samples of crushed and ground material,
8. Determination of efficiency of classification, Hydraulic, mechanical and Pneumatic,
9. Use of control instruments
10. Introduction to Various Mineral Processing Software

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Mineral Processing Technology" by Barry A. Wills, Tim Napier-Munn
2. "Mineral Processing Design and Operation" by Gupta and Yan
3. "Textbook of Mineral Processing" By D.V. Subba Rao

MINERAL PROCESSING – II

Credits: 3+1
Pre-Requisite: Nil

DESCRIPTION

The course is designed to equip mining engineering students with the knowledge and skills required for efficient minerals beneficiation and minerals extraction. The course focuses on the fundamental principles and techniques involved in beneficiation including gravity and heavy media separation; froth flotation; magnetic separation and solid-liquid separation. The students will develop a deep understanding of mineral processing towards the design of mineral processing plants.

COURSE LEARNING OUTCOMES

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

1. Understand the principles and applications of various mineral separation techniques
2. Describe the different types of separation equipment used in mineral processing, such as flotation machines, magnetic separators, and solid-liquid separation equipment.
3. Apply material balancing principles to ensure efficient operation and optimal resource utilization in mineral processing unit operations

COURSE CONTENT

1. **Heavy Media Separation:** Principles of Heavy media separation (HMS). Float sink analysis of coal and other metallic minerals
2. **Froth Flotation:** Flotation principle, contact angle, flotation process parameters/components (chemical, equipment and operating). Flotation reagents, flotation circuits and flowsheet design
3. **Flotation machines:** pneumatic and mechanical machines.
5. ***Magnetic and electrostatic separation:*** Magnetic and electrostatic separation, principles, machines and application.
6. ***Solid-liquid separation:*** Separation of solids from fluid, dewatering, sedimentation techniques, flocculation and coagulation, filtration, drying, equipment for for solid-liquid separation.
7. ***Material Balancing:*** Mass, water and component balancing around various mineral processing unit operations.
8. ***Metallurgical Treatment:*** Basics of Pyro-, Hydro- and Electrometallurgical processes for the extraction of metallic minerals from concentrates
9. ***Material Handling and Tailings Disposal***.
10. ***Mineral process & flowsheet design***

PRACTICAL REQUIREMENTS

1. Concentration by jigs,
2. Minerals separation by shaking table and mozley table.
3. Preparation of xanthates (propyl, butyl etc.),
4. Laboratory flotation of copper ore,
5. Study of concentration/pilot plant and flotation of sulfide ores,
6. Coal flotation, proximate analysis,
7. Study of drum and disc magnetic separator,
8. Study of Drum filter,
9. Elemental analysis of a sample on XRF spectrometer
10. Mineral Processing Software Introduction e.g. MODSIM etc

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Mineral Processing Technology" by Barry A. Wills, Tim Napier-Munn
2. "Mineral Processing Design and Operation" by Gupta and Yan
3. "Textbook of Mineral Processing" by D.V. Subba Rao

MINE VENTILATION

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

This course provides a fundamental understanding of mine ventilation principles and their practical application in ensuring safe and healthy working conditions in underground mines. It explores the theory of air flow in mines, ventilation planning and design, ventilation networks, and the selection and operation of ventilation equipment. Students will learn how to design and manage ventilation systems to ensure a safe and healthy working environment for miners.

COURSE LEARNING OUTCOMES

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

1. Explain the importance of mine ventilation in maintaining air quality, controlling gases, and ensuring the safety of underground environments.
2. Apply fundamental principles of airflow to design ventilation systems that effectively address the specific requirements of different mining operations.
3. Design and optimize mine ventilation systems based on the specific requirements of different mining operations.

COURSE CONTENT

1. Introduction to Mine Ventilation

- Importance of ventilation in underground mining
- Regulatory requirements and industry standards
- Overview of mine ventilation systems and components
- Introduction to mine gases and dusts

2. Mine Atmosphere and Airflow Fundamentals

- Properties of air and mine gases
- Principles of airflow in mines
- Factors affecting airflow distribution.
- Natural and induced ventilation

3. Ventilation Planning and Design

- Ventilation planning process
- Design criteria for air quantity and flow.
- Resistance and pressure calculations in mine ventilation networks
- Mine ventilation network analysis methods (e.g., ventilation circuits, pressure-volume relationships)

4. Ventilation Network Analysis

- Fan characteristics and selection.
- Airflow modeling using software tools.

5. Ventilation System and Equipment

- Types of mine fans: axial flow, centrifugal flow
- Fan selection and performance characteristics.
- Ventilation control devices (doors, stoppings, regulators)
- Auxiliary ventilation systems (local ventilation)

6. Mine Climate Control

- Heat sources in underground mines.
- Psychometrics and thermal comfort
- Cooling and dehumidification methods
- Mine air conditioning systems

7. Ventilation Simulation and Modeling

- Introduction to mine ventilation simulation software
- Hands-on exercises in ventilation modeling
- Interpretation of simulation results for system optimization

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Mine Ventilation and Air Conditioning" by Howard L. Hartman and Jan M. Mutmansky
2. "Subsurface Environmental Engineering" by McPherson

MINE VENTILATION AND SAFETY LAB

Credits: 0+1
Pre-Requisite: Nil

DESCRIPTION

The Mine Ventilation and Safety Lab course is an extension of the Mine Ventilation and Mine Safety courses, providing hands-on training in various aspects of mine ventilation and safety through laboratory exercises. The course focuses on practical applications and experiments related to mine ventilation systems and safety measures. Students will gain hands-on experience with ventilation equipment, monitoring devices, and emergency response strategies, contributing to their understanding of maintaining a safe and healthy underground working environment.

COURSE LEARNING OUTCOMES

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

1. Perform basic measurements and analyses of airflow in mines.
2. Detect and control gases in mines through simulated experiments.
3. Design mine ventilation networks.
4. Use ventilation simulation tools and software for practical applications.
5. Analyze ventilation systems.
6. Analyze and interpret data collected during experiments to make informed decisions.
7. Implement safety measures and emergency response strategies in a controlled setting.

