CURRICULUM

OF

MINING ENGINEERING

BS/BE/BSc

and

MS/ME/MSc

(Revised 2017)

HIGHER EDUCATION COMMISSION
ISLAMABAD

CURRICULUM DIVISION, HEC

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PREFACE

The curriculum, with varying definitions, is said to be a plan of the teaching-learning process that students of an academic programme are required to undergo to achieve some specific objectives. It includes scheme of studies, objectives & learning outcomes, course contents, teaching methodologies and assessment/ evaluation. Since knowledge in all disciplines and fields is expanding at a fast pace and new disciplines are also emerging; it is imperative that curricula be developed and revised accordingly.

University Grants Commission (UGC) was designated as the competent authority to develop, review and revise curricula beyond Class-XII vide 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).

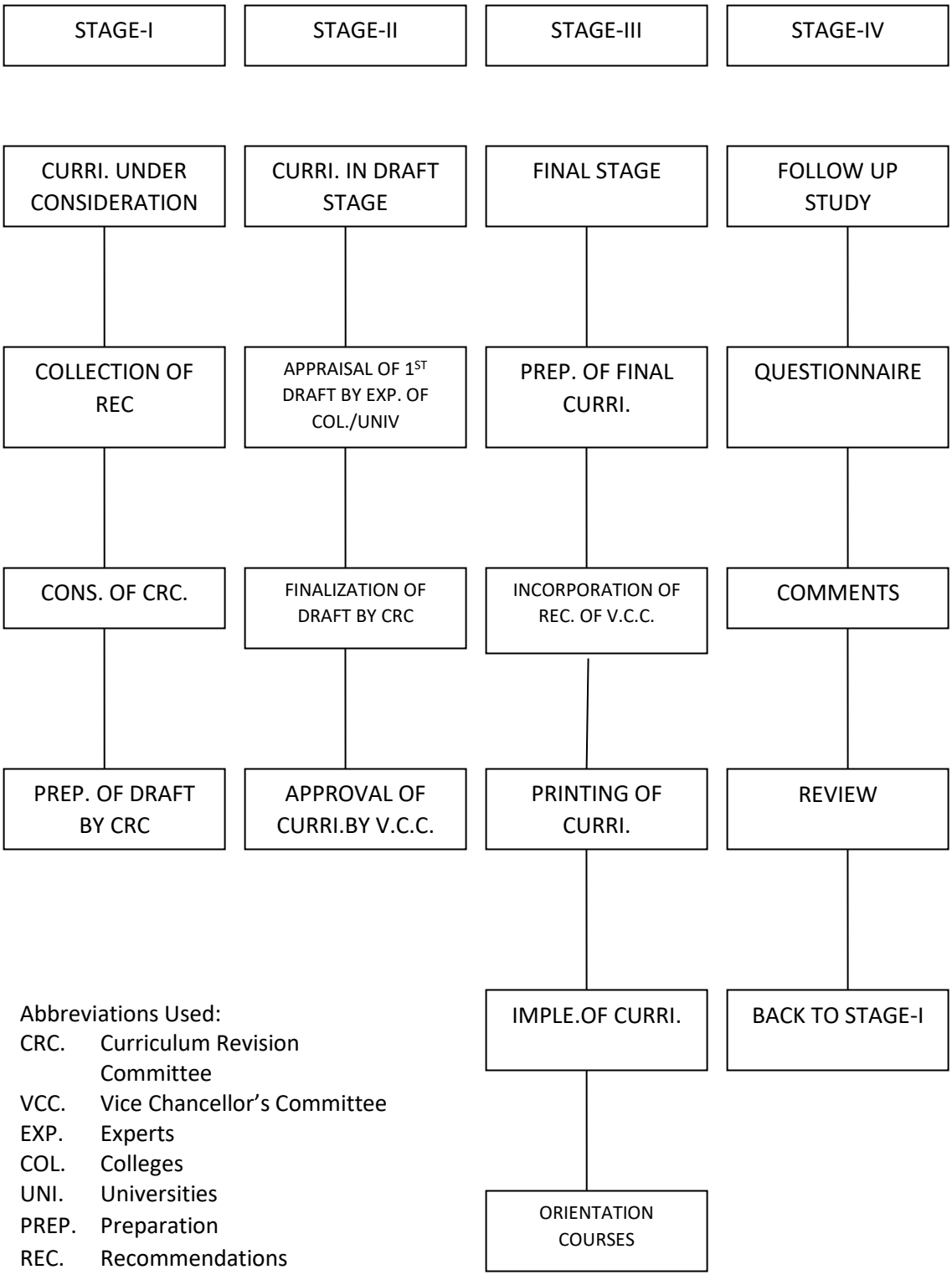
In compliance with the above provisions, the Curriculum Division of HEC undertakes the revision of curricula regularly through respective National Curriculum Revision Committees (NCRCs) which consist of eminent professors and researchers of relevant fields from public and private sector universities, R&D organizations, councils, industry and civil society by seeking nominations from their organizations.

In order to impart quality education which is at par with indigenous needs and international standards, HEC NCRCs have developed unified framework/ templates as guidelines for the development and revision of curricula in the disciplines of Basic Sciences, Applied Sciences, Social Sciences, Agriculture and Engineering.

It is hoped that this curriculum document, prepared by the respective NCRC’s, would serve the purpose of meeting our national, social and economic needs, and it would also provide the level of competency specified in Pakistan Qualification Framework to make it compatible with international educational standards. The curriculum is also placed on the website of HEC
http://hec.gov.pk/english/services/universities/RevisedCurricula/Pages/default.aspx

(Muhammad Raza Chohan)
Director General (Academics)

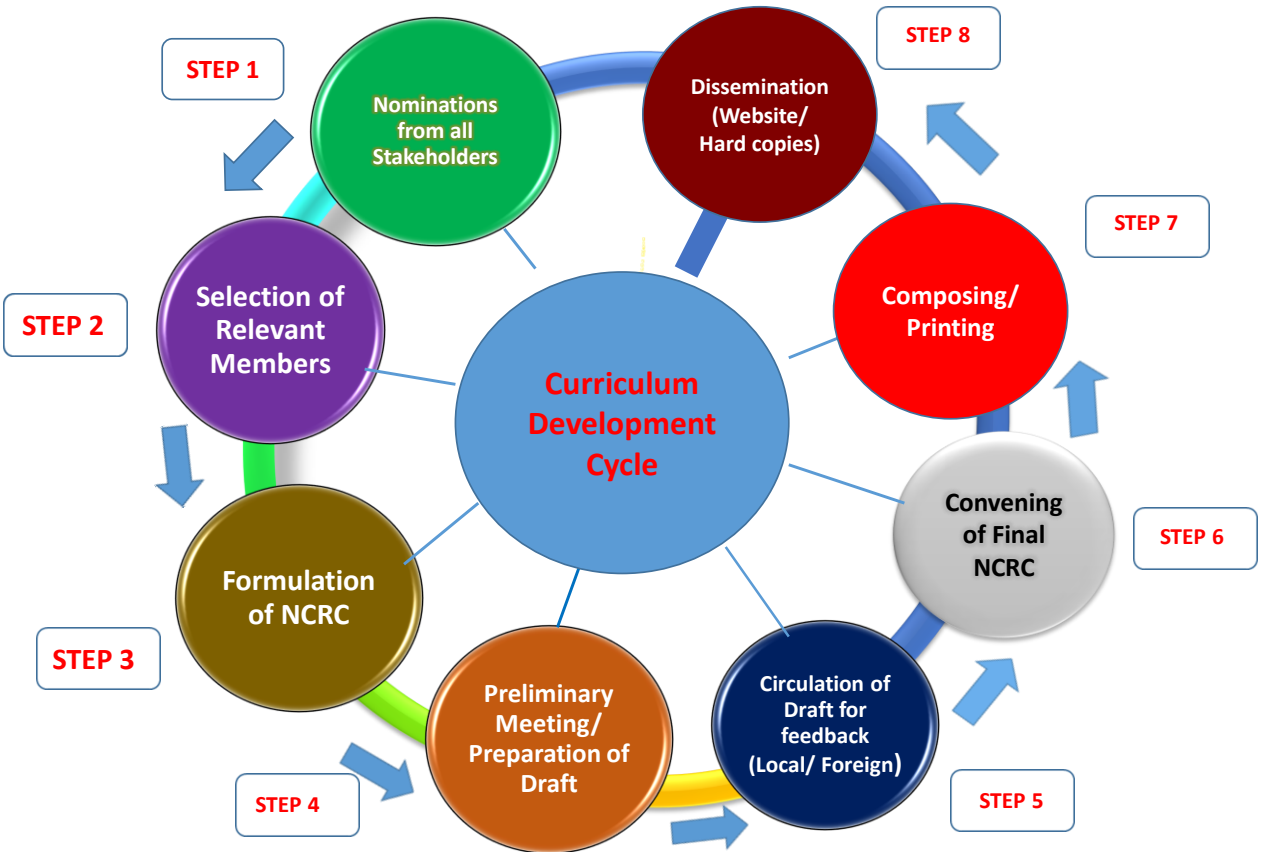
CURRICULUM DEVELOPMENT PROCESS



Abbreviations Used:

CRC.	Curriculum Revision Committee
VCC.	Vice Chancellor's Committee
EXP.	Experts
COL.	Colleges
UNI.	Universities
PREP.	Preparation
REC.	Recommendations

CURRICULUM DEVELOPMENT CYCLE



INTRODUCTION:

The final meeting of National Curriculum Revision Committee (NCRC) for the discipline of **Mining Engineering (BS/BE-MS/ME)** was held from **April 17-19, 2017** at **HEC, Regional Centre Karachi**. The purpose of the meeting was to finalize the draft curriculum prepared in its preliminary meeting held from March 13-15, 2017 at the Higher Education Commission, Regional Centre, Peshawar. The following members attended the meeting:

1. Engr. Dr. Syed Mohammad Ali Shah — Convener
   Professor, Department of Mining Engineering,
   Balochistan University of Information Technology,
   Engineering & Management Sciences (BUITEMS),
   Takatu Campus, Airport Road Baleli,
   Baleli, Quetta. 87300.

2. Engr. Dr. Zulfiqar Ali, — Member
   Chairman Department of Mining Engineering, UET
   Lahore.

3. Engr. Muhammad Khalid Pervaiz — Member
   Ex. chief Inspector of Mines Punjab and
   Chairman Pakistan Mine owners Association
   18 B Gulshane Ravi, Lahore.

4. Engr. Prof. Dr. Khan Gul Jadoon — Member
   COMSATS IIT
   Abbottabad Campus

5. Engr. Fazal Hussain — Member
   Senior Inspector of Mines,
   Directorate General of Mines & Minerals
   Khyber Road, Peshawar, Khyber PakhtunKhwa.

6. Engr. Dr. Ishaq Ahmed — Member
   Assistant Professor, Department of Mining Engineering,
   University of Engineering & Technology, Peshawar — Member

7. Engr. Dr. Muhammad Azeem Raza
   Assistant Professor, Department of Mining Engineering,
   University of Engineering & Technology, Lahore.

8. Engr. Dr. Khan Muhammad — Secretary/Member
   Assistant Professor
   Department of Mining Engineering
   University of Engineering & Technology, Peshawar.

The following members sought leave of absence from the final meeting held in Karachi (from April 17-19, 2017) however, they attended the preliminary meeting held in Peshawar (from March 13-15, 2017).

1. Engr. Prof. Dr. Noor Mohammad, Professor Mining Engg./ Pro-Vice Chancellor University of Engineering & Technology, Peshawar.
2. Engr. Prof. Dr. Abdul Ghani Pathan, Dept of Mining Engineering, Mehran UET Jamshoro.
3. Engr. Prof. Dr. Muhammad Mansoor Khan, Dean Qurtaba University, DI Khan.

The meeting started with recitation from the Holy Quran. Afterwards, Mr. Javed Ali Memon, Director, HEC Regional Centre Karachi, welcomed all the participants on behalf of the Chairman, HEC, and briefed the members of the responsibilities of the Commission to review/revise the curriculum.

Ms. Syeda Sanobar Rizvi, Deputy Director (Curriculum) Co-coordinator HEC, briefed the participants of the meeting, the obligations of the Commission to review/revise curriculum as per provision of the Act of the parliament 2002. She also informed the august house regarding the main purpose of revising the curriculum framework of BE/BS/BSc and ME/MS/MSc Mining Engineering so that courses could be made compatible with the international Outcome Based Education (OBE) standards and in line with the requirements of Pakistan Engineering Council (PEC).

The meeting started with the deliberation on the preliminary draft prepared in its last meeting held on March 13-15, 2017, at HEC Peshawar Centre. The convener presented the comments of Dr. Waqar Ali Asad (Head of Department, Mining Engineering at Curtin University Australia) on the preliminary draft. The committee expressed their gratitude for the feedback on the preliminary drafts which were discussed and the recommendations were fine-tuned where considered expedient.

The NCRC discussed different aspects of the curriculum **(BE/BS/BSc-ME/MS/MSc** Mining Engineering) at length. After detailed discussion and in depth analysis of framework, CLOs and course contents; the curriculum was finalized in accordance with the International Outcome Based Education (OBE)

standards in line with the requirements of Pakistan Engineering Council (PEC).

The salient features of the revised draft are as under:

1. The credit hours for the B.E/BS/B.Sc. Mining Engineering were designed to give flexibility to the concerned universities for designing the framework within 134-140 credit hours (as per guidance of the HEC).
2. Course Learning Outcomes (CLOs) of courses were developed and added for all the courses.
3. The ratio of the engineering to non-engineering courses was worked out as 69 & 31 percent, within the generic framework guidelines of 70-30 percent.
4. Lists of optional interdisciplinary and social science courses were added to address the needs of mining/mineral industry of various regional localities in Pakistan. The universities are expected to adopt courses from this list in accordance with the Program Learning Outcomes (PLOs).
5. An opportunity is provided to the universities under the heading of special topics/courses to introduce/test new course in the interdisciplinary and social sciences knowledge areas.
6. The following courses were added to abridge the market needs and strengthen the depth/breadth of the program:
    a. “Computer Applications in Mining Engineering” course was added into the “Computing” knowledge area.
    b. “Mining and Environment” course was added into the “major core (breadth)” knowledge area.
    c. “Engineering Workshop” course was added into the “Engineering Foundation” knowledge area.
7. The following course was amended to address the market needs within the constraints of the advised framework of the curriculum
    a. In Humanities section “English II” and “English III” were merged into a single course “Communication and Technical Report writing”
    b. The Management courses “Engineering Management” and “Engineering Economics” were revised as “Mine Management” and “Mine Economics” respectively.
    c. The subject “Probability and Statistics” was revised as “Engineering Statistics” and moved from the knowledge area of “Computing” to “Natural Sciences”.
    d. The “Mineral Exploration” course was revised as “Mineral Resource Estimation”.
    e. “Mine Power, Drainage and Materials Handling” course was removed from the “major core (depth)” knowledge area. The course contents of this subject were added into other relevant courses as given below.

S. No.	Contents of subject 'Mine Power Drainage & Material Handling'	Contents Merged in the following subjects
1.	Compressed air theory, Compressed air system design.	**Applied Thermodynamics**
2.	Electric Power, Selection of Power Cables, power-factor correction, load flow analysis and power cost.	**Basic Electrical Technology**
3.	Different types of pumps, their characteristics, and applications. Calculation of power requirements. Pumping system analyses. Hydraulic power systems, its design and selection procedures.	**Fluid Mechanics**
4.	Belt conveyor: General applications of belt conveyors design consideration material characteristics, belt capacity, width, speed and idler selection, belt tension power calculation. Application of different surface methods of haulage and the equipment used. Locomotive tractive-effort and duty cycle calculation, Power requirement calculations.	**Surface Mine Design**
5.	Haulage: Application of different underground methods of haulage and the equipment used. Locomotive tractive-effort and duty cycle calculation, Power requirement calculations. Hoisting: Hoisting equipment, Basic hoisting systems and their special application to different mine conditions, Hoisting calculations, Steel rope design and selection.	**Underground Mine Design**

The following recommendations were made by the NCRC:

1. The NCRC agreed that final draft of the document will be submitted to the HEC within 04 weeks (i.e. by 22-5-2017).
2. The Program Learning Outcomes (PLOs) should be tailored to the regional strengths of various universities and mineral resources found locally.
3. The committee also suggested that universities should exploit their strengths and link the PLOs with the university vision and mission.
4. In future, it is proposed that universities should emerge as center of excellence in the areas of their eminence focusing on diversified mining specialties and building on their regional mineral strengths linked to the PLOs.

The convener also thanked the competent authorities of the following universities and organizations for sending their representative to participate in this National cause:

1. University of Engineering & Technology, Peshawar.
2. Balochistan University of Information Technology, Engineering & Management
   Sciences (BUITEMS), Baleli, Quetta.
3. Mehran University of Engineering & Technology, Jamshoro
4. University of Engineering & Technology, Lahore.
5. Qurtuba University of Science& Information Technology, Shaikh Yousaf Road, D.I. Khan
6. ENERPOOL and Associates, Lahore.
7. Directorate General of Mines & Minerals, KPK.
8. COMSATS IIT Abbottabad
9. Pakistan Engineering Council, Islamabad.

The members thanked HEC for the initiative it has taken to bring the standard of engineering curricula in the country at par with the International Outcome Based Education (OBE) standards and in line with the requirements of Pakistan Engineering Council (PEC). The meeting concluded with mutual vote of thanks.

RATIONALE / SCOPE:

The efficient recovery of mineral resources requires Mining Engineers with a sound knowledge of fundamentals and latest technological developments relevant to this field. The mission of the Mining Engineering education is to produce graduates who can not only satisfy the current needs of the Pakistani Mining industry, but are also able to develop technologies indigenously, by preparing the effective and efficient professionals, through research, develop the methods to utilize all the available natural resources in order to fulfill the energy/mineral industry needs of Pakistan in coming years. This will contribute in socio- economic development of Pakistan and the region.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs):

The program emphasis on building up of strong base in Engineering foundation and Basic Science subjects and detailed understanding of core areas with practical knowledge that comprehends with use of professional software and lab practices. The program is competent to enhance capabilities for higher education and to fulfill the requirements of the mining industry. It is also oriented towards the Outcome Based Education (OBE). Following are the main objectives:

i) Apply state of the art engineering skills for exploitation of mineral deposits of the province specifically and Pakistan generally, building on

the strengths of indigenous resources.

ii) Exhibit high level technical competency, applying research and problem solving skills to generate innovative solutions in the field of Mining Engineering profession.

iii) Promote professional excellence through interpersonal and communication skills focusing on safety, environment sustainability and high ethical morality disposed to interests of major stakeholders and societal growth.

iv) Continually update management and engineering skills for solution of contemporary problems in mining industry and matters important to society at national and international levels.

