Minutes of the 23rd Meeting of the Board of Studies Faculty of Engineering Sciences held on 16th March, 2021 through VLC

Bahria University Islamabad

Contents

Minutes of the 23rd Meeting of Faculty Board of Studies Engineering Sciences held on 16th Mar, 2021 through Video Conferencing

Attendance:

BUIC

Prof. Dr. Atif Raza Jafri	Dean ES	Chair
Snr. Prof. Dr. Said Akbar Khan	HoD(E&ES)	Member
Snr. Assoc. Prof. Dr. Muhammad Muzammal	HoD(CS)	Member
Snr. Assoc. Prof. Dr. Awais Majeed	HoD(SE)	Member
Snr. Asst. Prof. Dr. Shahzad Hassan	HoD(CE)	Member
Snr. Asst. Prof. Dr. Junaid Imtiaz	HoD(EE)	Member

BUKC

Snr. Assoc. Prof. Dr. Sohaib Ahmed	Associate Dean	Member
Assoc. Prof. Dr. Syed Safdar Ali	HoD(CS)	Member
Snr. Asst. Prof. Dr. Salma Hamza	HoD (E &ES)	Member
Snr. Asst. Prof. Dr. Osama Rehman	HoD(SE)	Member
Snr. Asst. Prof. Dr. Najam M. Amin	HoD(EE)	Member
Snr. Asst. Prof. Dr. Shoaib Mughal	HoD(CE)	Member

BULC

Snr. Asst. Prof. Dr. Khawaja Qasim Maqbool	HOD(CS)	Member

Proceedings

Preliminaries

FBoS-ES meeting took place on 16th March, 2021, with the quorum complete, the proceedings commenced at 1030 hrs, with recitation from the Holy Quran.

In his opening remarks, the Chair stressed the importance for participation in the proceedings while staying focused on the point under deliberation.

New Items:

Item 2301: Framework for PhD Programs offered in FoES	
Sponsor: Dean (ES)	Referral Authority:

Summary of the Case

- HEC has issued new PhD 2021 policy for all Higher Education Institutes to align their postgraduate programs with this new Policy.
- Dean ES directed all departments to present working paper on subject policy.
- Annexure-1.

Discussion

Working papers were thoroughly deliberated in 23rd meeting of FBoS-ES and a framework has been finalized in light of HEC new PhD policy which is attached at appendage 2301. The detailed working for each PhD program shall be deliberated after the approval of proposed PhD framework. Detailed Roadmap of each PhD program shall be presented in next ACM for approval.

Decision 2301

The case to be forwarded for the approval in ACM.

Item 2302: Revised Roadmaps of MS Environmental Sciences, MS Geophysics and MS Geology	
Sponsor: HOD (E&ES) BUIC	Referral Authority: DBOS E&ES BUIC

Summary of the Case

- E&ES BUIC presented revised roadmaps of three MS programs which were deliberated in 23rd meeting of FBoS-ES in detail.

Discussion

The sponsor presented and reiterated the agenda point, after detailed discussion and deliberation the house suggested few changes which were incorporated. The Revised Roadmap of MS Geology, MS Geophysics and MS Environmental Sciences programs is attached at Appendage 2302

Decision 2302

The case to be forwarded for the approval in ACM.

Item 2303: Addition of Elective Courses in BEE Roadmap	
Sponsor: HoD (EE) BUIC & BUKC	Referral Authority: DBOS EE BUIC & BUKC

Summary of the Case

- Following new elective courses are suggested to be included in BEE roadmap by HoD EE BUIC to make it at par with current technology advancements:
    - Cryptography and Network Security (Elective: Telecom/ Electronics/ Power)
    - Introduction to Quantum Computing (Elective: Telecom/ Electronics/ Power)
    - Introduction to Quantum Computing Lab (Elective: Telecom/ Electronics/ Power)
    - Introduction to Block chain (Elective: Telecom/ Electronics/ Power)
    - Robotics (CEN 458) (3 Credit Hours) (Approved in 26th ACM)
    - Robotics Lab (CEL 458) (1 Credit Hour) (Approved in 26th ACM)
    - Cyber Security (ITC 411) (3 Credit Hours) (Approved in 31st ACM)
- HoD EE BUKC requested to add lab component of 1 credit hour to existing 3 credit hour course of Microelectronics Technology (Course Code: EEN 471) due to availability of requisite software

tool. This lab component was erroneously offered during Fall-2020 semester. Hence, expostfacto approval may please be given to add lab component in Microelectronic Technology course.