COURSE CONTENT

- Airflow measurements
- Determining the characteristics of an axial fan with regard to the variation of pressure, power consumption and efficiency with quantity passed by the fan.
- Design of fan characteristics for pressure, power, quantity
- Determination of fan characteristics for series and parallel operations
- Detection of gases
- Measurement and control of dust in simulated underground operations.
- Mine rescue operations

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Mine Ventilation and Air Conditioning" by Howard L. Hartman and Jan M. Mutmansky
2. "Subsurface Environmental Engineering" by McPherson
3. "Industrial Accident Prevention" by Hein Rich
4. "Loss Control Management" by Bird
5. "Safety at Work" from John Riley
6. "Accident Investigations" by Jeffery W. Vicoli
7. Safety Notes of Cornwall School of Mines

ROCK MECHANICS

Credits: 3 +1
Pre-Requisite: Nil

DESCRIPTION

This course is designed to analyze the mechanical behavior of rocks/rock masses to determine their strength, deformation, and failure characteristics in mining/excavation environments. Also, to apply rock mechanics principles to design stable underground and surface excavations, ensuring the safety of mining personnel and equipment. Further, to optimize mining operations by understanding the response of rocks to stress and developing support systems to mitigate potential rock-related hazards

COURSE LEARNING OUTCOMES

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

1. Describe the significance of various tests for measuring the geo-mechanical properties of rocks.
2. Explain stress and strain concepts in relation to rocks and analyze the mechanical behavior of rocks and rock masses.
3. Evaluate various techniques of rock mechanics for rock stress determination.
4. Understand and apply support and reinforcement design principles for primary failure modes in excavation design and analysis through numerical techniques.
5. Collect and prepare the representative rock samples for conducting different laboratory tests **(LAB).**
6. Conduct/perform laboratory testing to determine physical and mechanical properties of the rock **(LAB).**
7. *Analysis* of experimental data based on concepts of Rock Mechanics **(LAB**).
8. *Adopt* necessary protocols during experiments needed for safe and disciplined environment. **(LAB)**

COURSE CONTENT

1. Theory of elasticity

- Component of stress
- Component of strain
- Hooke's Law

- Plane stress and plain strain conditions
- Differential equations of equilibrium
- Boundary conditions
- Stress Functions
- Closed form solutions

2. Classification of rock properties

- Mechanical properties
- Intrinsic properties
- Index properties

3. Criteria of Deformation fracture and yields

- Coulomb's failure criterion
- Mohr's theory of failure
- Griffith's criterion
- Empirical criteria (Hoek-Brown Failure criterion)

4. Insitu testing and determination of rock mass properties

- Strength and deformability of jointed rock mass
- Fracture strength of jointed rock mass.
- Concept of joint compliance
- Flat jack test
- Modulus of elasticity test
- Insitu compression test
- Insitu stresses and excavation induce stresses (Hydro fracturing and overcoring technique).

5. Time dependent deformation of rocks

- Rheology
- Flow in rock
- Factors effecting creep
- Insitu creep measurements
- Long term strength of rock

6. Stress analysis by numerical Methods

- Finite difference method
- Finite element method
- Boundary element method

7. Rock Mass and Support interaction analysis

PRACTICAL REQUIREMENTS

A tentative list of laboratory tests is given and the HEI can modify it based on the resources available.

1. UCS determination of rocks
2. Tri-axial tests
3. Brazilian Tests
4. Direct Shear Strength
5. Slake Durability tests
6. Point Load Index test
7. Schmidt Hammer Rebound Number determination tests
8. P and S wave determination
9. Determination of Rock Porosity and Permeability
10. Study of Creep Behavior of Rocks

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Engineering Rock Mechanics: An Introduction to the Principles By John A Hudson, John P Harrison Fundamentals of Structural Geology By David D. Pollard, Raymond C. Fletcher
2. Design Analysis in Rock Mechanics by William G. Pariseau
3. Rock Mechanics For underground mining by B.H.G. Brady , E.T. Brown
4. Goodman, Introduction to Rock Mechanics, 1989, John Wiley and Sons

MINE POWER, DRAINAGE AND MATERIALS HANDLING

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

This course equips undergraduate mining engineering students with the fundamental knowledge and design principles related to mine power systems, drainage systems, and material handling methods. It covers various power sources, compressed air and electrical systems, hydraulic systems, belt conveyors, haulage and hoisting systems, and mine drainage pumps. Students will gain practical skills through laboratory experiments and assignments, preparing them for real-world applications in the mining industry.

COURSE LEARNING OUTCOMES

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

1. Design and analyze mechanical systems, including compressed air and hydraulic power systems, considering component selection and power calculations.
2. Evaluate and optimize haulage methods and equipment for mining operations, taking into account mining conditions and locomotive performance.
3. Design and analyze material handling systems, such as belt conveyors and hoisting systems, considering capacity, speed, and power requirements.
4. Select and analyze pumps for mine drainage, considering operating conditions and calculating power requirements.

COURSE CONTENT

1. Power Systems in Mining

- Introduction to various power sources in mining (diesel, electricity, compressed air, hydraulics).
- Principles and design considerations for compressed air systems.

2. Electric Power Systems

- Selection of power cables and equipment for electric power systems.
- Power-factor correction and load flow analysis.
- Optimization of power costs in mining operations.

3. Hydraulic Power Systems

- Principles of hydraulic power systems and their design.
- Selection procedures for hydraulic systems in mining equipment.

4. Material Handling Systems

- General applications of belt conveyors in mining.
- Design considerations, material characteristics, and capacity calculations for belt conveyors.

5. Haulage Systems

- Application of different surface and underground haulage methods.
- Locomotive tractive-effort calculations and duty cycle analysis.
- Power requirement calculations for haulage systems.