PROGRAM LEARNING OUTCOMES (PLOs):

The following Program Learning Outcomes (PLO's) for undergraduate program are adopted:

PLO-01: Engineering Knowledge:

Ability to apply knowledge of mathematics, science and engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

PLO-02: Problem Analysis:

Ability to identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

PLO-03: Design/Development of Solutions:

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.

PLO-04: Investigation:

Ability to investigate complex engineering problems in a methodical way including literature survey, design and conduct of experiments, analysis and interpretation of experimental data, and synthesis of information to derive valid conclusions.

PLO-05: Modern Tool Usage:

Ability to create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering activities, with an understanding of the limitations.

PLO-06: The Engineer and Society:

Ability to apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solution to complex engineering problems.

PLO-07: Environment and Sustainability:

Ability to understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.

PLO-08: Ethics:

Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.

PLO-09: Individual and Team Work:

Ability to work effectively, as an individual or in a team, on multifaceted and/or multidisciplinary settings.

PLO-10: Communication:

Ability to communicate effectively, orally as well as in writing 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 documentations, make effective presentations, and give and receive clear instructions.

PLO-11: Project Management:

Ability to demonstrate management skills and apply engineering principles to one's own work, as a member and/or leader in a team to manage projects in a multidisciplinary environment.

PLO-12: Lifelong Learning:

Ability to recognize importance of, and pursue lifelong learning in the broader context of innovation and technological developments.

In order to achieve the above PLO's each course has been designed with course learning outcomes (CLOs) that can be further linked to the PLOs. For making the program more competitive, specific teaching methods and assessments are described. These include the following:

INTAKE / ADMISSION CRITERIA:

The intake / admission criteria for B.E/BS/BSc Mining Engineering shall follow National Qualification Framework of Pakistan 2015 and Pakistan Engineering Council Regulations for Engineering Education in Pakistan, Article 2, which is reproduced as under:-

ARTICLE 2:
Minimum Qualification for Admission to Engineering Bachelor's Degree Programmes Offered by Engineering Institutions and Universities

A candidate seeking admission in an Engineering Institution/University for working towards Bachelor's Degree in any recognized branch of Engineering must fulfill the following minimum requirements: ─

(a) (i) He or she has passed the Higher Secondary School Certificate (HSC/HSSC) Pre-Engineering Examination with Physics, Chemistry and Mathematics, securing at least 60% marks in aggregate of a University, a Board of Intermediate or Board of Intermediate and Secondary Education in Pakistan. In addition, a combination of Physics, Mathematics and Computer Studies/Computer Science may be allowed for admissions in all Computer related Engineering Programmes, Electronics, Telecommunications and Avionics Engineering Programmes and a combination of Biology, Physics, Chemistry may also be allowed for Biomedical or Bio-Engineering: Provided that any candidate who has been admitted in an Engineering Institution or University for working towards Bachelor's degree in any recognized branch of engineering before the 6th June, 2003, and does not fulfill the above specified minimum requirements for such admission, shall be considered for registration by the Pakistan Engineering Council. OR

(ii) He or she has passed any other examination of a Foreign University/Institution/Examination Body, with both standard as well as scope wise is equivalent to the Higher Secondary School Certificate (Pre-Engineering) of a University or a Board of Intermediate/Intermediate and Secondary Education in Pakistan. Equivalence of the Examination passed by the candidate shall be determined by the concerned University.

(b) He or she has passed an entrance test conducted by the respective Institution or University.

(c) (i) A candidate who has passed the Diploma of Associate Engineer (DAE) Examination, securing at least 60% aggregate marks shall be eligible for applying in admission against reserved seats in relevant discipline of Engineering in which he or she has passed the DAE examination; and the relevancy of DAE will be as determined by Accreditation Committee of this Council; and

(ii) A candidate possessing B.Tech (Hons)/B.Sc. Engineering Technology or equivalent qualification duly recognized by HEC seeking admission towards the relevant engineering discipline against 02% reserved seats of B.Tech (Hons)/B.Sc. Engineering Technology, shall be considered for admission in 2015 and after, with

one year of exemption: Provided that the candidate possessing B.Tech (Pass), B.Tech (Hons) qualification recognized by HEC enrolled/ graduated upto 31st December, 2014 in relevant engineering discipline against reserved seats, with one year and two year of exemption respectively, shall be considered for registration with the Council.

(d) A candidate seeking admission should possess adequate mental and physical health to be able to obtain engineering education as prescribed and necessary steps should be taken by University/ Institution to ensure this provision on admission of students.

The intake / admission criteria for ME/MS/MSc Mining Engineering shall follow National Qualification Framework of Pakistan 2015 and Minimum Criteria for Admission in MS/MPhil Programmes of HEC which is reproduced as under: -

(a) Sixteen years of schooling or 4 year education (124 credit hours) after HSSC/FA/FSc/Grade 12 equivalent will be required for admission in the MPhil/MS.

(b) The GAT-General (www.nts.org.pk/gat/gat.asp) conducted by the National Testing Service with a minimum 50% cumulative score will be required at the time of admission to MPhil/MS. The GAT-General test is valid for a period of two years.

(c) For award of MPhil/MS/Equivalent degree, candidates will either need to complete 30 credit hours of coursework or complete 24 credit hours of coursework along with a minimum of 6 credit hours for research work/thesis.

(d) There should be at least 2 relevant full time PhD Faculty members in a department to launch the MPhil/ME/MS/MSc programmes.

FRAMEWORK FOR BE/BS/BSc. MINING ENGINEERING:

Based on HEC existing Scheme of Studies for Bachelor of Mining Engineering, a critical review in line with emerging trends, future developments and strengthening of knowledge in respect to industry requirements was carried out in line with similar programmes of international repute. The review includes changes in course contents, deletion and addition of new courses, considerations of prerequisite courses and changes in scheme of studies. A proposed revised Scheme of Studies for BE/BS/BSc. Mining Engineering is recommended as under:

Duration:	4 years
Number of Semesters	8
Number of weeks per semester:	18 (16 for teaching and 2 for examinations)
Number of credit hours per semester:	13 – 20
Total number of credit hours:	130-140 (Within the HEC guidelines)
Non-Engineering Courses (Maximum):	15 Courses, 43 Cr Hrs, 31 % of total
Engineering Course (Minimum):	28 Courses, 96 Cr Hrs, 69 % of total

Non-Engineering Domain							
Knowledge Area	**Subject Area**	**Name of Course**	**Lec CH**	**Lab CH**	**C H**	**Total Courses**	**Total C Hrs**
Humanities	English	English-I (Comprehension and Composition)	3	0	3	2	6
		English-II (Communication & Technical Report writing)	3	0	3		
	Culture	Pakistan Studies	2	0	2	2	4
		Islamic Studies/ Ethics	2	0	2		
	Social Sciences	*Social Sciences-I	3	0	3	2	6
		*Social Sciences-II	3	0	3		
Management sciences		Mine Management	2	0	2	2	4
		Mine Economics	2	0	2		
Natural Science	Mathe-matics	Maths-I (Analytical Geometry and Calculus)	3	0	3	4	11
		Maths-II (Differential Equations)	3	0	3		
		Maths-III (Linear	3	0	3		

		Algebra)					
		Engineering Statistics	2	0	2		
	Sciences	Applied Physics	3	1	4	3	12
		General Geology	3	1	4		
		Physical and Industrial Chemistry	3	1	4		
TOTAL						15	43

Engineering Domain							
Knowledge Area	**Subject Area**	**Name of Course**	**Lec CH**	**Lab CH**	**CH**	**Total Courses**	**Total C Hrs**
Computing	Fundamentals	Numerical Methods in Computing	2	0	2	3	6
	Programming	Computer Programming	2	1	3		
	Application	Computer Application in Mining Engineering	0	1	1		
Engineering Foundation	Engineering Foundation	Mining Engineering Fundamentals	3	0	3	9	31
		Engineering Drawing and Graphics	1	2	3		
		Engineering Workshop	0	2	2		
		Applied Thermo-dynamics	3	1	4		
		Fluid Mechanics	3	1	4		
		Mechanics of Materials	3	1	4		
		Basic Electrical Technology	3	1	4		
		Structural Geology	3	1	4		
		Engineering Mechanics	3	0	3		
Major Based Core (Breadth)	Major Based Core (Breadth)	Rock Mechanics	3	1	4	7	24
		Underground Mine Design	3	0	3		

		Surface Mine Design	3	0	3		
		Mineral Processing/ Mineral Processing – I	3	1	4		
		Mine Surveying	3	1	4		
		Explosives Engineering	3	1	4		
		Mining and Environment	2	0	2		

Major Based Core (Depth)	Major Based Core (Depth)	Mine Hazards and Safety	3	1	4		19
		Coal Technology / Mineral Processing II	2	1	3		
		Mine Ventilation	3	1	4	5	
		Tunnel and Excavation Engineering	3	1	4		
		Mineral Resource Estimation	3	1	4		
Interdisciplinary Engineering Breadth (Electives)	Inter Disciplinary Engg. Breadth	* (Optional)			6	2/3	6
Senior Design Project		Senior Design Project – I	0	3	3	2	6
		Senior Design Project – II	0	3	3		
TOTAL			0	0	0	28	96
Industrial Training	Compulsory	Certifications on: -First-Aid Training -Industrial Training/Internship -Surveying Camp	0	0	0		
Grand Total						43	139

Interdisciplinary Optional Courses	**Courses on Social Sciences (Optional I & II)**
Gems and Gemology	Logic & Critical Thinking
Operations Research	Understanding Psychology and Human Behaviour
GIS and Remote Sensing	Professional Ethics
Solution Mining	Sociology and Development
Groundwater Aspects in Mining	Social Anthropology
Utilization of Industrial Minerals	Professional Psychology
Finite Element Analysis	Organizational Behavior
Drilling Technology	Introduction to Sociology
Strata Control/ Mine Geotechnical Engineering	Entrepreneurship
Mineralogy and Petrology	Project Management
Cement Technology	Chinese/Any other Language
Mine Water and Dewatering Design	Special topics/Course
Mining Laws	
Extractive Metallurgy	
Engineering Geology	
Commercial Explosive Handling and storage	
Special topics/Course	

Notes:

1. *One credit hour lab is equal to three contact hours.*
2. *Social sciences courses have been proposed. Universities may select any two courses according to their own preferences.*
3. *Special topics/course gives the department an opportunity to introduce a new course*

SUGGESTED SCHEME OF STUDIES
MINING ENGINEERING*

First Semester	**Th + Lab**
Maths-I (Analytic Geometry and Calculus)	3+0
Physical and Industrial Chemistry	3+1
General Geology	3+1
Engineering Workshop	0+2
Pakistan Studies	2+0
Engineering Drawing and Graphics	1+2
	12+6 = 18
Second Semester	Th + Lab
Maths-II (Differential Equations)	3+0
Mining Engineering Fundamentals	3+0
Structural Geology	3+1
Computer Programming	2+1
Basic Electrical Technology	3+1
English-I (Comprehension and Composition)	3+0
	17+3 = 20
Third Semester	Th + Lab
Maths-III (Linear Algebra)	3+0
Islamic Studies/ Ethics	2+0
Engineering Mechanics	3+0
Applied Thermodynamics	3+1
Applied Physics	3+1
Communication & Technical Report Writing	3+0
	17+2 = 19
Fourth Semester	Th + Lab
Fluid Mechanics	3+1
Engineering Statistics	2+0
Mechanics of Materials	3+1
Numerical Methods in Computing	2+0
Mine Surveying	3+1
Social Sciences Optional Course I	3+0
	16+3 = 19
Fifth Semester	Th + Lab
Rock Mechanics	3+1
Mineral Resource Estimation	3+1
Mine Ventilation	3+1
Computer Application in Mining Engineering	0+1
Explosives Engineering	3+1
	12+5 = 17

Sixth Semester	Th + Lab
Mine Economics	2+0
Surface Mine Design	3+0
Mine Geotechnical Engineering	3+1
Underground Mine Design	3+0
Mineral Processing/Mineral Processing-I	3+1
	14+2 = 16
Seventh Semester	Th + Lab
Coal Technology/Mineral Processing-II	2+1
Tunnel and Excavation Engineering	3+1
Interdisciplinary optional course I	3+0
Mine Management	2+0
Senior Design Project – I	0+3
	10+5 = 15
Eighth Semester	Th + Lab
Interdisciplinary optional course II	3+0
Social Sciences Optional Course II	3+0
Mine Hazards and Safety	3+1
Mining and Environment	2+0
Senior Design Project – II	0+3
Certifications on: -First-Aid Training -Industrial Training/Internship -Surveying Camp	0
	11+4 = 15

**This scheme of studies is provided as guideline, where a university may exercise to tailor the courses as per its own requirement.*

Optional:

As given on page 14.

Note:

* Mineral Processing is a terminal course*. If Mineral Processing-I is selected/taken then Mineral Processing-II will be mandatory.*

** *University may add one course according to their requirements up to 3 Credit Hours.*

DETAILS OF EACH COURSE FOR BE/BS/BSc. MINING ENGINEERING

Course title: **English Comprehension and Composition**
Credit hours: **3+0**
Prerequisite: **Pre-Engineering or Equivalent**

Course Learning Outcomes (CLOs):

After studying this course, the learners will be able to: -

1. Understand of the basic principles and elements of English Grammar.
2. Develop capability for taking notes, fluent and effective reading, time management, organizing and taking information.
3. Boost verbal abilities which can be applied to every field of study.
4. Analyze and comment on different texts/researches.
5. Enhance formal writing and presentation skills.
6. Perform and communicate well in corporate environment.

Content List:

1. Basics of Grammar
    a. Parts of speech and use of articles
    b. Sentence structure
    c. Active and passive voice
    d. Practice in unified sentence
    e. Analysis of phrase, clause and sentence structure
    f. Transitive and intransitive verbs
    g. Punctuation and spelling.
2. Comprehension
    a. Answers to questions on a given text.
3. Discussion
    a. General topics and every day conversations (topics for discussion to be at the discretion of the teacher keeping in view the level of students).
4. Listening
    a. To be improved by showing documentaries/films carefully selected by subject teachers.
5. Translation skills
    a. Local language to English.
    b. Urdu to English
6. Paragraph writing
    a. Topics to be chosen at the discretion of the teacher.
7. Presentation skills
    a. Introduction.

Note:

1. Extensive reading is required for vocabulary building.
2. Students should be encouraged to read daily newspapers and journals.

Practicals:

NIL

Bibliography/References

1. Books:
   a. Grammar
      i. A.J. Thomson and A.V. Martinet, “Practical English Grammar Exercises 1”, Third edition, Oxford University Press. 1997. ISBN 0194313492
      ii. A.J. Thomson and A.V. Martinet, “Practical English Grammar Exercises 2”, Third edition, Oxford University Press. 1997. ISBN 0194313506
   b. Writing
      i. Marie-Christine Boutin, Suzanne Brinand and Francoise Grellet, ‘Writing Intermediate”, Oxford University Press, 1987.
      ii. A Haley, “Oxford Supplementary Skills. Fourth Impression”, Oxford University Press. 1993. ISBN 0194534057
   c. Reading/Comprehension
      i. Brain Tomlinson and Rod Ellis, “Reading. Upper Intermediate”, Oxford Supplementary Skills, Third Impression 1992. ISBN 0194534022.
      ii. Brian. Tomlinson and Rod Ellis, “Reading Advanced (Oxford Supplementary Skills)”, Third Impression ISBN: 0194534030.
2. Journals/Periodicals:
   NIL

3. World Wide Web:
   NIL

Course title: **English Communication and Technical Report Writing**
Credit hours: **3+0**
Prerequisite: **English Comprehension and Composition**

Course Learning Outcomes (CLOs):

After studying this course, the learners will be able to: -

1. Comprehend technical and non-technical contents.
2. Develop presentation skills (process and model, purpose, gathering support materials, organizing and outlining, and developing visual aids).
3. Develop employment communications, official correspondence, emails, proposals, interview and well-structured presentation skills, etc.
4. Analyze, comprehend, correct and re-produce technical and non-technical texts.

Content List:

1. **Introduction to Communication Skills**
   a. Communication principles;
   b. Process of communication;
   c. Importance of good communication skills in business environments;
   d. Communication in business organizations: Internal-operational; External-operational; Personal;
   e. Challenge of communication in the global market.
2. **Study Skills**
   a. Brainstorming;
   b. Time-management;
   c. Effective reading strategies;
   d. Notes-taking;
   e. Organization;
   f. Summarizing.
3. **Components of Communication**
   a. Sender – Encoder;
   b. Message;
   c. Medium;
   d. Receiver – Decoder;
   e. Feedback.
4. **Non-verbal Communication**
   a. Appearance and dress codes;
   b. Body language;
   c. Silence time and space;
   d. Importance of listening in communication.
5. **Public Speaking**
   a. Difference between speech and writing;
   b. Reading texts of good public speeches and analysis of their components;
   c. Listening to famous public speeches;
   d. Exercises in public speaking.
6. **Formal Presentations**
   a. Difference between informal and formal presentations;
   b. Modes of formal presentation: Extemporaneous; Prepared; Reading out from a written text; combination of the above- mentioned methods.
7. **Correctness of Language**
   a. Importance of clarity in writing; Elements of clear writing: Directness; Brevity; Pitfalls to avoid; Hackneyed phrases; Redundancies; Slang; Passive voice; E-language; Sentence length; Specific Words and concrete words.
8. **Business Correspondence**
   a. Memorandums: Types of memos: Status negative; Personal;

Analysis of samples;
b. Minutes of a meeting;
c. E-mails: When and how to write an e-mail? Etiquettes of e-mailing;
d. Resume and cover letter writing;
e. Applications and follow-up letters;
f. Business Letters: Format; Elements;
g. Language: How to write?
h. Language to avoid;
i. Analysis of sample letters;
j. Practice exercises on different types of official correspondence.

9. Interview Skills

a. Handling the interview;
b. Investigating about the company;
c. Making good appearance;
d. Anticipating questions and preparing answers;
e. Making oneself at ease – increasing confidence level ;
f. Successful preparation of an interview: Knowing one's submitted resume well; Knowing the company applied to; Knowing the requirements of the available positions; Knowing the importance of non-verbal appearance; Knowing the importance of rehearsals.

10. Phonetics and Phonology

a. Phonetic symbols;
b. Transcribing;
c. Assimilation and elision;
d. Use of dictionary;
e. Stress patterns Intonation (practice in reading skills);
f. First language interference in individual pronunciation.

11. Vocabulary Building

a. Techniques of building word power;
b. Importance of reading as a voluntary habit and a vocabulary builder;
c. Correct word usage;
d. Synonyms;
e. Ladder of accuracy;
f. Words easily confused;
g. Words with dual function.

12. Written Reports

a. Daily reports;
b. Research methodology;
c. Types of reports;
d. Formal and informal reports;
e. Executive summary; Scope; Purpose; Introduction; Writing the main report; Conclusion; Bibliography;
f. APA and MLA styles;
g. Plagiarism: What is plagiarism? How it can be avoided?