Discussion:

- The sponsor presented and reiterated the agenda point, after detailed discussion and deliberation the house suggested few changes which were incorporated and following courses are recommended to be included in BEE roadmap (the details are given at appendage 2303):
    - Course Code: EET 462, Course Title: Cryptography and Network Security, Credit Hour: 3, Specialization: Telecommunication
    - Course Code: EET 459, Course Title: Introduction to Block chain, Credit Hour: 3, Specialization: Telecommunication
    - Course Code: EEL 470, Course Title: Microelectronics Technology Lab, Credit Hour: 1, Specialization: Electronics wef Fall-2020

Following already available courses in BU course code book also to be added in electives of BEE Road map

- Course Code: CEN 458, Course Title: Robotics, Credit Hour: 3, Specialization: Electronics
- Course Code: CEL 458, Course Title: Robotics Lab, Credit Hour: 1, Specialization: Electronics
- Course Code: ITC 411, Course Title: Cyber Security, Credit Hours: 3, Specialization: Telecommunication

Decision 2303:

The case to be forwarded for the approval in ACM.

Item 2304: Uniform CBT for Bachelor's Degree in Undergraduate Engineering and Computing Programs

Sponsor: HOD (EE) BUIC — Referral Authority: DBOS EE BUIC

Summary of the Case

- Currently the entry tests (CBT) for undergraduate engineering programs and undergraduate computing programs vary slightly. The CBT of computing programs contains the sections of Mathematics, English and Quantitative Analysis whereas the entry test of engineering programs contains the section of Physics in addition to Mathematics, English and Quantitative Analysis.
- This difference in the CBT restricts the applicant of computer science (if not selected in CS department) to apply for Engineering programs even if he/she fulfills the criteria to take admission in engineering program.
- By making the uniform CBT, those not fall in merit list of computing programs will be eligible to take admission in Engineering Programs.
- EE BUIC presented the agenda which was deliberated in 23rd meeting of FBoS-ES in detail.
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Discussion

The sponsor iterated and presented the agenda item, which was deliberated by the house in detail. A uniform CBT scheme for engineering and computing programs is attached at appendage 2304.

Decision 2304

The case to be forwarded for the approval in ACM.

Item 2305: Corrections in Prerequisites of Electives courses for BEE Roadmap (Ref 32nd ACM) and BCE Roadmap (Ref 31st ACM)

Sponsor: HOD EE & CE BUIC — Referral Authority: DBOS EE & CE BUIC

Summary of the Case

- Some inconsistencies have been identified in the prerequisites of some courses offered in Telecommunication and Electronics specializations in the Roadmap of BEE which was approved in 32nd ACM. An alignment is required
- Following changes are presented by HoD EE BUIC and are recommended by FoES for implementation after approval from ACM:

Course	• Current Prerequisite (Telecommunication)	• Current Prerequisite (Electronics)	• Recommended Prerequisite •
Digital Image Processing (CEN 444) (3+0)	• Computer Communication & Networks (CEN 223)	• Digital Signal Processing (EEN 325)	• Signals and systems (EEN 313)
FPGA-Based Systems Design (CEN 441) (3+1)	• Digital Signal Processing (EEN 325)	• Digital Logic Designs (CEN 120)	• Digital Logic Designs (CEN 120)
Linear Integrated Circuits and Applications (EEN 469) (3+1)	• Digital Logic Designs (CEN 120)	• Electronic Devices and Circuits (EEN224)	• Electronic Devices and Circuits (EEN224)

- Similarly following changes in pre-requisite in BCE roadmap, approved in 31st ACM (Agenda Item: 3104), are presented by HoD CE BUIC and are recommended by FoES for implementation after approval from ACM:

• Course	• Current Prerequisite (Electronics)	• Recommended Prerequisite •
• Signals and systems (EEN 313)	• GSC-220	• None

Discussion
The sponsor presented the agenda point which was deliberated in detail by the house. The house also suggested few changes which are incorporated.

Decision 2005
The case to be forwarded for the approval in ACM.

Item 2306: Addition of Management Science Elective Course in BS(CS) and BS(IT) Programs
Sponsor: HOD(CS) BUKC Referral Authority: DBOS CS BUKC

Summary of the Case

1. Maritime education aim is to provide a wide range of talent in the ship building industry, fisheries, maritime information systems, port, crew training and a wide range of maritime services such as maritime finance, maritime security and delivery services.
2. To enhance maritime education in Pakistan, Bahria University has introduced BS programs in Maritime Business and management to open doors for new entrants and maritime professionals. With the advancement of technologies, the use of computing has been increased in every field of life including Maritime sector.
3. Introducing a course of related to maritime industry in BS(CS) and BS(IT) curriculum will offer the diversity to the student to apply themselves in different area of maritime field.
4. After deliberation in 23rd FBoS, it was mutually decided to add this course as management science elective in BS(CS) and BS(IT) programs.