6. Hoisting Systems

- Overview of hoisting equipment and basic hoisting systems.
- Special applications to different mine conditions.
- Hoisting calculations and steel rope design.

7. Drainage Systems

- Types of pumps used in mining, characteristics, and applications.
- Calculation of power requirements for pumping systems.
- Analysis of pumping systems in mine drainage.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Mining Engineering Analysis" by Christopher J. Bise
2. "Coal Mining Technology: Theory and Practice" by Robert Stefanko
3. "Introductory Mining Engineering by Howard L. Hartman
4. "Construction Planning Equipment and Methods" by R.L. Peurifoy,
5. "Mining Engineering Handbook" from SME

List of Technical Electives -III
• Tunnel Engineering • Rock Engineering • Sustainable Mining • Dimension Stone Mining • Coal Mining • Strata Control / Ground Control Engineering • Mining and Processing of Rare Earth Elements • Placer Mining and Processing

TUNNEL ENGINEERING

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

This course is designed to provide the students with the main concepts associated to the design and construction of tunnels. Tunnels excavated in hard and weak rock masses are given particular attention. Precise consideration is given to rock mass characterization, excavation methods, improvement and reinforcement techniques, the available analysis methods and tunnel instrumentation and observation.

COURSE LEARNING OUTCOMES

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

1. Identify main characteristics of different ground behavior,
2. Identify and plan tunnel excavation method from technical, production, and sustainability point of view,
3. Design tunnel reinforcement based on empirical, analytical and numerical assessment depending on complexity and acquire a holistic perspective on the design process,
4. Analyze cost and time for ordinary tunnels based on risks and construction management principles.

COURSE CONTENT

- Classifications of underground openings/ excavations
- Tunnel Planning and Site Investigation
- Tunnel Design (x-section and Longitudinal section)
- Fundamental Concepts of Rock Breaking and Tunnel Construction
- NATM method of Tunneling
- Mechanized Tunneling methods (Tunnel Boring Machine, Road header, etc.)
- Problems in tunneling and ground behavior
- NTNU drill ability Indices in Hard Rock Tunneling
- Tunneling through soft rock and associated behaviors
- Ground Treatment and Water Control Methods
- Monitoring of Excavation during and after Construction.
- Tunnel support and reinforcement: empirical, GRC, FEM analysis
- Tunnel cost and time planning
- Risk aspects in tunneling

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Handbook of Tunnel Engineering: Design, Construction & Risk Assessment" by Dosemeci Garry
2. "Technical Manual for Design and Construction of Road Tunnels" by U.S. Department of Transportation
3. "Hard rock Tunnel Boring Machines" by Bernhard Maidl, Leonhard Schmid, Willy Ritz, Martin Herrenknecht
4. "Soft Ground Tunnel Design" by Benoit Jones
5. "Ground Support Technology for Highly Stressed Excavations: Integrated Theoretical, Laboratory, and Field Research" by Ernesto Villaescusa, Alan G Thompson, Christopher R Windsor, John R Player

ROCK ENGINEERING

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

The Rock Engineering course aims to impart an understanding of engineering practices related to working with rock, particularly in constructing structures within or on rock masses. These structures encompass a range of applications including slopes, tunnels, mines, and drilling/boring. The curriculum delves into the fundamental principles, theories, and practical applications of engineering within rock formations. Key topics encompass rock mechanics, properties, excavation methodologies in rocks, stability assessment, support systems, and real-world case studies illustrating engineering projects involving rock.

COURSE LEARNING OUTCOMES

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

1. To develop a fundamental understanding of the behavior of rock masses under different loading and environmental conditions.
2. To learn various methods for analyzing and predicting the stability of excavations in rocks.
3. To familiarize students with the design and implementation of rock support systems.
4. To examine case studies of real-world engineering projects involving rock and understand the engineering challenges and solutions.

COURSE CONTENT

1. **Introduction to Rock Engineering**
   - Definition and scope of rock engineering
   - Importance and applications in civil, mining, and geotechnical engineering
   - Historical development and notable achievements in rock engineering
2. **Rock and rock mass Properties**
   - Classification of rocks and rock masses
   - Physical properties of rocks (density, porosity, permeability, etc.)
   - Mechanical properties of rocks and rock masses (strength, elasticity, deformability, etc.)
   - Geological factors influencing rock properties
3. **Rock Mechanics**
   - Stress and strain in rocks

- Rock failure mechanisms
- Laboratory testing methods for rock mechanics

4. **Slope Stability Analysis**

- Types of rock slopes
- Methods for analyzing slope stability (limit equilibrium methods, numerical modeling)
- Factors affecting slope stability
- Mitigation measures for unstable rock slopes
- Case studies

5. **Rock tunnelling**

- Methods of rock excavation
- Factors influencing excavation design (Ground composition and Project related factors)
- Tunnelling techniques and considerations
- Case Studies

6. **Mine Design**

- Interactions between Rock Mechanics and Rock Engineering Systems
- Fundamental Principles of Excavation
- Mechanisms of Instability in Surface Excavations
- Mechanisms of Instability in Underground Excavations
- Geotechnical Considerations in Selecting Mining Methods
- Designing Pillars and Planning Extraction Sequences
- Establishing Stope Dimensions and Sequences Considering Geological and Geotechnical Conditions
- Geotechnical Factors in Pit Planning
- Support Systems for Longwall Faces
- Implementation of Caving Methods and Ground Reinforcement

7. **Support Systems and Ground Control**

- Rock Support Interaction
- Rock Support analysis
- Modes of Instability & Classification of Stabilization Methods
- Application and Evaluation of Stabilization Methods

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Engineering in Rocks for Slopes, Foundations and Tunnels" by T. Ramamurthy
2. "Practical Rock Engineering" by Evert Hoek
3. "Rock Mechanics Principles in Engineering Practice" By John A. Hudson
4. "Engineering Rock Mechanics; An Introduction to the Principles" By John A. Hudson and John P. Harrison

SUSTAINABLE MINING

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

The Sustainable Mining course for undergraduate degree programs focuses on responsible mining practices. It covers exploration, extraction, processing, and closure, emphasizing sustainability in economic, social, and environmental aspects. Through theory and practice, students learn about environmental impact assessment, community engagement, resource management, and regulatory compliance, preparing them to promote sustainable mining in their careers.