13. **Presentations and Seminars**

Practicals:

NIL

Bibliography/References:

1. Books:
    a. Introduction to Business Communication by Zane K. Quible, Margaret H. Johnson and Dennis L. Mott, ISBN: 0134790723
    b. Business Communication Today by Courtland L. Bovée, John V. Thill and Barbara E. Schatzman ISBN: 0130928585
    c. Effective Business Communication by Herta A. Murphy, Herbert W. Hildebrandt and Jane P. Thomas, ISBN: 007044398X
    d. Business Presentation by Lani Arredondo, ISBN: 0070028400
    e. Courtland Bovee, John V. Thill, "Business Communication Today", 11th Edition, Prentice Hall, 2011.
    f. Mary Ellen Guffey and Dana Loewy, "Essential of Business communication" 2014.
    g. Zane K. Quible, Margaret H. Johnson and Dennis L. Mott, "Introduction to Business Communication", ISBN: 0134790723
    h. Herta A. Murphy, Herbert W. Hildebrandt and Jane P. Thomas, "Effective Business Communication" ISBN: 007044398X

1. **Journals/Periodicals:**
    NIL
2. **World Wide Web:**
    NIL

Course title: **Pakistan Studies**
Credit hours: **2+0**
Prerequisite: **Pre-Engineering or Equivalent**

Course Learning Outcomes (CLOs):

1. Describe the history and ideology of creation of Pakistan.
2. Discuss the basic knowledge about Pakistan
3. Understand the present conditions of Pakistan, the problems, issues, needs and requirements in different fields such as a system of government, geography and natural resources, industry, economy, social structure etc.
4. Develop interest in Pakistan by highlighting common features in the fields of culture, language and literature.
5. Compare international affairs of Pakistan with Muslim state as well as Non-Muslim state.
6. Understand and evaluate the concepts of foreign policy.

Content List:

1. **Ideology of Pakistan**
   a. Definition and Explanation; Aims and objectives of formation of Pakistan;
   b. Ideology of Pakistan in the light of the sayings and speeches of Allama Iqbal and Quaid-e-Azam.
2. **A Brief History of Muslim Society in Subcontinent**
   a. The arrival of Muhammad Bin Qasim;
   b. The Afghan invasions from north; The domination of Islam in the sub-continent;
   c. The downfall of Muslim rulers and renaissance of Muslim rule in sub-continent.
3. **Historical Background of the Ideology of Pakistan: National and Reformative Movements**
   a. Sh. Mujaddad Alf-e-Sani: Biography of Sheikh; Social and religious Services; Jihad against non- Islamic fundamentals; Difficulties of imprisonment; Effects of the movement;
   b. Shah Wali Ullah: Biography of Jihad against non-Islamic fundamentals; Reforms, social and religious services; Jama'at-ul-Mujahiddeen;
   c. Sayyed Ahmad Shaheed: Biography; Jihad against Sikhs; Opposition from Afghan tribes; Martyrdom at Balakot; Mujahiddeen Movement.
4. **Educational Efforts**
   a. Ali Garh;
   b. Deoband;
   c. Nadwah;
   d. Anjaman Himayat-e-Islam;
   e. Sindh Madrassat-ul-Islam;
   f. Islamia College, Peshawar and other educational institutions.
5. **Political Struggles**
   a. Constitutional reforms and Muslims' separate electorate.
6. **The Pakistan Movement**
   a. Muslim Nationality: Evolution of two-nation theory;
   b. Independence of India and Muslims: Presidential Address of Allama Iqbal at Allah Abad in 1930;
   c. 1937 Elections: Congress's behavior;
   d. The Pakistan Resolution;
   e. 1946 Elections and transfer of power;
   f. How to safeguard the ideological state in present era
7. **Creation of Pakistan**
   a. Role of scholars and Mashaikh, students and women, Journalists and Adeebs in the creation of Pakistan;
   b. Initial difficulties after creation of Pakistan;
   c. Anti-Muslim riots in India;

d. Massacre in East Punjab;
e. Canal water and distribution of assets;
f. Annexation of states: Hyderabad; Junna Garh;
g. Kashmir: Background and danger for the peace of South Asia.

8. **The Land of Pakistan**
   a. Geographical unity;
   b. Location and importance;
   c. Rural and urban areas;
   d. Resources of agriculture, industry, workforce and education.
9. **Efforts for Execution of Islamic System in Pakistan**
   a. Objectives Resolution;
   b. Islamic clauses of the constitutions of 1956, 1962 and 1973;
   c. Implementation of Shariah: Practical steps;
   d. Our Destination – Establishment of complete Islamic society.
10. **Foreign Policy of Pakistan**
   a. Principles of Pakistan's foreign policy;
   b. Importance of Pakistan in Islamic world;
   c. Formation of Islamic Summit;
   d. Rabita-e-Alam-e-Islami;
   e. Formation of Muslim Bank and Bloc;
   f. Economic and defence planning;
   g. Pakistan in the changing world.

Practicals:

NIL

Bibliography/References:

1. Books:
   a. Hamid Khan," Constitutional and Political History of Pakistan", 2nd Edition, Oxford University Press, 2005.
   b. S. Akbar Zaidi, "Issues in Pakistan's Economy", 2nd Edition, Oxford University Press, USA, 2006 ISBN: 9780195979145
   c. Burki, Shahid Javed, "State and Society in Pakistan", The Macmillan Press Ltd.
   d. S. M. Burke and Lawrence Ziring, "Pakistan's Foreign policy: A Historical analysis", Oxford University Press, Karachi. ISBN: 9780195774078
   e. Mehmood, Safdar, 'Pakistan Political Roots and Development", Lahore. ISBN: 9788120711259
   f. Wilcox, Wayne , "The emergence of Bangladesh: Problems and opportunities for a redefined American policy in South Asia (Foreign affairs study)", American Enterprise, Institute of Public Policy Research, Washington. ISBN: 9780844731124
   g. Amin, Tahir, "Ethno – National Movement in Pakistan", Institute of

Policy Studies, Islamabad.

h. Zahid Ansar, “History and Culture of Sindh’, Karachi: Royal Book Company.
i. Afzal, M. Rafique, “Political Parties in Pakistan”, Vol. I, II and III, National Institute of Historical and cultural Research, Islamabad.
j. Sayeed, Khalid Bin, “The Political System of Pakistan”, Houghton Mifflin, Boston. ASIN: B0000D5J2X

2. **Journals/Periodicals:**
   NIL

3. **World Wide Web:**
   NIL

Course title: **Islamic Studies**
Credit hours: **2+0**
Prerequisite: **Pre-Engineering or Equivalent**

Course Learning Outcomes (CLOs):

After studying this course, the learners will be able to: -

1. Enhance the religious knowledge in more informative and comprehensive manner.
2. Create interest towards Sharia, Quran & Hadith.
3. Acquire knowledge in character building, developing Islamic approach & thinking, and developing the habit of finding solutions of daily life problems through Quran and Sunnah.
4. Learn Biography of the Holy Prophet (PBUH) highlighting his status as a guide to mankind.
5. Understand Islamic civilization and a brief history of its impacts on world.
6. Acquire knowledge about the achievements of Muslim scholars and scientists.

Content List:

1. Al-Quran-ul-Karim:
   a. Significance of the Holy Quran, Compilation of the Holy Quran, Ijaz-ul-Quran.
   b. Textual Study of Surah Al-Hujurat (Complete), (Translation and Explanation: Manners of meeting with the Holy Prophet; Brotherhood; Equality; Backbiting; Blame and foolery)
   c. Textual Study of Surah Al-Maidah (Verses 1-26), (Translation and Explanation: Commands of Halal and Haram; The importance of cleanliness in Islam; The relations between Muslims and Ahl-e-Kitab;

Attitude of Ahl-e-Kitab towards Muslims)

d. Textual Study of Surah Al-Furqan (Verses 63-77), (Translation and Explanation: Characteristics of Ibad-ur-Rehman)
e. Textual Study of Holy Quran: Surah Luqman (Complete), Translation and Explanation: Lahv-o-La'ab; Azmat-e-Quran; Taskheer of the Universe;
f. Disobedience of parents is forbidden; To see the parents with love is as Hajj; Intense care of parents in old life; Treatment and behavior with parents; Amr Bil Maruf-o-Nahi An'il Munkar; Need and importance of preaching (Dawat-din); Methods of preaching; Characteristics of a preacher.

Note: Teacher may select any number of Surah as per his discretion.

2. Al-Hadith Al-Sharif
   a. The need and importance of Hadith
   b. An introductory note about compilation of Hadith
   c. A brief introduction of Sihah Sittah and their compilers
   d. Balugh-ul-Maram
   e. Kitab-ul-Jami: Bab-ul-Adab; Bab-ul-Bir Wa Salah
   f. Rights of individuals in Islam
   g. Relations with the relatives.
   h. Textual Study of Ahadith (Arba'een-e-Nava'vi: 1-21 Translation and Explanation).

3. Deen-e-Islam:
   a. The Study of Cardinals/Articles of Faith: Touheed, Fundamentals of Touheed, Types of Touheed, Prophet-hood and finality of Prophet-hood, The day of judgment.
   b. Pillars of Islam: Prayer: Imposition of Prayer; Orders; Shariah's point of view; Significance; Fasting: Meaning of fasting; Obligation of fasting; Significance; Disbursement; Physical and spiritual advantages; Zakat: The economic system of Islam; Importance of Zakat; Prohibition of (Riba) Sood; Comparison between Islamic economic system and Socialism, Capitalism and Communism; Hajj: Imposition of Hajj; Commands and rites of Hajj; Financial, Social, Spiritual advantages of Hajj; Jihad: Importance and significance; Necessity of Jihad in modern age; Kinds of Jihad.

4. Seerat-un-Nabi
   a. Life of the Holy Prophet (S. A. W. W): From Prophet-hood to Hijrah, at Madina
   b. Madina Pact
   c. Holy Prophet as a complete person; Mohammedan Revolution.

5. Islam and Modern Science
   a. Quran as a guide for the modern scientific development: Surah Al-Baqarah: 164; Surah Aal-e- Imran: 190-191; Importance of science

education in the modern age; Introduction of Muslim scientists; Contribution of Muslim scholars towards development of science.

6. Principles of Tafseer
   a. Hadood-o-Tazirat: Rape; Qadaf; Liaan; Ifk; Privacy and Hijab – Al-Baqarah: 178 – 179; Al- Nisa: 92 – 93; Al-Maidah: 8, 31 – 34, 38; Al-Noor: 2 – 6, 27 – 29, 31 – 60; Al-Ahzab: 32 – 33, 53, 55, 59.
7. Ethics
   a. Ethics and Religion: Ethical behavior of the Prophet; Impact of belief on ethics; Concept of worship and manners / social relation in religion and their impact on ethics
   b. Ethics and character building significance of moral values: Charity; Tolerance; Simplicity; Respect of mankind; Social etiquettes; Etiquettes of meeting; Etiquettes of eating and drinking; Etiquettes of conversation; Rights of people
   c. Verses of the Holy Quran about ethics: Aal-e-Imran: 112; Al-Nisa: 43, 90 – 91; Al-Aaraf: 35; Al-Ra'ad: 30; Al-Nahal: 90 – 91; Bani Israil: 29 – 37; Al-Fatah: 26;
   d. Moral values in the light of Hadith: Bab-ul-Zuhad wal Wara: Ahadith 2, 6; Bab-ul-Tarheeb Min Masavi Al-Akhlaq: Ahadith 1, 6, 9.

Practicals:

NIL

Bibliography/References

1. Books:
   a. M. D. Zafar, "A Textbook Of Islamic Education", Aziz Book Depot - Lahore,2001
   b. Hameed ullah Muhammad, "Emergence of Islam", IRI, Islamabad
   c. Hameed ullah Muhammad, "Muslim Conduct of State", IRI, Islamabad
   d. Hameed ullah Muhammad, "Introduction to Islam", IRI, Islamabad
   e. Mulana Muhammad Yousaf Islahi, Hussain Hamid Hassan, "An Introduction to the Study of Islamic Law", leaf Publication Islamabad, Pakistan.
   f. Ahmad Hasan, "Principles of Islamic Jurisprudence" Islamic Research Institute, International Islamic University, Islamabad (1993)
   g. Mir Waliullah, "Muslim Jurisprudence and the Quranic Law of Crimes" Islamic Book Service (1982)
   h. H. S. Bhatia, "Studies in Islamic Law, Religion and Society", Deep and Deep Publications New Delhi (1989)
   i. Dr. Muhammad Zia-ul-Haq, "Introduction to Al Sharia Al Islamia" Allama Iqbal Open University, Islamabad (2001)

1. **Journals/Periodicals:**
   NIL
2. **World Wide Web:**
   NIL

Course title: **Mine Economics**
Credit Hrs: 2+0
Pre-requisites:

Course Learning Outcomes (CLOs):}

On successful completion of the course students will be able to:

1. Understand the basics of economics and capital investments e.g. present worth, annual cost, rate-of-return, payback, break-even, benefit-cost ratio etc.
2. Calculate the time value of money using engineering economy factors and formulas, as well as the implications and importance of considering taxes, depreciation, and inflation.
3. Apply the appropriate engineering economics analysis method(s) for practical mining situations.
4. Analyze the life cycle cost of multiple projects and make a quantitative decision between alternatives.

Course Outline:

1. **Fundamentals of Engineering Economy**
   Principles of Engineering Economy
   Definitions of economic Terms
2. **Engineering Economics and Costs**
   Types of costs
   Cost Based Economic Design: Examples with solutions
2. **Financial Statements**
   Types of financial statements with examples
3. **Time value of Money**
   Simple and Compound Interest, Time Value of Money: Examples with solutions
4. **Capital Budgeting**
   NPV
   Internal rate of return
   Equivalent annual cost
   Escalation and inflation consideration
5. **Uncertainty and risk analysis**
6. **Depreciation and depletion analysis**
7. **Mine Economics Case Studies**

Recommended Text Books:

1. W. G. Sullivan, J. A. Bontadelli and E. M. Wicks, Engineering Economy, 11th Ed., Prentice Hall Inc., 1999
2. Franklin and John Stermole, Economic Evaluation and Investment Decision Methods (9th Edition)
3. Vogely, H. S., Economics of Mineral Industries. Mud Series, AIME

Recommended Reference Books:

1. Chan S. Park, and Gunter P. Sharp-Bette, Advanced Engineering Economics, 10th Ed., John Wiley & Sons Inc., 1990

Course title: **Mine Management**
Credit Hours: **2+0**
Prerequisites: **N/A**

Course Learning Outcomes (According to Bloom's Taxonomy)

On successful completion of the course students will be able to:

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

Course Contents:

Management: Definition and Essential elements of Management

From Scientific management to Human Resource Management: Principles and Characteristics of different Management theories

Mine Management: Mine Engineer as Project Manager, Management tasks and responsibilities

Mine Organization: Duties and Characteristics of functional Organization.

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

EM by cost Accounting

Project Planning and control: Strategic Planning, project Network analysis Human and Performance: Recruiting selection, training, development, compensation.

Material Resource: Measurement, Material Management, Market Management, Reserve/Sampling Calculations, Pricing.

Project Budgeting: Budgets and Controls, Budgeting Methods.

Recommended Books:

1. Mine Management by SLOAN
2. Project Management by J.R. Meredith and S.J. Mantel
3. Engineering Management by Faridoon Mazda

Reference Sources:

1. SME Mining Engineering Handbook, Ch. 29 V.2 (The Latest Edition) Edt. By A.B. Cummins and I.A. Given.

Course title: **Analytical Geometry**
Credit Hours: 3+0
Prerequisites: N/A

Course Learning Outcomes (According to Bloom's Taxonomy):

On successful completion of the course students will be able to:

1. Solve problems involving lengths and distances in the plane, including midpoint and point-of-division formulas.
2. Demonstrate understanding of the notions of slope and inclination of lines, including angles between lines, parallel lines, and perpendicular lines.
3. Recognize the relationship between equations in two variables and graphs in the plane and use the equations to find pertinent information such as points of intersection, and intercepts.
4. Perform arithmetical and geometric operations involving vectors in the plane.
5. Use vectors to solve geometric and physical problems.
6. Sketch graphs of and discuss relevant features of curves in the plane determined by certain equations (including lines, circles, parabolas, ellipses, hyperbolas, polynomial functions, rational functions, and features such as slope, inclination, center, radius, vertices, foci, axes, eccentricity, intercepts, asymptotes).
7. Determine equations of curves when given information that determines the curves.
8. Perform translations and rotations of the coordinate axes to eliminate certain terms from equations.

9. Model real world situations with equations of conics.
10. Use the polar coordinate system, relate it to the rectangular coordinate system, and graph equations using polar coordinates. 11. Sketch graphs in the plane determined by parametric equations by direct sketching as well as elimination of the parameter to obtain a rectangular equation.

Course Contents:

Introduction to functions,
Introduction to limit,
Derivatives and their applications,
Integral calculus with applications,
Vector algebra,
Vector calculus,
Introduction to analytical geometry,
Straight line in R3,
Planes,
Cylindrical and spherical coordinates,
Surfaces,
Cylinders and cones,
Spheres,
Spherical trigonometry.

Recommended Books:

1. George B. Thomas and Ross L. Finney, *Calculus and Analytic Geometry*, 9th Edition, 1995, Addison-Wesley, ISBN: 0201531747.
2. George F. Simmons, *Calculus with Analytic Geometry*, 2nd Edition, 1996, McGraw-Hill, ISBN: 0070576424.
3. Gerald B. Folland, *Advanced Calculus*, 1st Edition, 2002, Prentice Hall, ISBN: 0130652652.
4. Monty J. Strauss, Gerald L. Bradley and Karl J. Smith, *Calculus*, 2002, Prentice Hall, ISBN: 0130918717.

Course title: **Differential Equations**
Credit hours: **3+0**
Prerequisite: **Calculus**

Course Learning Outcomes (CLOs):

After studying this course, the learners will be able to: -

1. Identify an ordinary differential equation and its order.
2. Develop fundamental skills of solving ordinary differential equations.
3. Classify ordinary differential equations into linear and nonlinear equations.
4. Develop differential equations to analyze and solve the engineering,

social and other physical models.
5. Link practical application of Mining engineering with differential equations.