S. No	Course Code	Course Title	Credit Hours
1	MTM-101	Introduction to Maritime Industry	3+0

Discussion

HoD CS BUKC presented the agenda point which was deliberated in detail by the house.

Decision 2306

The case for approval of addition of "Introduction to Maritime Industry" in management electives of BSCS and BSIT roadmap to be forwarded for the approval in ACM.

Item 2307: Courses Deviations in BS (Environmental Sciences) Roadmap

Sponsor: HOD (E&ES) BUKC Referral Authority: DBOS E&ES BUKC

Summary of the Case

1. A combined roadmap for BS (ES) and BS (Geo-Physics) was approved in 31st ACM (Agenda Item 3144) wef Fall 2018.
2. Multiple deviations from approved roadmap have been made by former head of E&ES department, Dr Syed Shahid Ali while offering the courses. Dr. Shahid implemented it because there was no intake in BS (Geo-Phy) and the 31st ACM roadmap was designed only for combine program of BS (ES) and BS (Geo-Phy) running in the department. The afore-mentioned reason is not valid. Moreover, HoD does not have the right to deviate from the decisions of ACM. However, at BUIC, 31st approved roadmap of BS-ES is being followed.
3. The comparison of semester wise courses in 31st ACM approved roadmap and the courses actually offered are given in (Annex-7).
4. Although the overall credit hours are not changed by this deviation, following anomalies and their impacts are stated below:

a. Students of Spring-19 to Fall-20 intake have been affected from this deviation in terms of sequence of course offering which can impact the honor and award aspect.

b. One course titled "(HSS 201) Introduction to Anthropology" which was not part of road-map was taught to student of Spring-19 and Fall-19 students which will impact the issuance of transcript and degree.

Decision 2307

In view of the above, the following is recommended for approval in ACM:

a. The deviation made to each intake may not affect the honors and awards of students

b. The course titled 'HSS 201 Introduction to Anthropology' be added to the roadmap as this was the course offered to students in Fall 2020. Revised Road Map is attached at appendage 2307.

Item 2308: Launch of PhD Computer Science (CS) program at BULC

Sponsor: HOD (CS) BULC Referral Authority: DBOS CS BULC

Summary of the Case

1. Mock audit of CS programs at BULC was carried out on 24-25 November, 2020.
2. In corrective action plan-II (item-7), HoD CS and Dean (ES) were given responsibility to start the PhD (CS) at BULC to be at par with other campuses and increase the research output.
3. HoD CS presented the work related to launch of PhD (CS) in 23rd FBoS (ES) meeting. Following aspects were discussed in detail and finalized:
    a. The eligibility criteria, duration, curriculum etc. shall be as per already approved PhD (CS) roadmap in 31st ACM (agenda: 3105).
    b. Names of following three PhD FMs shall be sent to HEC to meet minimum faculty requirement:
        i. Dr. Muhammad Asim Qureshi (Snr. ASP) (HEC Approved Supervisor)
        ii. Dr. Abdul Hafeez (Snr. AP) (HEC Approved Supervisor)
        iii. Dr. Iram Noreen (Snr. AP) (HEC Approved Supervisor)

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Discussion

HoD CS BUKC presented the agenda point which was deliberated in detail by the house. The house agreed to launch PhD-CS w.e.f Fall-2021 subject to HEC approval.

Decision 2308

New program proposal is attached at appendage 2308. The case to be forwarded for the approval in ACM.

Item 2309: Alignment of Department vision and Program mission with university vision and mission

Sponsor: HOD (EE) BUIC Referral Authority: DBOS EE BUIC

Summary of the Case

Bahria University Vision and Mission was recently revised and approved from BoG in July 2020. Each department is directed to ensure the alignment of its vision and mission with the revised BU Vision and Mission through respective DBoS and FBoS. In reference to letter no. BU-HO/DQA/2020/L/008, the CS Department's Vision and Mission statements is revised accordingly..

Discussion

HOD EE BUIC presented the agenda item while rest of the house suggested few changes which were later incorporated by the sponsor.

Decision 2309

The mapping of departmental vision and mission are approved and attached at appendage 2309.

Item 2310: Alignment of Department vision and Program mission with university vision and mission

Sponsor: HOD (E&ES) BUIC Referral Authority: DBOS E&ES BUIC

Summary of the Case

Bahria University Vision and Mission was recently revised and approved from BoG in July 2020. Each department is directed to ensure the alignment of its vision and mission with the revised BU Vision and Mission through respective DBoS and FBoS. In reference to letter no. BU-HO/DQA/2020/L/008, the CS Department's Vision and Mission statements is revised accordingly.