COURSE LEARNING OUTCOMES

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

1. Understand sustainable Mining and objectives of sustainable Development Goals
2. Demonstrate the Issues and impacts of Mining during life of a mine and protecting people and environment.
3. Correlate SDGS to Mining industry and orientation of its legal framework towards Sustainable Mining

COURSE CONTENT

1. **Introduction to Sustainable Mining**
2. **The Sustainable Development Goals.**
3. **The Challenges of Mining**
   - Environmental
   - Social
   - Economic
4. **Direct Impacts of Mining on Sustainable Development Goals**
   - Sd6: clean water and sanitation
   - Sdg7: affordable and clean energy
   - Sdg8: good jobs and economic growth
   - Sdg9: industry, innovation, and infrastructure
   - Sdg13, climate action
   - Sdg15, ecosystem and biodiversity protection

5. **Role of Authorities for Sustainable Mining**
    - Who has a role to play
    - The role of the mining companies
    - The role of governments
    - The role of the local population
    - The role of consumers
    - The role of the international community
6. **Impacts of Mining during the life of a mine**
    - Mineral exploration Phase
    - Mine development Phase
    - Mining Operations
    - Mine Closure
7. **Orienting legal frameworks towards sustainable development.**
    - The domestic legal framework
    - Mining contracts
    - International treaties, conventions and soft law
        - mineral waste,
        - water quality,
        - nature preservation,
        - biodiversity,
        - air pollution
        - and climate change
    - Voluntary standards
    - Customary rules
8. **Protection of Environment and people**
    - Trends and approaches in environmental regulation of mining,
    - Environmental and social impact assessment
    - Environmental monitoring and auditing Community consultation, engagement and protection, Free, prior and informed consent, Engagement during the life of a mine, Access to information, Grievance mechanisms,
    - Managing mine closure, Mine closure in the life of a mine, Financing mine closure,

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Sustainable Mining Practices: A Global Perspective" by Vasudevan Rajaram, Subijoy Dutta, Krishna Parameswaran,
2. "Mining, Materials, and the Sustainable Development Goals (SDGs): 2030 and Beyond" by Cristian Parra, Brandon Lewis, Saleem H. Ali
3. "Sustainable management of mining operations" edited by Botin, J. A.
4. "Managing mining for sustainable development: A source book" by UNDP Bangkok Regional Hub and Poverty-Environment Initiative Asia-Pacific of UNDP and UN Environment
5. "The Sustainable Development Goals challenging the Mining Industry: An article to understand the role and use of the Sustainable Development Goals in the mining industry" by United Nations.
6. "Mapping Mining to the Sustainable Development Goals: An Atlas" by UNDP

DIMENSION STONE MINING

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

The Dimension Stone course for Mining Engineering students covers techniques and challenges in extracting granite, marble, and limestone. It emphasizes responsible mining, integrating technical and environmental considerations. The curriculum fosters critical thinking and innovation to address industry complexities.

COURSE LEARNING OUTCOMES

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

1. Understand the basics properties of dimension stone and its applications
2. Comprehend different dimension stone extraction techniques for block extraction.
3. Assess quality of dimension stone for end use.

COURSE CONTENT

1. **Introduction to Dimension Stones**
   - Overview of different types of dimension stones
   - Geological characteristics and formation processes.
2. **Dimension Stone Reserves in Pakistan**
   - KPK, GB, Baluchistan, and AJK
3. **Site Selection and Exploration**
   - Criteria for selecting suitable quarry sites.
   - Exploration techniques to assess stone quality and quantity.
4. **Mining Methods and Equipment**
   - Surface and underground mining methods for dimension stones.
   - Introduction to specialized equipment used in dimension stone mining.
   - Factors affecting selection of mining techniques/method.
   - Geological Factors
   - Technological factors
5. **Safety and Environmental Considerations**
   - Safety protocols in dimension stone quarries.
   - Environmental impact assessment and mitigation measures.

6. **Extraction Techniques**
   - Quarrying and block extraction techniques, including drill and blast, plug and feathers, Diamond wire saw, expansive cement.
   - Procedure for Transporting of blocks to processing units.
   - Dimension Stone Processing and uses:
   - Cutting and shaping methods.
   - Polishing and finishing processes.
7. **Quality Control and Standards**
   - Evaluation of dimensional accuracy and surface finish.
   - Compliance with industry standards and specifications.
8. **Market and Economic Aspects**
   - Understanding the global dimension stone market.
   - Economic factors influencing the industry.
9. **Case Studies and Field Visits:**
   - Analysis of successful dimension stone mining operations.
   - Field visits to operational quarries and processing units.

PRACTICAL REQUIREMENTS

Field Visits of Different Dimension Stone Quarries

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Dimension Stone: Use in Building Construction" by Antony G. Cooper
2. "Report on Marble and Granite" by Trade Development of Pakistan.
3. "Report on Marble and Granites" by SMEDA
4. "Natural Stone: Weathering Phenomena, Conservation Strategies and Case Studies" by Eric Doehne and Clifford A. Price
5. Case studies

COAL MINING

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

This course aims to provide a comprehensive understanding of coal mining planning, design, and operations. It covers all the important aspects of planning and design, covering economic considerations, safety protocols, and environmental mitigation strategies. The curriculum underscores the integration of advanced technologies in both surface and underground mining operations, promoting a practical approach to industry challenges. The graduates emerge as proficient professionals prepared to navigate the intricacies of planning, designing, and executing mining operations.