Content List:

1. Laplace Transformation
   a. Laplace transforms of elementary functions.
   b. Unit step function,
   c. Dirac's delta function,
   d. Periodic functions,
   e. Inverse Laplace transforms,
   f. Convolution.
   g. Applications.
2. Ordinary differential equations
   a. System of differential equations,
   b. Physical problems.
3. Fourier series
   a. Periodic functions,
   b. Fourier series for the function of period 2-Pie, even and odd functions.
   c. Fourier series for functions having arbitrary period,
   d. Half range expansions,
   e. Complex form of Fourier series,
   f. Application to physical problems.
4. Double Integrals and its Applications.
   a. Double Integrals,
   b. Geometrical interpretation.
   c. Their applications in determining areas, volumes, centroids and moments of inertia,
   d. Double integrals in polar coordinates.
5. Series solution of Differential Equations and Special Functions.
   a. Beta and Grams Functions,
   b. Power series,
   c. Method of Frobenius,
   d. Lengendre's differential equation,
   e. Legendre polynomials,
   f. Generating function,
   g. Recurrence formulas,
   h. Orthodonality,
   i. Bissell's differential equation,
   j. Bissell functions of first and second kind,
   k. Generating functions,
   l. Recurrence formulas,
   m. Orthogonality,

n. Modified Bissell functions.

6. Partial differential Equations (pdes)
   a. Basic concepts,
   b. Derivation (modeling) of ID equations,
   c. Solution using method of separation of variables,
   d. D' Alembert solution of the wave equation,
   e. Classification of linear second order P.D. equations,
   f. Two dimensional partial differential equations (wave, heat and Laplace),
   g. General solutions,
   h. Laplace equation in Polar coordinates,
   i. Laplace equation in cylindrical and spherical polar coordinates.

Practicals:

NIL

Bibliography/References:

1. Books:
   a. Dennis G. Zill, Warren S Wright, "Differential equations with Boundary-Value Problems", 8th Edition, Cengage Learning, 2012.
   b. John Warren Dettman," Introduction To Linear Algebra And Differential Equations", McGraw-Hill Kogakusha - Tokyo, 1974
   c. Erwin Kreysizg, "Advanced Engineering Mathematics", ISBN: 9780470458365
   d. Schaum's Outline Series, "Differential Equations" , ISBN: 0071611622

2. **Journals/Periodicals:**
   NIL

3. **World Wide Web:**
   NIL

Course title: Linear Algebra
Credit hours: 3+0
Prerequisite: Calculus

Course Learning Outcomes (CLOs):

After studying this course, the learners will be able to: -

1. Students will demonstrate competence with the basic ideas of linear algebra including concepts of linear systems, independence, theory of matrices, linear transformations, bases and dimension, eigenvalues, eigenvectors and diagonalization.
2. Compose clear and accurate proofs using the concepts of this course.

Content List:

Algebra of matrices; inverse of a matrix; Gauss-Jordan method for the solution of a system of linear algebraic equations; vectors in the plane and in three dimensions; vector spaces; subspaces; span and linear independence; basis and dimension; homogeneous systems; coordinates and isomorphism; rank of a matrix; determinant; inverse of a matrix; applications of determinants; determinants from a computational point of view; properties of determinants; eigenvalues and eigenvectors; systems of linear differential equations; diagonalization; Hermitian matrices; singular value decomposition; quadratic forms; positive definite matrices; non-negative matrices; floating-point numbers; Gaussian elimination; pivoting strategies; matrix norms and condition numbers; orthogonal transformations; eigenvalue problem; least square problems.

Recommended Books:

1. Bernard Kolman and David Hill, Elementary Linear Algebra, 8th Edition, 2004, Prentice Hall, ISBN: 0130457876.
2. Kenneth Hardy, Linear Algebra for Engineers and Scientists Using Matlab, 1st Edition, 2005, Prentice Hall, ISBN: 0139067280.
3. Stephen Goode, Differential Equations and Linear Algebra, 2nd Edition, 2000, Prentice Hall, ISBN: 013263757X.

Course title: **Engineering Statistics**
Credit hours: **3+0**
Prerequisite: **Differential Equation, Calculus**

Course Learning Outcomes (CLOs):

After studying this course, the learners will be able to: -

1. Understand the fundamental concepts in Probability and Statistics.
2. Apply the rules and algorithms of Probability and Statistics; to generate probabilistic models.
3. Interpret probabilistic models for application to engineering problems.

Content List:

1. Basic probability,
2. Random variables and probability distributions,
3. Measures of central tendency.
4. Measures of dispersion.
5. Frequency distributions Binomial Normal,
6. Poisson, Cauchy, Gamma, Beta, Chi-square, student's-t, and F-distributions,
7. Bivariate Normal Distribution,
8. Estimations and hypothesis testing,
9. Confidence intervals Analysis of variance.

10. Curve fitting, Regression analysis, and correlation, Auto and Cross correlation.
11. Analysis of Time series.
12. Linear – simple and multiple Polynomial – power, orthogonal, nonlinear, step – wise.
13. Correlation.
    a. Auto and Cross correlation.
    b. Time trend analysis, filtering, moving averages data smoothing.

Practicals:

NIL

Bibliography/References:

1. **Books:**
    a. Walpole, Myers, Myers &Ye, Probability and Statistics for Engineers and Scientist, Latest edition.
    b. Allan G. Bluman, Elementary Statistics A step by step approach, Latest edition.
    c. Douglas C. Montgomery, Applied Statistics and Probability for Engineers, Latest edition
    d. Prof Sher Muhammad Ch. and Dr. Shahid Kamal," Introduction to Statistical Theory Part – I", Illmi Kitab Khana, Urdu Bazar, Lahore.
2. **Journals/Periodicals:**
   NIL
3. **World Wide Web:**
   NIL

Course title: **Applied Physics**
Credit hours: **3+1**
Prerequisite: **Pre-Engineering or Equivalent**

Course Learning Outcomes (CLOs):

After studying this course, the learners will be able to: -

1. Possess sufficient knowledge of fundamental concepts in classical and modern Applied Physics.
2. Understand the laws and concepts of Applied Physics and to solve the problems and to interpret the results.
3. Develop and analyze the mathematical models of Applied Physics.
4. Conducting lab experiments and to use laboratory work bench equipment.
5. Understand interfacing Physics and Engineering to create better infrastructure for the society.

Content List:

1. Electricity
    a. Electric field and electrical forces,
    b. Electric field calculations,
    c. Gauss's Law,
    d. Applications of Gauss's Law,
    e. Charges on conductors,
    f. Electrical Potential,
    g. Energy,
    h. Potential,
    i. Calculate of Potentials,
    j. Potential gradient,
    k. Cathode-ray tube.
2. Magnetic Field:
    a. Sources of Magnetic Field
    b. Magnetic field of a moving charge
    c. Magnetic field of a current element
    d. Ampere's Law
    e. Magnetic field of a long straight conductor
    f. Force between parallel conductors
    g. Magnetic field of circular loops solenoid
    h. Magnetism
    i. Magnetic field and displacement current
    j. Magnetic properties of materials.
3. Electromagnetic Induction:
    a. Induction phenomena,
    b. Motional electromotive force
    c. Faraday's law Induced electric fields
    d. Lenz's Law
    e. Eddy currents
    f. Maxwell's equations
    g. Electromagnetic Waves
    h. Introduction, speed of and electromagnetic wave
    i. Energy in electromagnetic waves
    j. Electromagnetic Waves in matter,
    k. Sinusoidal Waves
    l. Standing.
4. Interference and Diffraction.
    a. Waves and Oscillations.
    b. Sound Waves.
    c. Resultant of simple Harmonic Motions Resonance and Beats.
    d. Units and Measurement of Sound Waves.
    e. Reflector, Refraction of sound.
    f. Interference, Diffraction grating, Interference in Thin Film X-ray

Diffraction of sound waves.

5. Atomic Physics:
    a. Structure of atom
    b. Line spectra
    c. Energy levels
    d. Atomic spectra
    e. The laser
    f. Continuous spectra
    g. X-ray production and scattering.
6. Nuclear Physics
    a. The nuclear atom, properties of nuclear.
    b. Nuclear stability, radioactive transformations, Nuclear reactions, nuclear fission, nuclear fusion, reaction, Neutron thermalization, Radiation Detectors.
    c. Natural radioactivity, artificial radioactivity, three distinct types of radiation's radioactive series, Laws of radioactive disintegration, decay constant.
    d. Half period and mean constant, Interaction of rays with matter.

Practicals:

1. Ionization Potential of Mercury.
2. To study the state Characteristics of a transistor
3. To find the value of H by tangent galvanometer
4. To find the E/M of electron by deflection methods
5. To draw B-H curve of a given material
6. To find the velocity of sound waves in different media
7. To find the surface tension of a given liquid
8. C.R.O. demonstration.

Bibliography/References:

1. **Books:**
    a. Robert Resnick, Kenneth S. Krane, "Physics", Volume 2, Wiley, 2001.
    b. Raymond A. Serway, Clement J. Moses , Curt A. Moyer," Modern Physics", 3rd Edition, Cengage Learning, 2004.
    c. Hugh D. Young, Roger A. Freedman, Lewis Ford, "University Physics", 7th Ed., Addison Wesley,
    d. Halliday and Resince, "Applied Physics" 5th Edition
2. **Journals/Periodicals:**
   NIL
3. **World Wide Web:**
   NIL

Course title: **General Geology**
Credit hours: **3+1**
Prerequisite: **Pre-Engineering or Equivalent**

Course Learning Outcomes (CLOs):

After studying this course, the learners will be able to: -

1. Recognize and identify common rocks and minerals in hand specimens.
2. Recognize the effects of geologic processes acting in and on the Earth and describe these processes using appropriate terminology.
3. Clearly describe Plate Tectonics in general terms.
4. Evaluate typical laboratory materials pertinent to physical geology, and write laboratory reports in a style appropriate to the field.

Course Outline:

Scope in Mining Engineering. Introduction to various branches of geology. Origin of the earth and its place in universe, interior of the earth and chemical composition of the earth's crust.

Mountain building and valley formation, drainage patterns and their types, agents of weathering and erosion.

Deformational structural features of rocks, dip, strike, faults, folds, joints and fissures, unconformities etc.

Introduction to continued drift and plate tectonics, earthquakes and volcanism with special reference to Pakistan.

Formation of rocks and minerals, classification of rocks.

Occurrence of economic minerals and dimension stones of Pakistan.

Lab Outline:

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

Recommended Text Books:

1. K. M. Banger, Textbook of Geology
2. H. H. Read, Rutley's Mineralogy
3. Dana, Dana's Manual of Mineralogy
4. Santosh Kumar Grag, Textbook of Geology
5. Raymond, L. A., *The Study of Igneous, Sedimentary and Metamorphic Rocks,* McGraw-Hill, 2002

Recommended Reference Books:

1. Arthur Holmes and Dorris Holmes, Physical Geology
2. F. G. H. Blyth, Geology for Engineers

Course title: **Physical and Industrial Chemistry**
Credit hours: **2+1**
Prerequisite: **Pre-Engineering or Equivalent**

Course Learning Outcomes (CLOs):

After studying this course, the learners will be able to: -

1. Define and discuss basic theories, terms and concepts applicable in the field of Mining Engineering.
2. Understand various types of material and phases and their chemical properties.
3. Understand various chemical processes and its quantitative analysis.
4. Develop skills for solving problems related to Mining Engineering.

Content List:

1. Introduction to Chemistry
    a. State of matter
    b. Properties of solid, liquid, and gases
    c. Periodic classification of elements.
    d. Electronic Configuration and structure of atoms
2. Basic laws and principles
    a. Physical principles involved in the study of properties of metals and nonmetals,
    b. Solution, solubility,
    c. Raoult's Law, Henry's law, Law of diffusivity. Theory of crystallization, chemical kinetics,
    d. Viscosity, vapor pressure,
    e. Chemistry of solutions, azeotropic solution, vapor pressure and distillation of partially-miscible and miscible liquids, diffusion, osmosis, theory of dilute solutions, relation with vapour pressure.
    f. Chemical equilibrium
3. Organic Chemistry
    a. Chemistry of hydrocarbon compound,
    b. Cracking,
    c. Polymerization,
    d. Electrophilic and nucleophilic substitution in aromatic system.
4. Analytical Chemistry
    a. Introduction to analytical instrumentation,
    b. Concept of accuracy of analysis, separation techniques and gas chromatography, geochemistry,
    c. Gas chromatography,
    d. Basics of spectroscopy;

e. UV and visible spectroscopy.
f. Geo-chemical classification of elements,
g. Chemical weathering geo-chemical description,
h. Geo-chemical prospecting, significance and techniques

5. Electrochemistry
    a. Electrolysis, electrolytic conductance, transport number and transport phenomena determination of transport number, ionic equilibria, activity coefficient electrolyte,
    b. Debye-huckel theory, solubility products, galvanic cells, potentiometric titrations, ph, buffer solution, acid base indicators, molecular properties,
    c. Surface tension, interfacial tensions, surface films surface-active agents, free energy and equilibrium, chemical equilibrium surface phenomena and catalysis,
    d. Organic chemistry, electron displacement, resonance and its applications,
    e. Mechanism and methods of determining, stereochemistry, organic reaction, electrophillic substitution in aromatic system,
    f. Addition to carbon-carbon and carbon-oxygen double bond, elimination reactions, inter-conversion of functional group, organic nitrogen compounds and heterocylic system, aromatic series

Practicals:

1. Determination of Heat of Solution of a given salt solution.
2. Determination of the Heat of Neutralization of given Acid-Base pair.
3. Determination of the Surface Tension of a given Liquid by using Stalagmometer.
4. Determination of Viscosity (absolute and relative) of a given liquid by using Ostwald's Viscometer.
5. Determination of the %age composition of colored ions by using Photoelectric Colorimeter.
6. Determination of the %age composition of two liquids by viscosity.
7. Determination of the %age composition of two liquids by Refractive Index.
8. Determination of the strength of Acid/base by pH-Metric Titration.
9. Determination of the Molecular weight of a given substance by Depression in Freezing Point (Cryoscopic) methods.
10. Determination of Transition Temperature of a substance by thermometric method.
11. Determination of the Molecular weight of a given substance by Elevation of Boiling Point (Ebullioscopic) methods.
12. Determination of adsorption of a solute by activated charcoal.
13. Determination of the strength of Acid/base by Conductometric Titration.
14. Preparation of Buffer solutions of various pH ranges (by pH-metric methods)

Bibliography/References:

1. **Books:**
    a. Dennis G. Zill, Warren S Wright, “Differential equations with Boundary-Value Problems”, 8th Edition, Cengage Learning, 2012.
    b. John Warren Dettman,” Introduction To Linear Algebra And Differential Equations”, McGraw-Hill Kogakusha - Tokyo, 1974
    c. Erwin Kreysizg, “Advanced Engineering Mathematics”, ISBN: 9780470458365
    d. Schaum’s Outline Series, “Differential Equations” , ISBN: 0071611622
2. **Journals/Periodicals:**
    NIL
3. **World Wide Web:**
    NIL

Course title: **Numerical Methods in Computing**
Credit hours: **2+1**
Prerequisite: **Pre-Engineering or Equivalent**

Course Learning Outcomes (CLOs):

After studying this course, the learners will be able to: -

1. Understand the basics of elementary function and their applications.
2. Describe the difference between numerical and analytical methods and solutions.
3. Identify main sources of errors and take steps to eliminate or reduce the impact of errors
4. Apply numerical methods to solve Mining engineering problems.

Content List:

1. **Approximation and Errors**
    a. Accuracy,
    b. Truncation,
    c. Taylor series and bracketing methods
2. **Linear Equations**
    a. Gauss elimination,
    b. Eigen Values.
3. **Non-Linear Equations**
    a. Bisection method,
    b. iteration,
    c. secant method,
    d. Newton-Raphson method,
    e. System of Nonlinear Equations and,
    f. Convergence etc.

4. **Numerical Differentiation and Integration**
    a. Accuracy of derivatives,
    b. Newton-Cotes Integration Formulae,
    c. Integration for multiple and improper integrals.
5. **Interpolation and Curve Fitting Methods**
    a. Binary Search,
    b. approximation,
    c. Lagrange polynomials,
    d. Inverse type,
    e. Least Squares and,
    f. Orthogonal Polynomials including rational and spline function.

Practicals:

Lab part of the course will include Mathematica 11, or Matlab 2016. The introductory programming with coursework related to the course outline shall be carried out.

Bibliography/References:

1. **Books:**
    a. C. Woodford, C. Phillips. “Numerical Methods with Worked Examples: Matlab Edition”, Springer Science and Business Media
    b. Steven T. Karris. “Numerical Analysis Using MATLAB and Excel”, Orchard Publications
    c. Steven C. Chapra, Raymond P. Canale. “Numerical methods for engineers”, McGraw-Hill Higher Education
    d. Timothy Sauer. “Numerical analysis”, Pearson Education
    e. Stephen Wolfram. “An elementary introduction to the wolfram language”, Wolfram Media, Incorporated.
    f. Cliff Hastings, Kelvin Mischo, Michael Morrison, “Hands-on start to wolfram Mathematics”
2. **Journals/Periodicals:**
    NIL
3. **World Wide Web:**
    NIL

Course title: **Computer Programming and Software Applications**
Credit hours: **2+1**
Prerequisite: **Pre-Engineering or Equivalent**

Course Learning Outcomes (CLOs):

After studying this course, the learners will be able to: -

1. Understand the local and global impact of computer programming on individuals, organizations and society.
2. Develop practical understanding of Programming language syntax, semantics and pragmatics.

3. Use computer programming to numerically solve engineering problems relating to interpolation, integration, differentiation, etc.
4. Solve common computation problems related to Mining Engineering Courses.

Content List:

1. Introduction to Digital Computer Hardware.
2. Elements of Programming.
3. Programming Languages, Introduction to Operating systems and Compilers.
4. Problem analysis. Flow charts with algorithms.
5. Programming Examples and Exercises using C/C++ language (or any latest programming languages) with application to Engineering Problems.
6. Debugging Techniques.