Discussion

HOD EE BUIC presented the agenda item while rest of the house suggested few changes which were later incorporated by the sponsor.

Decision 2310

The mapping of departmental vision and mission are approved and attached at appendage 2310.

Item 2311: Alignment of Department vision and Program mission with university vision and mission

Sponsor: HOD (SE) BUIC Referral Authority: DBOS SE BUIC

Summary of the Case

Bahria University Vision and Mission was recently revised and approved from BoG in July 2020. Each department is directed to ensure the alignment of its vision and mission with the revised BU Vision and Mission through respective DBoS and FBoS. In reference to letter no. BU-HO/DQA/2020/L/008, the CS Department's Vision and Mission statements is revised accordingly.

Discussion

HOD SE BUIC presented the agenda item while rest of the house suggested few changes which were later incorporated by the sponsor.

Decision 2311

The mapping of departmental vision and mission are approved and attached at appendage 2311.

Item 2312: Alignment of Department vision and Program mission with university vision and mission

Sponsor: HOD (CE) BUKC Referral Authority: DBOS CE BUKC

Summary of the Case

Bahria University Vision and Mission was recently revised and approved from BoG in July 2020. Each department is directed to ensure the alignment of its vision and mission with the revised BU Vision and Mission through respective DBoS and FBoS. In reference to letter no. BU-HO/DQA/2020/L/008, the CS Department's Vision and Mission statements is revised accordingly.

Discussion
HOD CE BUKC presented the agenda item while rest of the house suggested few changes which were later incorporated by the sponsor.
Decision 2312
The mapping of departmental vision and mission are approved and attached at appendage 2312.

Item 2313: Alignment of Department vision and Program mission with university vision and mission
Sponsor: HOD (SE) BUKC Referral Authority: DBOS SE BUKC

Summary of the Case
Bahria University Vision and Mission was recently revised and approved from BoG in July 2020. Each department is directed to ensure the alignment of its vision and mission with the revised BU Vision and Mission through respective DBoS and FBoS. In reference to letter no. BU-HO/DQA/2020/L/008, the CS Department's Vision and Mission statements is revised accordingly.

Discussion
HOD SE BUKC presented the agenda item while rest of the house suggested few changes which were later incorporated by the sponsor.
Decision 2313
The mapping of departmental vision and mission are approved and attached at appendage 2313.

Item 2314: Adoption of New FYP Policy
Sponsor: Associate Dean ES Referral Authority: FYP Policy Committee

Summary of the Case
Dean (ES) made FYP Policy Committee with Assoc. Dean (ES) as its chair. Committee presented the FYP policy after due deliberation.
Discussion
FYP policy was thoroughly deliberated in 23rd meeting of FBoS-ES and finalized FYP policy is attached at appendage 2314.
Decision 2311
The FYP policy is approved and attached at appendage 2314.

Closing of the Meeting
There being no further points, the Chair brought the meeting to close, thanking the participants for their wholehearted participation in both sessions.

Prof. Dr Atif Raza Jafri
Dean (ES), Head FBoS

Distribution:

BUHQ:	Rector, Pro-Rector, Registrar DAA
BUIC:	DG BUIC, DIC HOD(EES), HOD(EE), HOD(CS), HOD(SE), HOD(CE)
BUKC:	DG BUKC, DKC HOD(EES), HOD(EE), HOD(CS), HOD(SE), HOD(CE)
BULC:	DLC, HOD(CS)

April, 2021

Appendages:

Appendage 2301

PhD Framework for BSEAS in Light of HEC PhD Policy – 2021

Relevant Paragraph of HEC policy	Phase	Admission after 18 Year Education from relevant domain	Admission after 16 Year Education (Relevant Domain)	Admission after 16 Year Education (Non-Relevant Domain)
Section 3.4	Eligibility Criteria	Minimum CPGA = 3.0	Minimum CPGA = 3.0	Minimum CPGA = 3.0
Section 3.5	Admission Test	- GAT Subject - Passing criteria ○ 70% marks in BU test or 60% marks in testing services exam (GRE/NTS)	- GAT General - Passing criteria ○ 70% marks in BU test or 60% marks in testing services exam (GRE/NTS)	- GAT General - Passing criteria ○ 70% marks in BU test or 60% marks in testing services exam (GRE/NTS)
Section 3.6	Admission Interview	Evaluation of Statement of Purpose (Research Proposal) and admission interview performance	Evaluation of Statement of Purpose (Research Proposal) and admission interview performance	Evaluation of Statement of Purpose (Research Proposal) and admission interview performance
N/A	Registration in Deficiency Courses	NA	NA	- Up to 30 Credit Hrs as per recommendations of admission committee. - To be given provisional admission - Pass the deficiency courses by getting at least 60% marks