COURSE LEARNING OUTCOMES

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

1. Analyze geological conditions and coal formations comprehensively for effective coal mining.
2. Evaluate and compare mining techniques for informed decision-making.
3. Apply economic and environmental assessments for sustainable mine planning.
4. Understand safety protocols and emergency response in coal mining operations.

COURSE CONTENT

1. **Geological Foundations of Coal Mining**
   - Coal Formation Processes
   - Types of Coal and Characteristics
   - Geological Conditions Impacting Mining
2. **Advanced Mining Techniques**
   - Surface Mining Innovations
   - Underground Mining Technologies
   - Comparative Analysis of Mining Techniques
3. **Economic Considerations in Coal Mining Operations**
   - Economic Drivers in Mining
   - Financial Modeling for Mining Projects (Thar coal Case study)
   - Application of discounted cash flow analysis in mine planning.
   - Optimizing production schedules for economic efficiency

4. **Mine Planning and Design**
    - Overview of mine planning as a multidisciplinary process.
    - Strategic / Long-term Mine Planning
    - Tactical / short to medium-term operation planning
    - Learning from historical cases of both successful and challenging mining projects
5. **Hydrogeological Conditions**
    - Hydrogeological characteristics of coals and coal-bearing sequences
    - Understanding the necessity and methods of dewatering during mining.
    - Mitigation strategies for potential hydrogeological impacts
6. **Safety Standards and Regulations**
    - Global Safety Standards in Mining
    - Queensland Specific Safety Protocols (Thar coal case study)
    - Risk Assessments and Management
    - Emergency Response Planning

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "SME Elements of Practical Coal Mining" by S.M. Cassidy
2. "SME Coal Preparation" edited by J.D. Leonard and R.D. Mitchell, (Latest Edition)
3. "Coal Mining Technology: Theory and Practice" by R. Stefanko and C.J. Bise
4. "Coal Geology and Coal Technology" by Colin R. Ward
5. "Coal Geology" by Larry Thomas

STRATA CONTROL/ GROUND CONTROL ENGINEERING

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

Ground Control Engineering is an advanced course designed for undergraduate students in BSc Mining Engineering. This course delves into the design, assessment, and management of ground control in mining and excavation projects. Students will explore the principles of rock mass behavior, ground support system design, and the application of modern tools, including numerical modeling and monitoring techniques, to ensure the safety and stability of underground and surface excavations.

COURSE LEARNING OUTCOMES

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

1. Explain design principles for openings in both massive and jointed rocks.
2. Analyze the influence of geological features and rock mass properties on ground stability.
3. Apply various rock mass classification systems to characterize the rock mass and recommend appropriate ground control strategies.
4. Design stable excavations (tunnels, slopes, shafts) considering stress distribution, rock mass behavior, and support requirements.

COURSE CONTENT

1. **Design of Openings in Rocks**
   - Principles of designing single and multiple openings in massive rock.
   - Design considerations for openings in jointed rocks.
   - Geological structures and their effects on excavations.
2. **Rock Mass Classification**
   - Introduction to rock mass classification systems (RMR, RQD, Q, GSI, etc.).
   - Applications of rock mass classification in ground control engineering.
3. **Ground Support System Design**
   - Principles of designing effective rock support systems.
   - Pillar design considerations for underground excavations.
4. **Subsidence Engineering**
   - Evaluation of subsidence engineering principles.

- Strategies for minimizing subsidence in mining operations.

5. **Rock Slope Engineering**
   - Principles and methods of rock slope engineering.
   - Stability assessment and design considerations for surface excavations.
6. **Monitoring and Instrumentation**
   - Implementation of monitoring techniques in ground control engineering.
   - Selection and use of instrumentation for stability assessment.
7. **Numerical Modeling Applications**
   - Introduction to numerical modeling tools
   - Application of numerical modeling in ground control stability assessment.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Strata Control" by Bieniawski
2. "Coal Mine Ground Control" by Syd S. Peng
3. "Surface Subsidence Engineering" by Syd S. Peng
4. "Rock Slope Engineering" by Hoek and Bray
5. "Longwall Mining" by Syd and Peng

MINING AND PROCESSING OF RARE EARTH ELEMENTS

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

This course is designed to develop students' understanding about the different rare earth elements found in the earth, their extraction and processing techniques and their uses. The students will also be familiarized with the environmental impacts of rare earth elements mining and processing.

COURSE LEARNING OUTCOMES

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

1. Identify different rare earth elements.
2. Understand different equipment and methods used for mining and processing of REE.
3. The students will also be aware about different environmental impacts of REE.

COURSE CONTENT

1. Introduction to Rare Earth Elements (REEs)

- Definition and characteristics of REEs
- Historical overview of REE mining and usage
- Importance of REEs in modern technology and industry

2. Geological Occurrence and Distribution of REEs

- Types of REE deposits: primary and secondary
- Geological settings favorable for REE concentration
- Global distribution of REE resources

3. Exploration Techniques for REE Deposits

- Remote sensing methods
- Geophysical surveys
- Geochemical analysis
- Drilling techniques and sampling strategies

4. Mining Methods for REE Extraction

- Open-pit mining
- Underground mining
- In-situ leaching
- Dredging and seabed mining for marine deposits

5. Ore Processing Techniques and Unit Operations

- Crushing and grinding
- Gravity separation
- Magnetic separation
- Flotation and froth flotation

6. Hydrometallurgical and Pyrometallurgical Processing of REEs

- Acid leaching
- Solvent extraction
- Smelting and refining

7. Environmental and Social Impacts of REE Mining and Processing

- Water and air pollution
- Habitat destruction
- Health and safety concerns
- Community relations and stakeholder engagement

8. Recovery of By-Products and Waste Management

- Recovery of other valuable metals
- Tailings management and reclamation
- Recycling of REE-containing products