Practical:

1. Programming exercises leading to developments of programs for engineering applications.

Bibliography/References:

1. Books:

a. Robert Lafore, “Waite Group's Turbo C Programming for the PC”, Rev Sub Edition, Financial Times Prentice Hall, 1988.
b. Peter H. Salus, “Programming Languages Handbooks Manuals , Object Oriented Programming Languages Handbooks Manuals, Techmedia - New Delhi, 1998.
c. Yashavant P. Kanetkar, “Let Us C”, Infinity Science Press, 2008, 9781934015254

2. Journals/Periodicals:

NIL

3. World Wide Web:

NIL

Course title: **Computer Application in Mining Engineering**
Credit hours: **0+1**
Prerequisite: **Pre-Engineering or Equivalent**

Course Learning Outcomes (CLOs):

On successful completion of the course students will be able to:

1. Introduce different application of computers in mining industry
2. Develop background in Databases, CAD programs and productivity tools
3. Practice surface mine design with AutoCAD® program
4. Understand the process of ore reserve estimation via the use of CS

Mine® program
5. Design the production plan and phase scheduling via Excel ® sheets.
6. Design UG openings and Surface cuts size via the use of FEM and BEM
7. Design unit operations drilling, blasting, loading and hauling via Excel sheets.
8. Examine ventilation flow nets via VentSim®
9. Examine mineral processing designed flow sheets via Modsim®
10. Introduce different application of computers in mining industry

Content List:

1. Computer application in Surface mining, Underground mining and mining unit operations
2. Introducing the database structure and use
3. AutoCAD basics for mining application
4. CS Mine program for surface mine design
5. Excel sheet design and application in scheduling
6. Application of FE practices in design of underground mines and mine highwall
7. Principles of running ventilation systems simulation
8. Principles of examining flow sheet in mineral processing plant via ModSim

Name of Course: **Mining Engineering Fundamentals**
Credit Hours: 3+0
Prerequisites: N/A

Course Learning Outcomes (According to Bloom's Taxonomy):

On successful completion of the course students will be able to:

1. Explain the phases/life-stages (prospecting, exploration, development, exploitation, and reclamation) of mining.
2. Explain the unit operations (drill, blast, load, haul) of mining.
3. List the basic mine support types based on their principle, relative costs, and installation techniques and demonstrate the use of support systems in underground mines
4. Interpret the basic theory of mine auxiliary operations i.e. compute air requirements for a simple mine, interpret pumping curve and compute pumping time for a simple mine

Content List:

1. An introduction to the field of mining engineering and its economic importance.
2. Mining Terminology
3. Brief review and production of minerals in Pakistan
4. Mine Life Stages
    a. Prospecting

b. Exploration
c. Development
d. Exploitation,

5. Unit Operations of Mining
    a. Drilling and boring
    b. Explosive and blasting
    c. Material handling
6. Mine supports
7. Mine Ventilation
8. Mine water and its disposal
9. Mine System Curve
10. Mine Pump Types and its applications
11. Interpretation of pumping curve
12. Drainage of a flooded mine

Text Book:

1. Raza, M. A. (2015), Course Notes on MINE-130 (Surface Hard Rock Mine Design); https://www.coursesites.com/webapps/portal/frameset.jsp?tab_tab_group_id=_52_1 Or https://www.coursesites.com/s/_MINE-130
2. Hartman, H. L., Mutmansky, J. M., (2007), Introductory Mining Engineering, 2nd Ed., John Wiley & Sons, Inc. New York, USA

Reference Books:

1. Hartman, H. L., (1992), SME Mining Engineering Handbook, 2nd Ed., Vol. 1, SME, Littleton, CO.
2. Lewis, R. S., Clark, G. B., (1964), Elements of Mining, John Wiley & Sons Inc. New York, USA

Name of Course: **Engineering Drawing and Graphics**
Credit Hours: 0+2
Prerequisites: Pre-Engineering or Equivalent

Course Learning Outcomes (CLOs):
After studying this course, the learners will be able to: -

1. Elaborate the basic principles of developing, designing and drawing.
2. Perform basic sketching techniques, orthographic projections and sections, use of architectural and engineering scales, and to produce engineered drawings.
3. Possess knowledge of technical rules and regulations of Engineering Drawing and its evaluation.
4. Design Engineering Projects independently.

Content List:

NIL

Practicals:

1. Introduction to the subject use of instruments.
2. Introduction: Types of lines, lettering, dimensioning, and drawing instruments. Lettering and dimensioning the principal requirement of a working drawing.
3. Projection, Types of projection, orthographic projection. Plan of projection, four quadrants.
4. Planning of a drawing sheet, the projector of simple solids simple position, and the oblique and auxiliary planes.
5. Traces of a line, true length of line, inclination to both the planes, projection of planes.
6. Loci of Points. Loci of points and straight line, loci of crank mechanism.
7. Curves Used in Engineering Practice. Cycloid, Throchoid, epicyclide, Pitrochoid, hypotrochoid (superior and inferior).
8. Involute, evolute, archemedian, spiral.
9. Development of solids. Types of solids, polyhedra, solids of revolution, construction, of polygon, prism, pyramid, cylinder, cones sphere, (development of all solids with passing cutting plane).
10. Intersection of Surfaces. Intersection of cylinder and cylinder, cone and cylinder., cone and prism.
11. Axonometric Projection. Types isometric projection of solids, planes and typical examples. Projection of Auxiliary Planes. Auxiliary planes and views, Projection of points, plane, true length of line. Projection of solids. True shape of section on auxiliary plane of various solids.
12. Isometric and pictorial projection of solid figures, making of freehand sketches from solid objects and from orthographic projection.
13. Section of solids, riveted joints.
14. Screw thread systems, nut and bolt, keys and cotter, coupling and simple bearings.
15. Pipe connections, engine detail.
16. Introduction of engineering drawing techniques in Auto CAD.

Bibliography/References:

1. **Books:**
   a. N. D. Bhatt, “Elementary Engineering Drawing Plane And Solid Geometry”, 30th Edition, Charotar Publishing House, 1990
   b. A. C. Parkinson,” A First Year Engineering Drawing”, Pitman - London, 1939
   c. Warren J. Luzjader, ‘Fundamentals of Engineering Drawing: With an Introduction to Interactive Computer Graphics for Design and Production”, ISBN: 9788120308855
   d. Baker, Arthur Latham, “The Elements of Solid Geometry”, Boston, MA: Ginn and Co., 1893.

2. **Journals/Periodicals:**
   NIL
3. **World Wide Web:**
   NIL

Course title: **Engineering Workshop Practice**
Credit hours: **0+2**
Prerequisite: **Pre-Engineering or Equivalent**

Course Learning Outcomes (CLOs):

After studying this course, the learners will be able to: -

1. Understand the functions of different hand tools and instruments used during workshop practices.
2. Design and conduct experiments as well as to analyze and interpret data to strengthen the theoretical concepts.
3. Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety.
4. Function in multi-disciplinary team.

Content List:

NIL

Practicals:

1. **Machine Shop (**Learn to operate lathe, milling, drilling, cutting, grinding and make a workpiece)
   a. Further work on the lathe including drilling from the tailstock, boring in chuck and holding work on faceplate.
   b. Introduction and demonstration on the million machine, methods of holding work, use of dividing head.
   c. From cutting of involutes gear and generation of spiral.
   d. Study of universal tool cutter grinding machine, use of gauges.
2. **Fitting Shop (**Make a small hand tool, including marking out from blue-print, filing to size, and punching marks)
   a. The making of a small hand tool, involving marking out from blue-print and filling to size.
   b. Use of surface place and surface gauge.
   c. Measurement by micrometer or Vernier caliper.
   d. Stripping down a small assembly to examine its needs for repair and its re-erection. Basic knowledge of limits and Fits system.
3. **Electrical Shop**
   a. Wiring of circuit to a blue-print.
   b. Make an electric circuit work piece
   c. Study of wiring circuit of a mechanically propelled vehicle.

d. Connection of single and three phase motors, battery and its charging.

4. **Carpentry and Pattern Shop**
   a. Introduction to pattern making practice.
   b. Different types of pattern.
   c. Shrinkage and other allowance.
   d. Preparations of a pattern with core print and core box.
   e. Wood turning practice.
   f. Make a wooden work piece from blue-print of a given design specifications.
5. **Smithy and Foundry Shop**
   a. Introduction and use of molding / molder's tools.
   b. Preparation of a mold and a core.
   c. Method of melting/shaping metals.
   d. Making of a casting from a simple pattern in either ferrous or non-ferrous metal.
6. **Welding**
   a. Fabrication exercises in electrical and gas welding.
   b. Inspection of welding joints steel metal work.

Bibliography/References:

1. **Books:**
   a. K.C. John, "Mechanical Workshop Practice", Second Edition, Prentice-Hall of India Pvt. Limited, 2010 ISBN: 978-81-203-4166-1
2. **Journals/Periodicals:**
   NIL
3. **World Wide Web:**
   NIL

Course title: **Applied Thermodynamics**
Credit hours: **2+1**
Prerequisite: **Applied Chemistry and Applied Physics**

Course Learning Outcomes (CLOs):

After studying this course, the learners will be able to: -

1. Understand the fundamentals of applied thermodynamics
2. Identify and describe energy exchange processes.
3. Apply the Laws of thermodynamics on different systems. (heaters, coolers, pumps, turbines, pistons, etc.)
4. Understand the calculation of heat and work quantities for physical processes.
5. Explain the underlying principles of phase equilibrium (PVT) in two-component and multi-component systems.

Content List:

1. Introduction to thermodynamic systems and processes, equilibrium, thermodynamic variables, intensive and extensive variables, thermodynamic properties, state functions, derived intensive variables.
2. Types of work, kinetic and potential energy, the first law of thermodynamics, internal energy, energy transfer by heat, energy balance, energy analysis of cycles.
3. Quasi-static processes, reversibility, heat capacities.
4. Property relations relevant to engineering thermodynamics, P-V-T relation, evaluating thermodynamic properties, generalized compressibility chart Ideal gas model, internal energy, enthalpy and specific heat of ideal gases, evaluating changes in specific enthalpy and internal energy for ideal gases, polytrophic process of an ideal gas.
5. Introducing the control volume, conservation of mass and energy in a control volume, Steady-state and transient forms of mass and energy rate balances.
6. Second law of thermodynamics, irreversible processes, entropy.
7. Applying the second law to thermodynamic cycles, the Carnot cycle.
8. The Clausius inequality, entropy changes, evaluating entropy data.
9. Entropy balance for closed systems, entropy rate balance for control volumes, isentropic processes, isentropic efficiencies of turbines, nozzles, etc.
10. Equations of state, property relations from exact differentials, fundamental thermodynamic functions, relations for gas mixtures and multi-component systems, the Gibbs-Duhem relation.
11. Applications to flow processes, nozzles, turbines, compressors, Heat Engines, Refrigeration and Air Conditioning, and Liquefaction of gases.
12. Thermal expansion coefficients of metals, thermal conductivity of liquids, thermal radiation and Stefan Boltzmann law, steam power plant, refrigeration unit, freezing point depression, PVT cell.

Practicals:

1. Measurement of following liquid properties
   a. Density
   b. Specific Weight
   c. Specific Volume
   d. Surface Tension
   e. Viscosity
2. To examine the relation between temperature and pressure for saturated steam.
3. To produce energy balance for small steam plant.
4. To study the performance of small high-speed steam motor.

5. Calculation of coefficient of performance for the refrigeration machine
6. Study and operation of a vapor compression refrigeration unit.
7. Study and operation of Heating ventilation and air conditioning Unit (HVAC)
8. Study and operation of air flow rig
9. Determination of thermal conductivity of different metal specimens using Fourier's law apparatus
10. Study of performance of parallel and counter flow heat exchanger
11. Determination of heat transfer coefficient for natural and forced convection from pinfin.

Bibliography/References:

1. **Books:**
   a. Smith J.M., Van Ness H.C., Abbott M.M. "Chemical Engineering Thermodynamics" 8th Ed. McGraw-Hill International Edition, 2005.
   b. Daubert Thomas E. "Chemical Engineering Thermodynamics", 1st Ed., McGraw-Hill Book Company, 1985.
   c. Sandler Stanley I. "Chemical and Engineering Thermodynamics" 3rd Ed. John Wiley and Aons, Inc.
   d. Moran M. J., Shapiro H. N., "Fundamentals of Engineering Thermodynamics" 6th Ed. John Wiley and Sons, Inc.
   e. Cengel, Y. A., Boles, M. A., "Thermodynamics: An Engineering Approach", McGraw-Hill, 2008
   f. Thomas D. Eastop, A. McConkey, "Applied Thermodynamics for Engineering Technologists", 5th Edition, Prentice Hall, 1996.
   g. S. S. Thipse," Advanced Thermodynamics", Narosa Publishing House - New Delhi, 2013.
2. **Journals/Periodicals:**
   NIL
3. **World Wide Web:**
   NIL

Course title: **Fluid Mechanics**
Credit hours: 2+1
Prerequisite: Pre-Engineering or equivalent

Course Learning Outcomes (CLOs):

1. Understand the basic principles of fluid mechanics and its application on types of flow.
2. Perform a basic analysis of static and dynamic fluid systems.
3. Carry out basic design calculations of fluid engineering systems (pumps, compressors etc.)
4. Apply their understanding and analysis on real-life problems related to equipment.

Content List:

Physical properties of fluids: Density, specific weight, specific volume, specific gravity, surface tension and compressibility.

Viscosity: Newton's equation of viscosity, units of viscosity, measurement of viscosity, dissipation of energy in lubricated bearings.

Fluid statics: Pressure, pressure-specific weight-height relationship.

Unit of pressure: Absolute and gauge pressure.

Measurement of pressure: Bourden Gauge, manometers and differential manometers. Forces on submerged plane and curved surface and their application.

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. Bernoulli's Theorem. Impulse-momentum equation.

Flow measurement: Measurements of velocity, pitot tube, measurement of discharge, venturimeter, orifices, notches and weirs. Concept of Vena-Contract.

Steady flow through pipes*:* Darcy Weisbach equation for flow in pipes, Chezy, Manning and Kutter's formula. Losses in pipe-lines, hydraulic and energy gradients, transmission of energy through pipes. Uniform flow through open channels. (Chezy's and Manning's formulae). Economical cross-section; rectangular, triangular and trapezoidal. Use of pumps and their characteristics.

Practicals:

1. Measurement of following liquid properties
    a. Density
    b. Specific Weight
    c. Specific Volume
    d. Surface Tension
    e. Viscosity
2. To determine the stability of floating bodies and measure the meta-centric height
3. To determine the magnitude of hydrostatic force and center of pressure
4. To validate the Bernoulli's theorem
5. To measure flow rate through pipe using venture meter and to calibrate it
6. To measure flow rate through an orifice and to calibrate it
7. To measure flow rate in an open channel by Notch and to calibrate it
8. To determine the coefficient of discharge of an Orifice Meter.
9. To determine the coefficient of discharge of Notch (V, Rectangular and Trapezoidal types).

10. To determine the friction factor for the pipes.
11. To determine the coefficient of discharge of Venturi meter.
12. To determine the coefficient of discharge, contraction and velocity of an orifice.
13. To verify the Bernoulli's Theorem.
14. To find critical Reynolds number for a pipe flow.
15. To determine the minor losses due to sudden enlargement, sudden contraction and bends.
16. To study Velocity, Viscosity and Pressure measuring device.

Bibliography/References:

Recommended Text Books:

a. R. L. Daugherty, J. B. Franzini and E. J. Finnermore, Fluid Mechanics with Engineering Applications, McGraw Hill.
b. E. H. Lewitt, Hydraulics and Hydraulic Machinery, Pitman and Sons.

Reference Books:

a. Bruce R. Munson , Donald F. Young , Theodore H. Okiishi, Wade W. Huebsch "Fundamentals of Fluid Mechanics", 6th Edition, Wiley, 2010
b. Robert Byron Bird, Warren E. Stewart, Edwin N. Lightfoot, "Transport Phenomena", 2nd Edition, John Wiley & Sons, 2007
c. Fanzini, J Band E J Finnemore, "Fluid Mechanics with Engineering Applications, 9th Edition or latest, WCB/McGraw Hill, 1997
d. White, F M, "Fluid Mechanics" 4th Edition, McGraw Hill, 1999
e. Douglas J F, J M Gasiorek and J A Swaffield, "Fluid Mechanics" 2nd Edition, Longman Publishing Group.

1. **Journals/Periodicals:**
   NIL
2. **World Wide Web:**
   NIL

Course title: **Mechanics of Materials**
Credit hours: **2+1**
Prerequisite: **Engineering Mechanics**

Course Learning Outcomes (CLOs):

After studying this course, the learners will be able to: -

1. Understand the fundamental concepts of stress, strain, buckling, geometrical properties and materials properties in tension and compression.
2. Learn the beams and short columns design concepts.
3. Develop and solve problems of the stress on a beam section, circular shafts and short columns due to tension, compression, torsion, bending, shear, combined loading etc.

Content List:

1. Types of stresses and strains.
2. Load extension diagrams.
3. Hooke's Law.
4. Temperature stresses.
5. Geometrical properties of plane areas. (Centroid, Moment of Inertia and Product of Interia) Shearing Force and Bending Movements for simply supported beams, Cantilever and overhanging beams.
6. Theory of simple Bending and Shearing Stresses in beams.
7. Theory of Torsion in circular shafts (solid and hollow).
8. Short Columns.
9. Combined bending and direct stresses.
10. Euler's Theory of buckling for long column-Empirical formula.
11. Mechanical properties of metals and timber in tension and compression.
12. Principles of testing machine.
13. Impact Loads.
14. Hardness.
15. Failure criteria.

Practicals:

1. Layout Plan of Strength of Materials Laboratory.
2. Study of small instruments.
3. To perform direct shear test on plain mild steel bar.
4. To perform punching shear test on plain mild steel bar.
5. To perform tension test on plain mild steel bar.
6. To perform compression test on wooden cubes, when load is applied: -
   a. Perpendicular to grain.
   b. Parallel to the grains.
7. To perform hardness test on mild steel and High Carbon steel specimen.
8. To perform bending test on wooden beam.
9. To verify the principal of super position by beam deflection.
10. To perform impact test on steel specimen: -
    a. In tension.
    b. In bending.

Bibliography/References:

Recommended Text Books:

a. R. C Hibbler, Mechanics of Materials
b. Andrew Pytel and Ferdinand, Strength of Materials

Reference Books:

a. Andrew Pytel, Ferdinand L. Singer, "Strength of Materials", 3rd Edition, Harper and Row, 1998.
b. Robert R. Archer , Stephen H. Crandall , Norman C. Dahl," An Introduction To The Mechanics of Solids", McGraw-Hill - New York, 1959.
c. R.C. Hibbeler, "Mechanics of Materials", 8th Edition, Prentice Hall, 2011

1. **Journals/Periodicals:**
   NIL
2. **World Wide Web:**
   NIL

Course title: **Basic Electrical Technology**
Credit hours: **2+1**
Prerequisite: **Physical and Industrial Chemistry and Applied Physics**

Course Learning Outcomes (According to Bloom's Taxonomy):

After studying this course, the learners will be able to: -

1. Get familiar with fundamental concepts in Electrical Engineering.
2. Understand the interaction of electrical and magnetic circuits and their role in operating principle of electrical machines.
3. Explain construction and operation principle of transformers and Induction Motors.
4. Analyze, design and test electrical circuits.

Content List:

1. Electric and Magnetic Circuits
   a. AC Poly Phase systems,
   b. DC Machines,
   c. AC Synchronous Machines,
   d. AC Induction Machines.
2. Induction Motors
   a. Construction,
   b. Types,
   c. Rotating field theory principle of working,
   d. Slip and its effect on motor current quantities.
   e. Losses Efficiency and performance curves Starting,
   f. Full load maximum torque relations, and
   g. Torque slip characteristics.
3. Transformers;
   a. Converting Machines;
   b. Rotary Converters; Construction; Principle of working; Transformer connections, Voltage and current ratings of single and three phase converters;
   c. Mercury arc rectifiers, Construction, Operation; Transformer

connections, Voltage and current ratios of single phase and three phase rectifiers.