9. Market Trends and Economic Considerations

- Supply and demand dynamics
- Price fluctuations
- Investment opportunities and challenges

10. Case Studies of REE Mining Projects

- Notable REE mining operations around the world
- Successes and failures in REE extraction and processing

11. Future Prospects and Emerging Technologies in REE Industry

- Technological advancements in extraction and processing
- Potential alternative sources of REEs
- Regulatory and policy considerations for sustainable REE production.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "The Science of Rare Earth Elements Concepts and Applications" by Frank R. Spellmans
2. "Rare Earths Industry: Technological, Economic, and Environmental Implications" by Ismar Borges de Lima
3. "Rare Earth Elements: A Brief Review" by Hongmin Zhu
4. "Rare Earths: Science, Technology, Production and Use" edited by Karl A. Gschneidner Jr., Jean-Claude G. Bünzli, and Vitalij K. Pecharsky

PLACER MINING AND PROCESSING

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

In placer mining and processing course, the students will learn various techniques for identifying and evaluating placer deposits, including sampling methods and relevant geological and geophysical exploration tools. They will gain knowledge in assessing the potential of placer deposits. The course covers different mining methods used in placer mining operations, such as panning, sluicing, dredging, and hydraulic mining. Students will study the equipment and machinery used in the processing of placer deposits like gravity separation devices. Further the resource estimation, environmental and social aspects will also be considered in the course.

COURSE LEARNING OUTCOMES

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

1. To acquire knowledge of different sampling and mining methods; equipment and machinery used in placer mining operations.
2. To investigate various processing methods of placer minerals
3. To know about the environmental and social aspects of placer mining

COURSE CONTENT

1. Introduction to Placer Mining

- Definition and characteristics of placer deposits
- Historical overview of placer mining
- Importance and economic significance of placer mining

2. Exploration and Evaluation of Placer Deposits

- Methods for identifying and locating placer deposits
- Sampling techniques for placer deposits
- Geological and geophysical methods for evaluating placer deposits

3. Placer Mining Methods

- Overview of different placer mining methods (e.g., panning, sluicing, dredging, hydraulic mining)
- Equipment and machinery used in placer mining operations
- Environmental considerations and regulations in placer mining

4. Placer Deposit Evaluation and Resource Estimation

- Resource estimation techniques for placer deposits

- Factors affecting placer deposit grade and tonnage
- Estimation of recoverable reserves in placer deposits

5. Placer Mining Operations and Techniques

- Planning and design of placer mining operations
- Extraction and recovery methods for different types of placer deposits
- Processing techniques for separating valuable minerals from placer materials

6. Environmental and Social Impacts of Placer Mining

- Environmental considerations and mitigation measures in placer mining
- Social and community impacts of placer mining operations
- Reclamation and rehabilitation of placer mining sites

7. Case Studies and Field Trips

- Analysis of real-world placer mining projects
- Field trips to operational placer mining sites for practical exposure

8. Safety and Risk Management in Placer Mining

- Occupational health and safety considerations in placer mining
- Risk assessment and management in placer mining operations
- Emergency response and rescue procedures in placer mining

9. Regulatory Framework and Legal Aspects

- Laws and regulations governing placer mining activities
- Permitting and licensing requirements for placer mining operations
- Compliance with environmental and safety regulations

10. Future Trends and Innovations in Placer Mining

- Emerging technologies and advancements in placer mining
- Sustainable practices and innovations in placer mining operations
- Potential challenges and opportunities in the future of placer mining

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Introductory Mining Engineering" by H. L. Hartman
2. "Placer Mining: A Guide to Environmental Impact Assessment" by Michael G. Moncur
3. "Placer Mining in the Western United States" by William B. Clark:
4. Placer Mining for Gold in California

MINING LAWS AND POLICIES

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

This course is designed to familiarize students with the basic terminology of the legislation related to mining. Students will understand and comprehend different sections of the Mines Act 1923. Students will also be able explain and comprehend the sections of the Coal Mines regulations 1926, the Metalliferous Mines Regulations 1926, the Consolidated Mines Rules 1952, bylaws, standing orders issued by the appropriate government. Students will also learn about the salient features of the National and Provincial Minerals Policies and related rules introduced by the appropriate government.

COURSE LEARNING OUTCOMES

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

1. Define and describe the basic terminologies of mining law.
2. Paraphrase different sections of Mines Act, rules and regulations made there under
3. Demonstrate adequate capacity in interpreting the mining laws for a given situation.
4. Devise a cogent case for specific scenario in light of the Mines Act

COURSE CONTENT

1. The Mines Act, 1923.
2. The Coal Mines Regulations, 1926.
3. The Metalliferous Mines Regulations, 1926.
4. The Mining Board Rules, 1951.
5. The Consolidated Mines Rules, 1952.
6. The Competency Certificates Examination Rules, 1981.
7. The Central Rescue Station (Coal Mines) Rules, 1986.
8. Introduction to Provincial Mining concession rules and procedures
9. Minerals Policies: National Minerals Policy (NMP), and Provincial policies applicable to the minerals sector.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Mining Labour Code by M. Shafi and P. Shafi
2. Mines and Minerals Act, Regulations, Rules of the Provincial government.
3. Introduction to Government of Pakistan Environmental Protection Act 1997

ENVIRONMENTAL ASPECTS OF MINING

Credit Hours: 3+0
Prerequisites: Nil

DESCRIPTION

This course aims to provide a comprehensive and practical understanding of the impacts both positive and negative that mining may have on society and the environment. It also provides an appreciation of management principles and practices vital to a mine manager's successful running of a mining enterprise.

COURSE LEARNING OUTCOMES

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

1. Understand the environmental pollution and ecological impacts associated with mining operations.
2. Classify and manage different types of solid and hazardous wastes generated by mining activities, including mines, mill tailings, and their disposal methods.
3. Assess and mitigate noise pollution and vibration effects resulting from mining activities, particularly blasting, and implement appropriate control strategies.
4. Evaluate the environmental impacts of Acid Mine Drainage (AMD) and other pollutants at mining sites, and implement measures to control and mitigate these impacts.

COURSE CONTENT

1. Environmental Pollution
2. Solid and Hazardous waste management
3. Sources of acid mine water draining and its control
4. Noise pollution sources at mine site and its control
5. Environmental pollution control laws and regulations
6. Pollution sampling and measuring techniques
7. Ecological impact and reclamation of mined land
8. Vibration and air blasts caused due to blasting and its control
9. Acid Mine Drainage.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Explosives and Blasting Procedures Manual" by Fletcher & D'Andrea
2. "Mining and its impact on the environment" by Fred G. Bell and Laurance J. Donnelly
3. "Environmental impacts of mining (Monitoring, Restoration and Control)" by M. Sengupta
4. "Mining environment (Problems and Remedies)" by O.P Singh

OCCUPATIONAL HEALTH AND SAFETY

Credit: 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

By the end of this course, students 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

1. **Health and Safety Foundations**
   - Nature and scope of health and safety
   - Reasons/benefits and barriers for good practices of health and safety
   - Legal framework and OHS Management System
2. **Fostering a Safety Culture**
   - Four principles of safety- RAMP (Recognize, Assess, Minimize, Prepare)
   - Re-thinking safety-learning from incidents
   - Safety ethics and rules
   - Roles and responsibilities towards safety
   - Building positive attitude towards safety
   - Safety cultures in academic institutions
3. **Recognizing and Communicating Hazards:**
   - Hazards and Risk
   - Types of hazards: Physical (mechanical and non-mechanical), Chemical (Toxic and biological agents), electrical, fire, construction, heat and temperature, noise and vibration, falling and lifting etc.

- Learning the language of safety: Signs, symbols and labels

4. Finding Hazard Information

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

5. Accidents & Their Effect on Industry

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

6. Assessing and Minimizing the Risks from Hazards

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

7. Preparing for Emergency Response Procedures

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

8. Stress and Safety at Work environment

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

9. Incident Investigation

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

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

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

PROBABILITY & STATISTICS

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

"Probability and Statistics" provides students with a comprehensive foundation in probability theory and statistical analysis within the context of Mechatronics engineering. Topics include basic statistics, data presentation, measures of central tendency and dispersion, probability theory, random variables, and probability distributions. Through theoretical study and practical exercises, students learn to analyse data, make informed decisions, and apply statistical methods to engineering problems.

COURSE LEARNING OUTCOMES

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

1. To understand the basic concept of Statistics and Probability and their need in engineering.
2. To Describe properties and classifications of probability density functions, regression analysis and interval estimation
3. To Apply different probability and statistics techniques in engineering problems

COURSE CONTENT

1. Basic Statistics

- Statistics, Branches of Statistics, Importance of statistics, population, sample, observation, variables, measurement of variable, Data, primary data, secondary data

2. Data Presentation

- Frequency distribution (grouped, ungrouped), stem and leaf display, histogram, frequency polygon, cumulative frequency polygon, Simple & Multiple Bar diagrams

3. Measure of Central Tendency

- Arithmetic Mean (A.M), Geometric Mean (G.M), Harmonic Mean (H.M), Quantiles (Median, Quartiles, Deciles, Percentiles), Mode, Applications of Averages

4. Measure of Dispersion

- Background, Range, Quartile deviation, Mean deviation, Variance, Standard deviation, Coefficient of variation, Moments, Moments ratios, Skewness, Kurtosis

- Applications in different Engineering Disciplines

5. Probability and Random Variables

- Probability review, Laws of probability, Conditional probability, Bayesian theorem, independent, dependent events.
- Random variables, Discrete and Continuous random variables, Probability mass and density functions, Distribution functions, Mathematical expectation,
- Variance of random variable, Bivariate distribution, Joint probability distribution, Moment generating function

6. Probability Distributions

- Discrete distributions:
- Bernoulli distribution, Binomial, Geometric, Negative binomial, Hyper-geometric, Poisson distribution, Properties and application of these distributions.
- Continuous Distributions: Uniform Distribution, Exponential distribution, Normal distribution, Applications

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Introduction to Statistical theory part 1" by Sher Muhammad Chuadary
2. "Advanced Engineering Mathematics" by Erwin Kreyszig
3. "Probability and Statistics for Engineers and Scientists" by Antony Hayter.
4. "Elementary Statistics" by Bluman.

APPLIED ELECTRICITY

Credit Hours: 2+1
Prerequisites: Nil

DESCRIPTION

This Course is designed to develop the ability of students to understand and apply the fundamentals of applied electricity in field of mining engineering.

COURSE LEARNING OUTCOMES

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

1. Explain with Examples the active circuit elements, passive circuit elements, their series and parallel combinations with time varying and DC excitation and various laws of Electrical Circuits, fundamentals, phasors ,different mathematical operations of phasors, series circuits with AC excitation.
2. Solve the problems related to application of various laws of Electrical Circuits
3. Analyze the importance of semiconductors/electronic devices and the complete internal structure of PN junction and types of bias.

COURSE CONTENT

1. **Circuit theory:** Solution of D.C. Circuits by Ohm's law and Kirchoffs laws, R.L.C. series and parallel Circuits calculation of power in single and three phase circuits. A.C and D.C. machines, transformer emf equation, losses and efficiency, open circuit and short circuit tests. Three phase transformer, connection construction and operation of synchronous machines, construction, operation and starting methods for-3-phase induction motor, including slipering motor. Construction operation of single phase motors i.e. split-phase, capacitor, shaded pole and universal motors. Construction and characteristics of series, shunt and compound generators and motors, emf and torque equations, starter and speed control of motor.
2. **Introduction to electronics:** Semiconductor fundamentals, Germanium and Silicon atoms and crystals, conduction in intrinsic Germanium and Silicon. N and P-type of semiconductors conduction in doped Germanium and Silicon. The PN Junction, diode biasing, diode characteristics, diode ratings, temperature considerations, diode construction, diode applications.
3. **Mine electrification:** Principles of mine electrical circuits required power calculations. Design of electric cables control devices, earthing.
4. ***Electrical instruments and measurements:*** Deflecting, controlling and damping devices, moving coil and moving iron ammeters and voltmeters-electro-dynamic and dynamometer instruments. Measurement of resistance, ohm meter, wheat-stone bridge, single phase energy meter (induction type).