Practicals:

1. Study and Use of Oscilloscope.
2. Resistance Measurement by Color Code and its Comparison with the Ohm-Meter Reading.
3. Study of Ohm's Law.
4. Study and Proof of Kirchhoff's Current Law (Nodal Analysis)
5. Study and Proof of Kirchhoff's Voltage Law (Loop Analysis). RC Time Constants.
6. To Plot the Capacitor Charging and Discharging Curves using Oscilloscope.
7. To Draw Vector Diagram of an A.C circuit containing,
   a. Resistance and Inductance in Series,
   b. Resistance and Capacitance in Series,
   c. Resistance, Inductance and Capacitance in Series.
8. To study the Effect of Frequency Variation on an R-L-C Series Resonant Circuit.
9. Power Measurement in a 3-Phase
10. Star Connected Balanced Resistive Load by Two Wattmeter Method and Verification of Relations:
    a. Line Voltage = 3 Phase Voltage,
    b. The current in the neutral conductor is zero
    c. Sum of Two Wattmeter Readings Total power in the Circuit

Bibliography/References

Recommended Books:

a. B. L. Theraja, A. K Theraja, “Textbook of Electrical Technology”, 25th Edition, Chand (S.) & Co Ltd ,India, 2012.
b. Robert L. Boylestad, “Introductory Circuit Analysis”, 12th Edition. Prentice Hall, 2010.
c. Stephen J. Chapman, “Electric Machinery Fundamentals”, 4th Edition McGraw-Hill Science/Engineering/Math, 2003
d. Admiralty,” Examples in Electrical Calculations” ASIN: B003MR22VS

1. **Journals/Periodicals:**

   NIL

2. **World Wide Web:**

   NIL

Course title: **Engineering Geology**
Credit hours: **2+1**
Prerequisite: **Physical and Industrial Chemistry and Applied Physics**

Course Learning Outcomes (According to Bloom's Taxonomy):

After studying this course, the learners will be able to: -

1. Identify the structural features of rock strata
2. Explain the significance of geological structures on mine excavations
3. Determine the geo-mechanical properties of rocks
4. Apply geological knowledge in mine design projects

Content List:

Engineering Fundamentals: Data collection, interpretation applying analysis techniques, site investigation etc.

Engineering soil: Cohesive and non-cohesive soil, unified and other soil classification, engineering properties of solid

Engineering properties of rocks: rock strength, rock deformation, index properties, Rock Masses.

Characteristics of discontinuities

Orientation, spacing, continuity, surface characteristics etc.,

Rock mass deformation, rock mass quality, rock mass dynamic elastic moduli, engineering classification of rocks

Sub surface water – occurrence, engineering significance & control of subsurface water

Construction uses of rocks – aggregate, geologic & performance characteristics

Landslides & related phenomena – evaluation landslide

Processes, mitigating the effects of landslides, subsidence, mitigating the effects of subsidence, expansive soils & mitigating their effects.

Earthquake induced processes – surface rupture, ground shaking, ground failure, tsunami and seiche so their occurrence .

Recommended Reference Books:

a. Principles of engineering Geology by Robert B. Johnson
   Geology for Engineering by Blyth & DeFreitas

Course title: **Engineering Mechanics**
Credit Hours: 3+0
Prerequisites: N/A

Course Learning Outcomes (According to Bloom's Taxonomy):

1. Define Newton's laws of motion.
2. Recall trigonometric laws and apply to the addition and decomposition of vectors quantities.

3. Identify the moment of a force and calculate its value about a specified axis. Define the moment of a couple.
4. Describe the concept of dry friction and analyse the equilibrium of rigid bodies subjected to this force.
5. Construct "Free Body Diagrams" of real world problems and apply Newton's Laws of motion and vector operations to evaluate equilibrium of particles and bodies.
6. Apply the principles of equilibrium of particles and bodies to analyse the forces in planar truss members.
7. Discuss the concepts of ``centre of gravity'' and ``centroids'' and compute their location for bodies of arbitrary shape.
8. Apply the concepts used for determining centre of gravity and centroids to find the resultant of a generally distributed loading.
9. Implement methods learnt for equilibrium of bodies and the resultant of a generally distributed loading to compute the internal forces in beams. Generalise the procedure to construct bending moments and shear force diagrams (internal forces) and utilise this information in engineering design.

Content List:

Vectors: Addition and subtraction of vectors, scalar and vector products, differentiation and integration of vectors, laws of triangle, parallelogram and polygon forces, parallel forces, moments and couples, friction, resultant of coplanar forces, general conditions of equilibrium of coplanar forces, funicular polygon, common and parabolic category, mechanical advantage and efficiency of simple machines.

Motion along a straight line with uniform acceleration Tangential and normal components of acceleration, Banking of tracks, Simple harmonic motion projectiles.

Work and energy power, momentum and conservation of momentum and energy.

Mechanics practical, experiments illustrating principles of mechanics

Course title: Rock Mechanics
Credit Hours: **3+1**
Prerequisites: **N/A**

Course Learning Outcomes (According to Bloom's Taxonomy):

1. Explain stress and strain concepts in relation to rocks.
2. Explain the significance of various tests for measuring the geo-mechanical properties of rocks.
3. Apply various techniques of rock mechanics in the evaluation of rock

stresses.
4. Analyze the mechanical behavior of rocks and rock masses.
5. Apply numerical techniques for design of underground excavation.

Content List:

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

Classification of rock properties

Mechanical properties
Intrinsic properties
Index properties

Criteria of Deformation fracture and yields

Coulomb's failure criterion
Mohr's theory of failure
Griffith's criterion
Empirical criteria
Von-Misses yield criterion

Insitu testing of Rock Mass

Pressure chamber test
Plate bearing test
Cable method of insitu rock testing
Combines cable and cylindrical jack method
Flat jack test
Modulus of elasticity test
Insitu compression test

Time dependent deformation of rocks

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

Stress analysis by numerical Methods

Finite difference method
Finite element method
Boundary element method

Stress analysis by photo elastic Method

Lab Outline:

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 Behaviour of Rocks

Recommended Text Books:

a. Goodman, Introduction to Rock Mechanics, 1989, John Wiley and Sons
b. Brady and Brown, Rock Mechanics, 3rd Edition, Reprint in 2006, Springer
c. Hudson and Harrison, Engineering Rock Mechanics

Recommended Reference Books:

a. Hoek, Practical Rock Engineering (www.rocksciences.com)
b. Obert and Duvall, Rock Mechanics and the Design of Structure in Rock
c. Jaeger and Cook, Fundamentals of Rock Mechanics

Course title: **Underground Mine Design**
Credit Hours: 3+0
Prerequisites: N/A

Course Learning Outcomes (According to Bloom's Taxonomy):

1. Describe various concepts of underground excavation design
2. Classify various underground mining methods
3. Suggest appropriate underground excavation techniques based on ore body characteristics
4. Analyze Techniques for assessing stability of underground rock structures
5. Suggest design guidelines for an underground mine

Content List:

Introduction

System Involved in Planning of a mine

Design Process in engineering

Input Parameters for Design

Geological site characterization (input parametrs of design), Ground stresses, Strength and deformability of rock masses, Properties of rock materials, Insitu

tests scaling of laboratory test data to in-situ values

Mining Methods
Classification of underground mining methods, Long wall mining methods, Room and pillar Mining Methods, Sublevel caving, Sub level open stopping, Selection of Mining Method, Shrink stopping, Calculation of total volume of tunneling engineering, Mine layout, panel layout, roadway layout and mode of development.

Empirical Design Methods
Classification system in rock engineering, Terzaghi rock load classification system. Deer's rock quality designation, Rock structure Rating (RSR) concept, Geomechanics classification system (RMR), Q. system

Integrated Design
Design of mine pillars, Application of rock mass, Classification to pillar design, integrated design procedure for the design of room and pillar mine workings.

Guided Design
General consideration for support design, roof support design in civil engineering tunneling

Analytical Methods of Design
Numerical Modeling, Physical Modeling

Excavation Design in Elastic and Jointed Rock Mass
Shaft Sinking
Selection of Pit Mouth Position, Usage of shafts and their equipment, Factors affecting the design of shaft, Methods of shaft sinking, lining of shafts.

Selection of Equipment and Machinery

Practical work:
Application of various methods for the design of underground mining excavations using field data.
Exercises in rock Mechanics design of various underground mining excavations.
Preparation of design maps.

Field Trip:

Field visit to some mine sites is an essential part of this course.

Recommended Text Books:

a. Hustrulid, Underground Mining Methods Handbook, AIME Publication, June 2001.
b. R. S. Lewis and Clark, Elements of Mining, John Wiley and Sons.
c. SME/AIME Mining Engineering Handbook Vol. I and II, 1992

d. Syd and Peng, Longwall Mining

Recommended Reference Books:

a. Rock mechanics for Underground mining by B.H.G Brady and E.T. Brown.
b. Rock Mechanics design in Mining and tunneling By Z.T. Bieniawski.
c. Fundamentals H. L. Hartman, Introductory Mining Engineering. John Wiley and Sons, 2nd Edition.
d. Coal Mine Ground Control By Syd. S. Peng.
e. Long-wall Thick Seam Mining By Raja V. Ramani and Ajoy K. Ghose.
f. Practical Handbook for Underground rock Mechanics by T.R Stacey.

Course title: Surface Mine Design
Credit Hours: **3+0**
Prerequisites: **N/A**

Course Learning Outcomes (According to Bloom's Taxonomy):

1. Describe various surface mining techniques and methods
2. Apply various techniques for the determination of optimum pit limits
3. Select different equipment for surface mining operations
4. Apply concepts of optimizing surface mining operations
5. Design of slopes and bench geometry in open pit mines

Content List:

Introduction & Surface Mining Methods;
Open Pit terminology & Purpose of Benches;
Unit operations & Mining steps;
Geometrical considerations in open pits;
Basic Bench Geometry;
Pit Expansion Process;
Pit Slope Geometry;
Final Pit Slope Angles;
Plane Representing Bench Geometry;
Addition of Road;
Stripping Ratios;
Pit limits;
Manual Methods for finding pit limits
Economic Block Models
Floating Cone Technique
Lerchs-Grossman 2-D algorithm;
Lerchs-Grossman 2 1/2-D algorithm;
Lerchs-Grossman 3-D algorithm;

Surface Mine Machinery

Equipment selection;

Production Planning

Quarrying ;
Placer Mining;
Case Histories

Practical:

Based on the above course work and facilities available

Field Trips:

Some mining field visits are essential part of this course.

Recommended Text Books:

a. E. P. PfLeider, Surface Mining
b. B. A. Kennedy, Surface Mining, SME, 1990
c. William Hustrulid and M. Kuchta, Open pit Mine Planning and Design, Vol. I, April 2006, 2nd Edition. Taylor and Frances.
d. James W. Martin, Surface Mining Equipment

Recommended Reference Books:

a. B. A. Kennedy, Surface Mining, 2nd Ed., SME
b. W. Hustrulid and M. Kuchta, Open pit Mine Planning and Design, Vol. II (published by A. A. Balkema)
c. Abid S. H. TLR on Surface hard rock Mining. 2000. Ministry of Education, Pakistan.

Course title: **Mineral Processing - I**
Credit Hours: 3+1
Prerequisites: N/A

Course Learning Outcomes (According to Bloom's Taxonomy):

1. Describe the basic concepts of Mineral Processing
2. Classify communition, sizing and classification equipment used for mineral processing
3. Apply theoretical concepts for conducting preliminary tests on various mineral processing equipment
4. Analyze the results for developing efficient mineral processing operation

Content List:

Introduction: Economic justification and scope of mineral processing for upgrading ores and minerals, types of flow sheets, liberation and concentration.

Communition: Definition and objectives of crushing and grinding.

Conventional and non conventional methods of crushing and grinding. Laboratory and industrial crushers and grinding mills, grinding circuits. Use of micro waves in crushing.

Laboratory Sizing and Industrial Screening: Laboratory sizing, wet and dry sieve analysis, size distribution, sub-sieve techniques, movement of solid in fluids, Stokes and Rittinger laws, industrial screening, performance of screens, types of screens, screening surfaces.

Classification: Principles of classification, free and hindered settling ratios, hydraulic and mechanical classifiers. Principles of cyclones and hydrocyclones.

Gravity Concentration: Principles of gravity concentration, gravity separators, jigging, Humphrey's spirals, flowing film concentration, tabling, concentration ratio, grade recovery relationship; heavy fluid and heavy media separation (H.M.S).

FLOTATION: Principles, machines and applications
Magnetic and electrostatic Separation: Principles, machines and applications
Solid Liquid Separation: Separation of Solids from fluid, dewatering filtration, drying and equipment used for solid liquid separation.
Coal Preparation: Introduction to coal cleaning and coal preparation.

Lab Outline:

1. Sampling on a given lot of ore using Coning and Quartering and mechanical samplers
2. Use of jaw crushers for crushing limestone and gypsum
3. Use of Rolls for closed-sized crushing for iron ore and chromite
4. Use of ball-mill and rod-mill for grinding of a given ore sample
5. Wet and dry sieve analysis and graphical presentations of size distribution data.
6. Experimental determination of free and hindered settling ratios
7. Concentration of a given sample ore on Laboratory Jig
8. Concentration of a given sample ore on Shaking table
9. Float-Sink Analysis for a coal sample
10. Flotation of a given ore sample.
11. Flotation of coal sample from Pakistan
12. Concentration of an ore using dry / wet magnetic separators

Recommended Text Books:

a. B. A. Wills, Mineral Processing Technology, 7th Ed., 2006
b. S. K. Jain, A. A. Balkema, Ore Processing, 1987

Recommended Reference Books:

a. Spotiswoods and Kelly, Mineral Processing, 1986

b. SME Mineral Processing Handbook, 1990
c. Abid S. H., TLR on Mineral Processing. 2000. Ministry of Education. Pakistan.

Course title: **Mine Surveying**
Credit Hours: **3+1**
Prerequisites: **N/A**

Course Learning Outcomes (According to Bloom's Taxonomy):

1. Understand the basic concepts of engineering surveying
2. Classify conventional and modern surveying techniques based on their uses and operations
3. Execute surveying for specific mining operations

Content List:

Fundamental Concepts: Definitions, uses & types of surveys, survey measurements, errors and adjustments.

Basic Survey Measurements: Distance measurements, leveling, different methods and types of instruments, angle and direction measurements; description and adjustment of transit & compass; theory and practical uses of stadia surveying.

Surveying Operation: Plane table traversing, Transit-tape traversing, 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.

Mine Surveying: Transfer of co-ordinates, level and meridian underground, use of auxiliary telescope, laying out of curves, underground mine surveying.

GIS: Introduction to GIS

Lab Outline:

1. Distance measurement
2. Leveling (Establishing vertical control by differential leveling method)
3. Compass Traverse
4. Triangulation (Establishing horizontal control)
5. Traversing
    (a) Plane table Traversing
    (b) Transit tape Traversing

a. Surveying using Total Station Theodolite and other modern equipment (e.g. GPS)

Field Trip:

A field surveying camp is advised for a good field practice.

Recommended Text Books:

a. Surveying by Davis and Foote, McGraw-Hill, 1968
b. Surveying and Levelling by Kanetker Vol.1&2, 1996

Recommended Reference Books:

a. Introduction to Mine Surveying by Stanley
b. Surveying Handbook by Russell Charles Brinker
c. Abid. S.H. TLR on Mine Surveying. 2000. Ministry of Education, Pakistan.

Course title: **Explosives Engineering**
Credit Hours: 3+1
Prerequisites: N/A

Course Learning Outcomes (According to Bloom's Taxonomy):

1. Classify explosives based on their properties
2. Explain the basic rock fragmentation theory
3. Select appropriate explosives for strength properties of rocks
4. Apply appropriate blasting technique for given situation
5. Design an optimum blast pattern for a given condition

Content List:

Explosives history and development, ingredients and chemistry of explosives.

Explosion, properties, classification and characteristics of commercial explosives and blasting agents.

Initiation system; Rock breakage theories; Principles of priming and loading, Fundamentals of surface and underground blast designs, controlled blasting techniques; Ground vibrations and air blast, safety in explosive handling and blasting. Introduction to commercial explosives of Pakistan.

Lab Outline:

1. Relevant Audio-visual programs demonstrating different safe blasting practices should be shown to the students.
2. Instructional tours may be arranged to visit various surface and underground mines to get the student familiar with various, initiation, priming, loading and other blasting practices.
3. Study the various inert (dummy) explosives and accessories manufactured by Wah Nobel Industries, write a short report on them indicating specifications, their uses etc.
4. Study the various inert explosives and inert accessories manufactured by Biafo industries and write a brief report stating their specification, uses etc.
5. Practice the recommended knots for detonating cord on inert detonating

cord or nylon strings. This is to be studied and practiced on a field trip as well.

6. Study a Nonel detonator (inert) and various associated accessories and delays (inert) and practice its connection in class and also in the field.
7. Start a Nonel shock tube (actual) with the help of Nonel starter/initiator in the class and do the same with a remote Nonel initiator as well.
8. Study various instrumentation involved in electric initiation system and also practice the recommended wire splices.
9. Using inert electric detonators, determine the continuity and resistance of series. Parallel, and series-parallel circuits (use the firing line, connecting wire and bus wire in the circuit).
10. Practice with the help of detonators (inert) and primer (inert) the various proper techniques in making primers. Study them on field trips as well.
11. On a field trip, watch and practice general blasthole loading procedures.
12. Create mock ground vibrations and air blast in the class and monitor and take readings with the help of seismographs. Also monitor them in actual field conditions on a study tour.
13. Study the various components of a sequential blasting machine in the class and use it in the field where electric initiation is practiced and get familiar with its use.
14. Study the various components, and get familiar with the use of a lightening detector when storm is approaching.

Field Trips:

Some mining field visits are essential part of this course.

Recommended Text Books:

a. Dick, Fletcher & D'Andrea, Explosives and Blasting Procedures Manual (IC 8925), 1995
b. Explosive and Rock Blasting, Atlas Powder Company, 1987.
c. Stig O. Olofsson, Applied Explosive Technology for Construction and Mining
d. Blaster's Handbook, 18th Edition, ISEE, 2011

Recommended Reference Books:

a. Gary B. Hemphill, Blasting Operation, McGraw-Hill
b. Rune Gustafsson, Swedish Blasting Technique. Published by SPI, Gothenburg, Sweden
c. Tariq M. TLR on Explosives and Blasting. 2000. Ministry of Education, Pakistan.

Course title: **Mining and Environment**
Credit Hours: **2+0**
Prerequisites: **N/A**

Course Learning Outcomes:

After the conclusion of the course the students will be able to:

1. Understand the environmental pollution and their ecological impacts issues related to mining operations.
2. Classify different types of solid and hazardous wastes produced by mining activity, mines and mill tailings and their management.
3. Understand noise pollution due to mining activity and vibration effects due to blasting and their control strategy.
4. Assess the environmental impacts of Acid Mine Drainage (AMD) and its control measures at a mining project site.
5. Assess the air quality by applying suitable pollution sampling and measurement techniques.
6. Interpret the environmental pollution control laws and regulations of the country.
7. Prepare an Environmental Impact Assessment report of mining project.

Course Outlines:

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

Recommended Text Books:

a. Fletcher & D'Andrea, Explosives and Blasting Procedures Manual (IC 8925), 1. Mining and its impact on the environment by Fred G. Bell and Laurance J. Donnelly, Publisher Taylor and Francis. (ISBN 0-415-28644-1 (hbk)
b. Environmental impacts of mining (Monitoring, Restoration and Control) by M. Sengupta by Lewis Publishers (ISBN 0-87371-441-5).
c. Mining environment (Problems and Remedies) by O.P Singh (ISBN 81-89233-16-5)

Course title: **Mine Hazards and Safety**
Credit Hours: **3+1**
Prerequisites: **N/A**

Course Learning Outcomes (According to Bloom's Taxonomy):

1. Describe different types of hazards and occupational diseases in mining operations
2. Explain remedial measures for different mining hazards
3. Control mine accidents by applying modern theories of causation of accidents
4. Analyze the economic impact of accidents

Content List:

Mine Dust and Gases: Source types, properties, effects, detection, analysis and precautions. Introduction to instruments used for detection and analysis.

Mine Fires Types: Causes, effects and prevention of underground fires, fire fighting equipment and organization mine explosions, ignition of fire damp, explosion of firedamp, coal dust explosions, stone dust barriers, mixed explosion, explosions in compressed air pipes, investigation of explosions.

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, mine, diseases, their treatment and preventions.

Safety: Mine accidents, analysis, and their prevention. Protection against hazards in mines. Instrumentation for mine safety

Lab Outline:

1. Determination of dust concentration using Aerosol Monitor.
2. Determination of dust concentration using Peizo-Balance Dust Counter.
3. Methane gas detection and estimation using mine safety lamp.
4. Measurement of methane gas using methane detectors.
5. Measurement of CO_2 using Infrared Monitor.
6. Measurement of H_2S using Personal Monitor & Alarm for H_2S.
7. Measurement of O_2 Deficiency / Excess.
8. Measurements of Carbon Mono oxide (CO)
9. Measurement of Nitrogen oxide (N_2O)
10. Operation and usage of Self Rescuer.
11. Operation of Oxygen Breathing Apparatus and Oxygen Mask.

Field Trip:

Field visit to some mine rescue stations is an essential part of this course.

Recommended Text Books:

a. J. Strang and P. M Wood, A Manual on Mine Rescue, Safety and Gas Detection, 1985

Recommended Reference Books:

a. Hein Rich, Industrial Accident Prevention
b. Bird. Loss Control Management
c. John Riley, Safety at Work
d. Jeffery, W. Vincoli, Accident Investigations
e. Safety Notes of Cornwall School of Mines
f. Tariq. M TLR on Mine Safety and Rescue. 2000. Ministry of Education, Pakistan

Course title: **Coal Technology**
Credit Hours: **2+1**
Prerequisites: **N/A**

Course Learning Outcomes (According to Bloom's Taxonomy):

1. Classify coal based on properties and appropriate utilization
2. Compare different coal value addition techniques
3. Analyze efficiency of coal washing techniques
4. Relate specialized clean coal utilization to coal deposits of Pakistan
5. Suggest environmental control measures for efficient utilization of coal

Content List:

Energy Resources for economic growth: Pakistan vs International Scenario
Characteristics and classification of fuels: Primary and Secondary fuels
Coal origin, Exploration and Occurrence: Coal deposits of Pakistan
Coal Mining and Utilization
Coal and Environment: Coal Bed Methane
Coal Washing: objectives, benefits and Wash ability studies of coal
Coal processing technologies
Factors for selection of coal processing technology
Coal Cleaning By Water Currents
Coal Cleaning By Flowing Film Concentration
Flotation of Coal
Thickening, Dewatering and Drying
Coal process control
Separation evaluation
Partition curves
Carbonization, Coke production
Coal Combustion
Coal Gasification and Conversion Technology
Environmental Control and Clean Coal Technology

Recommended Text Books:

a. SME Elements of Practical Coal Mining (The Latest Edition), Edited by S. M. Cassidy, 1981.
b. SME Coal Preparation (The Latest Edition), Edited by J. D. Leonard and R. D. Mitchell.
c. R. Stefanko and C. J. Bise, Coal Mining Technology: Theory and Practice (The Latest Edition),
d. Colin R. Word, Coal Geology and Coal Technology (The Latest Edition)

Recommended Reference Books:

a. SME Mining Engineering Handbook (The Latest Edition), Edited by A. B. Cummins and L. A. Given.
b. Lewis R. S. & G. B. Clark, Elements of Mining (The Latest Edition).
c. Abid. S. H. TLR on Coal Mining. 2000. Ministry of Education, Pakistan.

Course title: **Mineral Processing -II**
Credit Hours: **2+1**
Prerequisites: **N/A**

Course Learning Outcomes (According to Bloom's Taxonomy):

1. Select appropriate equipment for concentration processes
2. Analyze the results and interpretation of the experimental data
3. Analyze various separation techniques
4. Design mineral processing flow sheet for given minerals

Content List:

FLOTATION: Flotation, chemical and physical aspects, process, uses with examples. Flotation reagents, absorption mechanism, types and applications of reagents, and differential flotation of complex ores.

FLOTATION MACHINIES: Laboratory and industrial flotation machines, pneumatic and mechanical types. Column flotation

FLOCCULATION AND DISPERSION: Introduction to electrical double layer theory, flocculation, coagulation and dispersion phenomena, mechanism and application.

MAGNETIC AND ELECTROSTATIC SEPARATION: Magnetic, electrostatic and electro-dynamic separation: principles, machines and applications.

NON-CONVENTIONAL PROCESSES: Treatment of minerals by non-conventional processes such as color sorting, radiation sorting, and heating.

SOLID LIQUID SEPARATION: Separation of solids from fluid, dewatering, filtration, drying, and equipment used for solid-liquid separations.

AUXILIARY OPERATIONS AND FLOW SHEETS: Auxiliary operations plant flow sheets and circuit diagrams.

COAL PREPARATION: Introduction to coal cleaning and coal preparation

Lab Outline:

1. Synthesis of xanthate collectors
2. Flotation of a given ore sample
3. Flotation of a coal sample from Pakistan
4. Flocculation of a sample using synthetic/ polymer flocculants
5. Dispersion of a sample using suitable dispersants
6. Removal of impurities using dry / wet magnetic separators from a sample of industrial mineral
7. Concentration of an ore using dry / wet magnetic separators
8. Removal of impurities from a given ore sample using electrostatic separator

Recommended Text Books:

a. B.A. Wills, Mineral Processing Technology, 7th Ed.
b. S. K. Jain, A. A. Balkema, Ore Processing

Recommended Reference Books:

a. Spotiswoods and Kelly, Mineral Processing
b. SME Mineral Processing Handbook, Society of Mining Engr. Of AMIMMPE Inc. New York, 1986
c. R. K. Senha, Industrial Minerals, Aa Balkema, 1983
d. Crozier, Flotation Pergamon, 1992
e. Flotation: A. M. Gaudin memorial volume, Volume 1, American Institute of Mining, Metallurgical, and Petroleum Engineers, 1976, Digitized in 2007.

Course title: **Tunnel and Excavation Engineering**
Credit Hours: **3+1**
Prerequisites: **N/A**

Course Learning Outcomes (According to Bloom's Taxonomy):

1. Describe conventional and modern tunnel excavation methods
2. Recommend appropriate tunnel excavation technique for different ground condition
3. Analyze tunnel monitoring data during and after design
4. Design appropriate support system for a given tunnel

Content List:

Classifications of underground openings/ excavations;
Site investigation for tunneling & excavation projects;
Geological aspects of Tunnel & Shaft-sinking Design;

Fundamental Concepts of Rock Breaking;
Design of shape & size of tunnels & Shafts;

Excavation methods: Drill & Blast, Mechanical Excavation (Road Headers, Tunnel Boring Machines, TBM's & New Austrian Tunneling Method (NATM));
Tunneling & Shaft Sinking in problematic grounds.;
Ground Treatment and Water Control Methods;
Support and reinforcement of tunnels;
Ventilation during Construction of Underground Structures;
Collection of design data and monitoring of Excavation during and after Construction

Lab Outline:

Based on theoretical work –

Recommended Text Books:

a. Whittaker, B. N., Frith, R. C, Tunneling. Design, Stability and Construction 1990.

Recommended Reference Books:

a. Thomas R. Kuesel, Elwyn H. King, John O. Bickel, Tunnel Engineering Handbook (Latest Edition)

Course title: **Mineral Resource Estimation**
Credit Hours: **3+1**
Prerequisites: **N/A**

Course Learning Outcomes (According to Bloom's Taxonomy):

1. Describe various steps of mineral resource estimation
2. Differentiate between classical statistics and geostatistics
3. Apply linear geostatistics for resource estimation of recoverable reserves
4. Report mineral resource estimates following international standards
5. Develop deep appreciation for modeling uncertainty using nonlinear geostatistics

Content List:

1. INTRODUCTION TO MINERAL RESOURCE ESTIMATION

Introduction and Definitions

Data Collection and Sampling Techniques

Geologic interpretation Modelling and interpretation

2. MINERAL RESOURCE ESTIMATION

SME Guidelines, Resource and Reserve Classification, Resource estimation

methodology

Steps of ore reserve estimation

Compositing, grade distribution, resource estimation modelling and reporting

3. TRADITIONAL RESOURCE ESTIMATION

Polygonal Estimation

Triangular Method

Cross Sectional Method

Inverse distance weighting

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

4. GEOSTATISTICAL TECHNIQUES

Geostatistics vs classical statistics, why geostatistics?

Spatial Statistics:

h-scatter plots, Semi- variance, Variogram, Semivariogram Variogram calculation

4.1 Structural Analysis:

Variogram modelling , Linear, Spherical, exponential and Gaussian model

Stationarity, Geometric and Zonal anisotropies

4.2 Linear Geostatistical Estimation:

Kriging, Best Linear Unbiased estimator- Ordinary Kriging

Kriging variance, Uncertainty of estimated variable

Variogram parameters and Kriging

4.3 Search Strategies in Kriging Estimation

Search strategy and Search Neighbourhood

Cross validation

5. **INTRODUCTION TO NONLINEAR GEOSTATISTICAL TECHNIQUES**
   Indicator Kriging, Median indicator Kriging
   Conditional simulations

6. **Volume Variance Relationship**
   Recoverable Reserves, Selective Mining Unit, Mining Blocks/Panels
   Affine correction, indirect lognormal correction

7. **Reporting of Estimated Reserves**

Lab Outline:

1. Application of Statistical Terms in mineral Resource Estimation (Mean Variance and Correlation)
2. Exposure of students to any Geological Modelling and Mineral Resource Estimation using any Mineral resource Estimation software (e.g. Vulcan, Mine Sight, Surpac, Data Mine, Leap Frog)
3. Calculation of Experimental Variogram
4. Interactive Variogram Modelling
5. Solving Kriging set of Equations in Excel
6. Analyzing effect of various variogram parameters on estimated grades
7. Some Exposure to coding using VBA Excel

Text Books:

a. Introduction to Geostatistics, by Isaaks and Srivastava
b. Applied Mineral inventory Estimation, by inclair A.J. & Blackwell G. H.

Reference Book:

a. GSLIB: Geostatistical Software Library and User's Guide by Clayton V. Deutsch and A.G Journal

Course title: **Mine Ventilation**
Credit Hours: 3+1
Prerequisites: N/A

Course Learning Outcomes (According to Bloom's Taxonomy):

1. Understand the basic components of mine ventilation
2. Apply the concepts of ventilation in underground mine environment
3. Analyze ventilation system for a given mine environment
4. Design ventilation systems using natural and auxiliary ventilation principles

Content List:

Introduction: Objectives of mine ventilation, air conditioning and control process.

Quality Control: Mine Gases: Nature of air, types, sources, properties and control of mine gases.

Determination of dilution requirements. Mine Dusts: Types, sources, properties, effects and control, air borne dust.

Air Flows: Air flow in ducts and air ways. Nature of fluid flow, energy changes in fluid flow. Bernoulli's equation, head losses, and mine heads, Atkinson's equation, air power.

Heat and Humidity: Sources of heat in mines, physiological effects of heat and humidity on work capacity and efficiency of personnel.

Air Measurements: Temperature, atmospheric pressure, air density and air velocity.

Ventilation Survey: Mine resistances, series flow, parallel flow, natural splitting, controlled splitting

Principles of Natural Ventilation: Pressure source, characteristics, direction of intensity determination.

Ventilation Network Analysis: Iterative techniques for network analysis. Kirchoff laws

Economics of Air Flow: The basics of economic design, effect of airway characteristics on power consumption, design of air ways.

Mechanical Ventilation: Classification of mechanical ventilation devices, network analysis by computer, theory and design of fans, fan characteristics, fan laws, different types of fans.

Auxiliary Ventilation: Importance and methods of auxiliary ventilation, systems used for auxiliary ventilation.

Lab Outline:

1. a. Measurement of atmospheric pressure, dry and wet bulb temperatures of air using aneroid barometer and psychrometer.
   b. Determination of psychrometric and other properties of air from the measured data.
2. a. Determination of average air velocity in circular duct/ Tubing using pitot tube.
   b. Measurement of atmospheric pressure and temperature using aneroid barometer.
   c. Finding expressions for volume and mass flow rates and calculating them from the measured data.
3. Determining true air velocity from a vane anemometer calibrating it against a pitot tube. Finding the state of flow / Reynolds number. Drawing the velocity profile.

4. Determining the effect of misalignment of a pitot tube and vane anemometer to an air stream.
    a. Determining the characteristics of an axial fan with regard to the variation of pressure, power consumption and efficiency with quantity passed by the fan.
    b. Determining the effect on characteristics of running two similar fans in series.
    c. Determining the effect on characteristics of running two similar fans in parallel.
    d. Determining the effect on characteristics of running two different fans in series.
    e. Determining the effect on characteristics of running two different fans in parallel.
    f. Determining the effect on characteristics of running two similar fans in series and a different fan in parallel to them.
    g. Observing the smoke mixed helium gas layer on air in the layering apparatus in horizontal position.
    h. Observing the smoke mixed helium gas layer on air in the layering apparatus in an ascentional air flow.
    i. Observing the smoke mixed helium gas layer on air in the layering apparatus in a descentional air flow.

Recommended Text Books:

a. H. L. Hartman, Mine Ventilation and Airconditioning, 1997
b. McPherson, Subsurface Environmental Engineering, (Latest Edition).

Recommended Reference Books:

a. Pennman, Mine Ventilation
b. H. Rabia, Mine Environmental Engineering, (Latest Edition)
c. A. Roberts, Mine Ventilation
d. Abid. S. H TLR on Mine Ventilation. 2000. Ministry of Education, Pakistan.

Course title: **Senior Project Design**
Credit Hours: **0+6**
Prerequisites: **N/A**

Course Learning Outcomes (According to Bloom's Taxonomy):

1. (*Knowledge, Comprehension*) identify project/research problems; understand information and grasp meaning; translate knowledge into new context; use information, methods, concepts, and theories of fundamental topics in computer science in new situations;
2. (*Application and Evaluation*) apply computer science principles and practices to a real-world problem; demonstrate in-depth knowledge in

the area of the project they have undertaken; solve problems using required knowledge and skills; implement and test solutions/algorithms;
3. (*Analysis*) identify potential solutions/algorithms for the project problem; see patterns and modularize the problem, recognize hidden meanings and identify components, show proficiency in software engineering principles;
4. (*Synthesis*) create new ideas using the old ones; generalize from given facts in the project they undertake, relate knowledge from several areas in systematic scientific approach, predict and draw conclusions relevant to the project they undertake;
5. (*Team Work*) show evidence (group collaboration, regular meetings, email communications, significant knowledge and skills contributions, etc.) of working productively as an individual and in a team on a project that produces a significant software product;
6. (*Communications*) show evidence of competency in oral and written communications skills through oral presentations (project presentation, department seminar or conferences), technical reports and/or published research papers in conferences and/or journals;
7. (*Lifelong Learning*) use modern techniques, skills and tools necessary for computer science practices relevant to the project they undertake; use techniques in recent research papers to solve problems.

OPTIONAL COURSES

Course title: **Mining Laws**
Credit Hours: **2+0**
Prerequisites: **N/A**

Course Learning Outcomes (According to Bloom's Taxonomy):

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

Content List:

The Mines Act, 1923.
The Coal Mines Regulations, 1926.
The Metalliferous Mines Regulations, 1926.
The Mining Board Rules, 1951.
Electricity rules relating to the mines
The Consolidated Mines Rules, 1952.
The Competency Certificates Examination Rules, 1981.

The Central Rescue Station (Coal Mines) Rules, 1986.
Introduction to the Pakistan Mining Concession Rules, 2002.

Recommended Text Books:

a. M. Shafi and P. Shafi, Mining Labour Code, Bureau of Labour Publications, 2006 (Amended & Updated).
b. The Mining Concession Rules, 2002.
c. M. Amir Sohail, Electricity Laws in Pakistan, Khyber Law Publishers, Lahore, 1999 (Chapter-X)

Course title: **Gemology**
Credit Hours: 2+0
Prerequisites: N/A

Course Learning Outcomes (According to Bloom's Taxonomy):

1. Demonstrate basic knowledge of gemstones occurrence and mining
2. Demonstrate skills for identification of gemstones
3. Apply appropriate technique for value addition of a given gemstone

Content List:

Geology and exploration of gems, Gem producing countries of world, gem mining and its extraction, Gem storage, its proper identification and preventive measures of pilferage at mining sites, gem cutting and polishing techniques, identification techniques of gems for its quality. Gem pricing and grading according to prevailing international standards, Pakistani gems and its quality, pricing and marketing.

Lab Outline:

Based on theory

Recommended Text Books:

a. Peter G. Read, Gemology, 3rd Ed. 2005.

Recommended Reference Books:

a. Cally Hall, Gemstones, 1994
b. M. O'Donoghue, Gems, 6th Ed., 2006.

Course title: **Solution Mining**
Credit Hours: 2+0
Prerequisites: N/A

Course Learning Outcomes (According to Bloom's Taxonomy):

1. Explain the basic theory behind In-Situ Leaching (ISL)/Solution Mining (SM) techniques
2. Classify the mineral deposits suitable for SM/ISL based on their

physical properties
3. Analyze the effect of various SM/ISL techniques on environment
4. Design appropriate SM/ISL techniques and methods for a given deposit

Content List:

Introduction, scope and applications of solution mining

Physical and Chemical Amenabilities: Depth, hydrostatic pressure, permeability of the deposit, the chemical nature of mineralizations, their dissemination in the ore body in relation of natural flow channels

Laboratory and Field Testing: Selective dissolution of mineralizations, factors effecting economic viability, preferred directions of lixivant flows, lixivant containment and recovery issues, solution chemistry and side reactions, batch and column leach testing, geochemical conditions of the formation

Methods of Leaching and Equipment: Operating regimes (acidic or alkaline), well-field design, well-testing, production strategy, operating and performance parameters, process hydraulics, submersible pumps, filters, well-linings
Extraction Process: Ion-exchange: principles, resins, equipment. Solvent Extraction

Environmental Issues: Impact Assessment, waste treatment, land reclamation, prevention and treatment of contaminated water

Case studies of sulfur, copper, uranium, gold and silver.