5. ***Supply systems:*** Introduction to supply systems and equipment, comparison of supply system-overhead line conductor and insulators (pin type-cap and pin type insulator) underground cables, single core and 3-core solid type cables-fuses and circuit breaker, tariffs.

PRACTICAL REQUIREMENTS

1. To find the inductance of the unknown inductor by three voltmeters method
2. To find the unknown capacitance by three voltmeter method
3. Measurement of power factor by voltmeter ammeter and wattmeter
4. To find the single-phase power by three voltmeter method
5. To measurement the single-phase power of load by three ammeter method
6. To measure the intensity of light by lux meter
7. To study the speed test for an energy meter
8. To measure the current in circuit using tungtester
9. To measure the unknown resistance using megger
10. To measure the resistance of the grounding using megger
11. To calculate q factor of a circuit
12. To measure unknown resistance using Wheatstone bridge
13. To measure unknown inductance using Maxwell inductance bridge
14. To measure unknown inductance using Maxwell Wien bridge
15. To measure unknown capacitance using Schering bridge

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Applied Electricity: a Text-book of Electrical Engineering for Second Year Students" by J. Paley Yorke
2. "Applied Electricity for Practical Men" by Arthur John Rowland
3. "Introductory Circuit Analysis" by Boylestad
4. "Electronic Devices" by Thomas L. Floyd
5. "Electronics Principles" by Alberto P Malvino

ENGINEERING DRAWING & GRAPHICS

Credits: 1+2
Pre-Requisite: Nil

DESCRIPTION

To inculcate in students the ability to comprehend the science of Engineering Drawing so that they are able to convey their creative ideas effectively.

COURSE LEARNING OUTCOMES

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

1. Apply principles of engineering visualization and projection theory to prepare engineering drawings, using conventional and modern drawing tools
2. Draw orthographic projection, sectional views, and isometric views of different mechanical parts.

COURSE CONTENT

1. **Introduction:** Introduction to Engineering Drawing, I. S. specification for preparation of drawings, Use of drawing instruments and materials, Basic Tools, Lines: Types, configuration and application, Selection of line thickness.
2. **Orthographic Projection:** Principle and Methods of projection, Orthographic projection, Planes of projection, First and Third-angle projection, Reference line
3. **Projection of Points:** A point is situated in the first, second, third and fourth quadrant.
4. **Projection of Straight Lines:** Line parallel and perpendicular to one or both the planes, Line contained by one or both the planes, Projections of lines inclined to both the planes, True length of a straight line and its inclinations, Methods of determining traces of a line.
5. **Projection of Planes (2D):** Types and Traces of planes, Projections of planes, Projections of oblique planes
6. **Projections on Auxiliary Planes (2D):** Types of auxiliary planes and views, Projection of a point on an auxiliary plane, Projections of lines and planes.
7. **Projections of Solids (3D):** Types of solids and their projections, Projections of solids with axes inclined.
8. **Section of Solids (3D):** Section of planes, prisms, pyramids, cylinders, cones, spheres, Methods of development, Triangulation development, Developments of lateral surfaces of right solids

9. **Isometric Projections (3D):** Isometric axes, lines, planes, and scale, Isometric drawing or isometric view, Isometric drawing of planes or plane figures, prisms and pyramids, cylinders, cones and sphere
10. **Lettering, Numbering and Dimensioning:** Vertical and inclined single stroke letters, Lettering types and rules, Dimension lines, projection lines, leaders or pointer lines, Arrow heads, Dimensioning,
11. **Geometric Construction:** Drawing simple geometric objects (polygon, pentagon and hexagons etc).
12. **Orthographic Projections of different Solids**
13. **Orthographic Projections of Machine Elements:** Rivets, Nut and bolts, Different kinds of threads, Lap and butt joints, Flange couplings, Journal bearing, Open bearing, Footstep bearing, Crankshaft, Bearings
14. **Practical:** Select a machine and study its operation and machine elements detail, Draw the 3D model of the machine and draw 2D drawings

PRACTICAL REQUIREMENTS

Hands on experience using various software such as CAD etc

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Engineering Drawing and Graphics" by N.D Bhatt
2. "Technical Graphics Communication" by B. Wiebe, M. Mohler
3. "Practical Geometry & Engineering Graphics" by Abbot
4. "Engineering Graphics" by Craft, Meyers & Boyer,
5. "Technical Graphics Communication" by G. R. Bertoline, E. N. Wiebe
6. "Mathematical Elements for Computer Graphics" by D.F. Rogers, J.A. Adams
7. "A First Year Engineering Drawing" by A. C Parkinson

Annexure A

NON-EXHAUSTIVE LIST OF CONSIDERED KEY PHRASES IN UN SDGs

FOR MAPPING WITH BACHELORS OF ENGINEERING PROGRAM

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

levels……..)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

SDG-12 (12.5 …… substantially reduce waste generation through prevention, reduction, recycling and reuse)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Annexure B

MAPPING GUIDE OF SELECTED COURSES WITH SDGS
SOCIOLOGY FOR ENGINEERS

Credits: 02
Pre-Requisite: Nil

DESCRIPTION

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

Mapped SDGs:

SDG-13 Climate Change	13.2 Integrate climate change measures……..

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. .

SYLLABUS

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 & their 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.

12. 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

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http://www.pec.org.pk