Recommended Text Books:

a. R. W. Barlett, Solution Mining: Leaching and Recovery of Materials, 2nd Edition, 1998
b. W. J. Shlitt, D. A. Shock, Insitu Uranium Leaching and Ground Restoration. Society of Mining and Metallurgy, 1979

Recommended Reference Books:

a. SME Mining Engineering Handbook, Hartman (Editor), AIME, 1994

Course title: **Introduction to Remote Sensing and GIS**
Credit Hours: **2+0**
Prerequisites: **N/A**

Course Learning Outcomes (According to Bloom's Taxonomy):

1. Understand the principles of remote sensing, GIS and digital image processing
2. Apply remote sensing and GIS for mining and mineral exploration
3. Demonstrate ability to use commercial image processing and GIS software

Content List:

GIS Introduction, principles of GIS, Functional Subsystem, Raster Data Model, Vector Data Model, Attribute Data Model, Coordinate Systems Overview, Discrete Geo-referencing, Global Positioning Systems Overview, Projections and Transformations, Maps as Representations of the World, Data Transformation, Visualization of Spatial Data, Layers and Projections, Map Design Overlay Analysis, Spatial analysis, neighborhood function, Network and overlay analysis, buffering, Spatial Data Quality, Introduction to Remote Sensing-Basics of Remote Sensing and Photogrammetry, Data acquisition, image analysis, image classification, Sensor System, Platforms, Digital Image Processing, and Application etc with Case studies with use of software's to solve the geological problems.

Introduction to latest GIS software.

Recommended Books:

a. Chakraborty & Sahoo. Fundamentals of Geographic Information System. Published by Viva books, 2009.

Course title: **Mine water and dewatering Design**
Credit Hours: **2+0**
Prerequisites: **N/A**

Course Learning Outcomes (According to Bloom's Taxonomy):

1. Identify sources and effects of water entering in the mines
2. Demonstrate skills to predict and measure the pressure and capacity of underground aquifers
3. Apply prevention measures for mine water inflow
4. Design dewatering systems for a mine

Content List:

The Water Cycle: Processes, Equipotential Surfaces, Artesian Well, Residence Time.

Fundamentals of Fluid Flow: Darcy's Law, Specific Discharge and Hydraulic Gradient, Hydraulic Head and Fluid Potential, Hydraulic Conductivity, Permeability, Homogeneity and Anisotropy of Hydraulic Conductivity, Porosity & Void Ratio

Flow Nets: Piezometer and Piezometer Nests, Continuity Equation, Laws & Construction of Flow Nets

Water Table & Aquifers: Unsaturated Flow and Water Table, Moisture content, Negative Pressure heads and tensiometers, Perched and Inverted Aquifers, Aquifers and Aquitards, Steady State Flow and Transient Flow, compressibility and Effective Stress, Compressibility, Transmitivity, Storativity and Specific storage and Yield of Aquifers

Pumping Test: Transient Flow Equation, Radial Flow to a Pump, Pumping Test

Drainage: Reciprocating & centrifugal Pumps, Pumping Laws, Characteristic curves of a pump. Selection & Design of Drainage Systems for Mines, dewatering of mines. Water problems associated with mining.

Lab Outline:

1. Laboratory measurement of Parameter of Soil samples
    a. Hydraulic conductivity & Permeability
    b. Anisotropy & Homogeneity
    c. Grain Size Analysis, Porosity & Void Ratio
2. Pumping Test
    a. Measurement of aquifer properties through pumping test
b. Influence of Pumping on the aquifers
    c. Measurement of Storativity & Transmitivity of aquifers
3. Characteristic Curves of centrifugal pumps
4. Design of drainage and dewatering systems for mines

Recommended Text Books:

a. Allan Freez and Cherry, Ground Water, Prentice Hall Publishers, 1979
b. Robert Stefanko, Coal Mining Technology: Theory and Practice, 1983

Recommended Reference Books:

a. C W Fetter, Todd Rayne, Applied Hydrogeology, 3rd Ed., Macmillan Publishing Company, New York
b. Christopher Bise, Mining Engineering Analysis
c. H.M. Raghunath, Ground Water, 3rd Ed., New Age Publishing Company, 2007.

Course title: **Industrial Minerals**
Credit Hours: **2+0**
Prerequisites: **N/A**

Course Learning Outcomes (According to Bloom's Taxonomy):

1. Differentiate Industrial minerals from other Minerals
2. Understand the economic consideration of various industrial minerals
3. Implement strategies for efficient utilization of industrial minerals of Pakistan
4. Outline the significance of mineral based industries

Content List:

Introduction to Industrial minerals and brief geology, types of deposits, occurrences, exploration, mining, beneficiation, utilization and marketing of the following minerals:

Lime stone, silica sand, dolomite, magnesite, phosphate, barite, China clay, other clays, building stones: marble, limestone, granite, quartz, slate, sand-stone, soap stone, gypsum, evaporates, asbestos, fluorite and feldspar.

Recommended Text Books:

a. F. M Lea, *Chemistry of Cement and Concrete, 2004,* Butterworth-Heinemann.
b. A. M. Bateman, *Economic Mineral Deposits*, John Wiley & Sons, 1981
c. Mineral Directory of Pakistan – GSP Quetta.
d. Z. H. Syed, *Material of construction*

Recommended Reference Books:

a. Reports about Industrial minerals from GSP and other organizations.

Course title: **Finite Element Analysis**
Credit Hours: **3+1**
Prerequisites: **N/A**

Course Learning Outcomes (According to Bloom's Taxonomy):

1. Describe the general steps used in the FE methods to model problems in engineering
2. Apply conventional variational methods
3. Generate the governing Finite Element (FE) equations for systems governed by Partial Differential Equations (PDEs)
4. Develop stiffness matrices for spring, truss, beam and plane stress problems in 3D
5. Design safe design limits for mining structures

Content List:

Basic concepts of FEM

Introduction to variational methods of approximation: Ritz Method, The Method of Weighted Residuals

One-dimensional second order and fourth order equations: discretization, variational formulation, FEM formulation, Assembly, Imposition of boundary conditions, Post-processing of the solution

Isoparameteric elements and numerical integration

Two-dimensional second order equations involving multivariable equations: Plane elasticity, incompressible fluid flow problems

Computer implementation of FEM solutions

Recommended Text Books:

a. J. N. Reddy, An Introduction to Finite Element Method, McGraw Hill, 1993

b. Zienkiewicz, Finite Element Method, Butterworth-Heinemann; 6th Edition (March 19, 2000)

Recommended Reference Books:

a. Cook, Concepts and Applications of Finite Element Method, Wiley, 2001.

Course title: **Drilling Technology**
Credit Hours: 3+1
Prerequisites: N/A

Course Learning Outcomes (According to Bloom's Taxonomy):

1. Introduction to drilling for mining and petroleum industry
2. Functions of various components of drilling system
3. Types of drilling rigs and types of bit.
4. Basics of casing design and primary cementing,
5. Demonstrate skills for selecting suitable drilling techniques for different purposes

Content List:

1. Objectives of the subject- various purposes of drilling a borehole.
2. Brief introduction of the history and current state of the Rock drilling.
3. The various facets of drilling engineering and operations.
4. Basic rock drilling mechanism; working principles of various components of rig systems.
5. Drilling methods; classification of methods.
6. Field of drilling application; Mining purposes, sampling and core logging.
7. Types of drill bit and their selection.
8. Well drilling: On-shore, and off-shore drilling
9. Types of drilling fluids and their properties
10. Casing and cementing processes of wells
11. Factors affecting penetration rate
12. Drill cost calculations.
13. Blowout control (BOP)

Lab Outline: :

1. To measure the viscosity, gel strength and pH of mud.
2. Study of rotary drilling rig.
3. Study of cable tool percussion rig.
4. Study of wire line core barrel
5. Study of various types of bits

Recommended Text Books:

a. C. P. Chugh, Drilling Technology, 1985.
b. G. K. Pradhan, Ajoy K. Ghose, Drilling and blasting, MINTECH Publications, 1996.

Course title: **Strata Control/Mine Geotechnical Engineering**
Credit Hours: 2+0
Prerequisites: N/A

Course Learning Outcomes (According to Bloom's Taxonomy):

1. Assess the stability of underground openings in massive and discontinuous rock types
2. Use suitable instrumentation for monitoring ground movement
3. Analyze strata behavior above underground excavations
4. Design appropriate support (pillars, rock bolts etc.) for underground mines

Content List:

Design of gallery support: wooden sets, steel arches

Design of face support – concept of front and back abutment pressures in long wall faces

Design of section pillars, gate entry pillars, and barrier pillars

Pressure Arch Theory and Rock Bolting Systems and Design

Slope Stability Methods using Anchors and Wire Netting

Design and application of stowing systems

Subsidence prediction, prevention, control and remediation

Prediction and prevention of occurrence of rock bursts and coal bumps

Recommended Text Books:

a. Bieniawski, Strata Control, John Wiley & Sons, 1987
b. Syd S. Peng, Coal Mine Ground Control, John Wiley & Sons, 1978
c. Syd S. Peng, Surface Subsidence Engineering, Society for Mining Metallurgy; 1 edition (March 1, 1992)
d. Hoek and Bray, Rock Slope Engineering, CRC Press, 1981
e. Syd and Peng, Longwall Mining, John Wiley & Sons, 1984

Recommended Reference Books:

a. Holdings: Subsidence Engineer's Handbook, (Latest Edition)
b. FWA Rock Slope Engineering Course Manual

Course title: **Mineralogy and Petrology**
Credit Hours: **2+1**
Prerequisites: **N/A**

Course Learning Outcomes (According to Bloom's Taxonomy):

1. Understand basic crystallography with respect to 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

Content List:

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

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.

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.

Lab Outline:

1. Identification of igneous rocks using thin and polished section studies
2. Identification of sedimentary rocks using thin and polished section studies
3. Identification of metamorphic rocks using thin and polished section studies
4. Microscopic identification of minerals using thin and polished section studies
5. Chemical analysis of minerals using XRD
6. Chemical analysis of minerals using XRF
7. Chemical analysis of minerals using Atomic Absorption Spectrophotometer
8. Determination of mineral properties such as hardness, specific gravity, and refractive index.

Recommended Text Books:

a. Dana's Manual of Mineralogy, 21st Edition, Wiley, 1998
b. H. H. Read, Rutley's Manual of Mineralogy, 1981
c. Alfred Harker, Petrology for Students, General Books, 2009.

Recommended Reference Books:

a. Paul Kerr, Optical Mineralogy, McGraw-Hill, 1977.
b. D. Perkins, K. Henke, Minerals in Thin Sections, 2nd Ed. Prentice Hall, 2004.
c. W. D. Nesse, Introduction to Optical Mineralogy, Oxford University Press, 2003.

Course title: **Cement Technology**
Credit Hours: **2+0**
Prerequisites: **N/A**

Course Learning Outcomes (According to Bloom's Taxonomy):

1. Introduction to chemical composition of cement
2. Explain various steps during cement manufacturing process

Content List:

1 Overview of cement production
2 Raw materials used for cement manufacturing
3 Quarry operations
4 Quarry layout and design
5 Equipment and fleet selection for cement quarry operations
6 Loading and Haulage of raw material
7 History and trends in cement manufacturing
8 Raw mix design
9 Production scheduling of cement quarry operations
10 Optimization procedures and techniques cement quarry operations
11 Sustainable development and responsible mining
12 Introduction to software tools relating mine planning and design
13 Pyroprocessing and Cement Kiln
14 Mechanical aspects, Coolers, Thermodynamics, Cement grinding
15 Cement storage and handling, Material transport and conveying

Course title: **Applied Geology**
Credit hours: **2+1**
Prerequisite: **Pre-Engineering or Equivalent**

Course Learning Outcomes (CLOs):

After studying this course, the learners will be able to: -

1. Acquire knowledge about earth its history and the geological processes.
2. Understand the role of geology in the Mining Exploration.
3. Recognize and interpret geological structures and its impact on the development of Mining systems.
4. Identify minerals and rocks and to classify rocks types.
5. Assess sedimentary rocks potential as source, reservoir or seal rock.
6. Read and interpret different geological maps.
7. Solve geological problems using scientific techniques.

Content List:

1. Introduction to various branches of geology
2. Origin of earth and its place in universe
3. Interior of the earth and chemical composition of the earth's crust
4. Mountain building and valley formation

5. Drainage pattern and their types
6. Agents of weathering and erosion
7. Concepts of geological time and its scale.
8. Correlation techniques, isostasy and continental drift.
9. Theories of plate tectonics
10. Earth quakes and volcanism
11. Formation of rocks; sedimentary, igneous and metamorphic and minerals
12. Primary and secondary structures of sedimentary rocks
13. Determination of dip, strike, and thickness of beds.
14. Completion of outcrops and construction of cross sections.
15. Occurrence of mineral deposits in Pakistan.

Practicals:

1. Introduction of Minerals and Rocks.
2. Study of Moh's scale of hardness and identification of its minerals.
3. Study and identification of igneous rocks.
4. Study and identification of metamorphic rocks.
5. Study and identification of sedimentary rocks.
6. To study the different parts of Brunton Compass.
7. To measure the dip and strike of an inclined plane with the help of Brunton Compass.
8. To draw the cross-section of a contour map and show the drainage pattern of the area.
9. To determine the true dip value by the help of two apparent dips.
10. Three-point problem for measuring dip and strike if three outcrop are located on a contour map.
11. To calculate the thickness of beds.
12. To study various features on a Geological map.

Bibliography/References:

1. **Books:**
    a. Long, L. E., "GEOLOGY:" 14th edition, McGraw-Hill, New York, 2009.
    b. F. G. H. Blyth , M. H. De Freitas, "Geology For Engineers", Elsevier - Amsterdam, 1984
    c. K. M. Bangar, "Principles of Engineering Geology", Standard Publishers
    Distributors, 1995, New Delhi
    d. M. P. Billings, "Structural Geology", Prentice-Hall India, 1974, New Delhi
2. Journals/Periodicals:
    NIL
3. World Wide Web:
    NIL

Course Title: **Commercial Explosive Storage and Handling**
Credit Hours: **2+0**
Prerequisites: **N/A**

Course Learning Outcomes:

After the completion of the course the students will be able to:

1. Classify the explosive based on their chemistry, strength and use
2. Differentiate between general and permissible explosives used in mining
3. Explain the basic structural requirements for the commercial explosive magazines under the prevailing laws.
4. Explain the requirements for the safe transportation of commercial explosives under the prevailing laws
5. List the basic licensing requirements for use of commercial explosives in mines
6. Address the basic environmental hazards due to blasting

Content List::

ME/MS/MSc PROGRAM IN MINING ENGINEERING

INTRODUCTION

Energy is a key component in our everyday lives. A secure energy future requires a balance between environmental impact and affordable supply. Mining engineers are able to address and solve important issues that will lead to energy security and thus Mining engineers with graduate degrees are highly sought after by Mining industry worldwide.

Mining engineers have a future full of challenges and opportunities. They must develop and apply new technology to recover hydrocarbons from shale, tight sands, and onshore and offshore oil and gas fields. They must also devise new techniques to recover hydrocarbon left in the ground after application of conventional producing techniques.

OBJECTIVES

The objective of this program is to educate graduates to solve problems related to exploring and recovering subsurface hydrocarbon resources. The program allows students to take courses in a broad range of areas, including drilling engineering, formulation evaluation, Mining economics, production engineering, and reservoir engineering.

At the end of the course of studies, the students will be able to analyse hydrocarbon deposits both for quantity of reserves and production capacity, and will identify the best strategies for producing oil and/or natural gas based not only on technical feasibility but also economic and environmental sustainability.

ELIGIBILITY CRITERIA

Graduates with BE/BS/BSc degree in the field of Mining Engineering, Chemical Engineering and other relevant engineering disciplines are eligible to apply for admission. Candidates accepted for M.E/MS/MSc. programme in Mining engineering possessing engineering degree other than Mining engineering, will be allowed to make up deficiencies by taking up to six (06) credit hours of non-credit courses. This will be counted as part of minimum requirements to the M.E/MS/MSc. programme.

DESIGN OF COURSES

The courses are designed by taking into account the demands of National and International Mining industry. The leading universities courses were considered in designing of the course content.

FRAMEWORK FOR ME/MS/MSc PROGRAM IN MINING ENGINEERING

Compulsory or Core Courses (Group - A):

Sr. No.	Course Title	Credit Hours
1.	Loss Control & Safety in Mining	3
2.	Advanced Mineral Processing	3
3.	Environmental Controls in Mining	3
4.	Advanced Rock Mechanics	3
5.	Advanced Mine Ventilation Networks & Environment	3
6.	Computer Application in Mining & Advanced Programming	4
7.	Mineral Process Design	3
8.	Advanced Surface Mine Design	3
9.	Rock Slope Engineering	3
10.	Mine Environmental Control for Blasting	3
11.	Loss Control & Safety in Mining	3
12.	Advanced Mineral Processing	3
13.	Environmental Controls in Mining	3
14.	Technical Report Writing and Research Methodology / Research Methods and Techniques	3
15.	Advanced Drilling and Blasting	3
16.	Spatial Data Analysis & Reserve Estimation	4

Elective Courses (Group B.):

Sr. No.	Course Title	Credit Hours
1.	Mine Administration & Labor Relations	3
2.	Hazards Waste Management	3
3.	Coal Preparation	3
4.	Operations Research	3
5.	Hydrometallurgy	3
6.	Fine Particle Science and Processing	3
7.	Analysis of Deformed Geological Structures	3
8.	Subsidence Engineering	3
9.	Mine System Simulation	3
10.	Surface Coal Mine Design	3
11.	Advanced Excavation Engineering	3
12.	Project Management	3
13.	GeoChemistry	3
14.	Dimension Stone Mining	3
15.	Special Studies (Individual Studies on Selected Topics)	3
16.	Mine Cost Analysis	3
17.	Rock Mechanics in Mine Design	3
18.	Mineral Process Selection and Design	3
19.	Advanced Geostatistics for Mineral Resource Estimation	3

Research Work (compulsory)

1.	Master Thesis	6

Note:

1. Every student must take minimum 12 credit hours of coursework from Group A.
2. Practical marks where applicable comprise of 60% for sessional work and 40% for Viva.