				in each registered subject. - Result with Pass/Fail status - Maximum two years to complete the deficiency courses - Time duration to complete deficiency course not to be counted towards overall program duration
Section 4.2	Course Work	Min. 24 credit hours with 3.0 CGPA (50% course waiver as per HEC policy) (Minimum Time: 1.5 Year) (Maximum Time: 2.5 Years)	48 credit hours with 3.0 CGPA* (Minimum Time: 3 Year) (Maximum Time: 4 Years)	48 credit hours with 3.0 CGPA* (Minimum Time: 3 Year) (Maximum Time: 4 Years)
Section 4.3	Comprehensive	Two attempts allowed within one year of completion of course work for major & minor comprehensive exam.		
Section 4.4	Proposal Defence	Two attempts allowed within maximum period of one year from the date of having passed the Comprehensive Examination.		
	Research Work	36 Credit Hrs	36 Credit Hrs	36 Credit Hrs
Section 4.4	Internal Thesis Defence	6th Year	7th Year	7th Year
Section 4.4	Final Evaluation (as per HEC section 4.4 b)	7th Year	8th Year	8th Year

*In cases the scholar willing to quit, a lest 30 credit hr course work is required to be completed to issue MS degree in relevant domain.

Appendage 2302

Master of Science (MS) Environmental Sciences
Roadmap Amendments

Description	Existing	Proposed
Total number of credit hours	30	30

	Existing Roadmap	Proposed Roadmap
Semester	**Credit Hours (Courses)**	**Credit Hours (Courses)**
1	12 CH (2 Compulsory + 2 Electives)	12 CH (4 Compulsory)
2	12 CH (2 Compulsory + 2 Electives)	12 CH (4 Electives)
3	03 CH (Thesis)	03 CH (Thesis)
4	03 CH (Thesis)	03 CH (Thesis)
Total	30	30

Compulsory Courses

Course code	Course Title	Credit Hours	Proposed
ENV 531	Environmental Analytical Techniques	3	Contents Revision
~~ENV 532~~	~~Advances in Environmental Science~~	3	Course Removed
ENV 540	Climate Change Adaptation and Mitigation	3	New Course added
ENV 502	Environmental Management	3	Contents Revision
ESC 701	Research Methodology	3	Contents Revision

Elective Courses with Title/Content Revision

Course code	Course Title	Credit Hours	Proposed
ENV 530	Environmental Biotechnology	3	Contents Revision
ENV 503	Energy and Environment	3	Contents Revision
ENV 520	Solid and Hazardous Waste Management	3	Contents Revision
ENV 513	Health, Safety and Environment	3	Contents Revision
ENV 515	Environmental Risk Assessment	3	Contents Revision
GEO 520	Hydrochemistry and Groundwater Pollution	3	Contents Revision
ENV 509	Population Dynamics and the Environment	3	Contents Revision
ENV 510	Environmental Auditing	3	Contents Revision
ENV 511	Environmental Economics	3	Contents Revision
ENV 537	Environmental Engineering	3	Contents Revision
ENV 514	Remote Sensing and GIS Applications in Environment	3	Contents Revision
ENV 518	Watershed Management	3	Contents Revision
ENV 519	Epidemiology	3	Contents Revision
ENV 521	Marine Pollution	3	Contents Revision

ENV 505	Environmental Policies and Laws	3	Contents Revision
ENV 533	Advanced Environmental Chemistry	3	Contents Revision
GEO 528	Groundwater Modeling	3	Contents Revision
ENV 504	Environmental Impact Assessment	3	Contents Revision
ENV 522	Disaster Management	3	Contents Revision
ENV 507	Sustainable Development	3	Contents Revision
ENV 541	Advances in Plant Ecology	3	New course added
~~ENV 523~~	~~Climate Change~~	3	Course removed
~~ENV 508~~	~~Environmental Sociology~~	3	Course removed
~~ENV 534~~	~~Advanced Environmental Microbiology~~	3	Course removed
~~ENV 535~~	~~Freshwater Ecology~~	3	Course removed
~~ENV 536~~	~~Advanced Environmental Geology~~	3	Course removed
~~ENV 512~~	~~Project Management~~	3	Course removed
~~ENV 516~~	~~Wildlife, Forestry and Wetland Management~~	3	Course removed
~~ENV 524~~	~~Air and Noise Pollution~~	3	Course removed

Master of Science (MS) Environmental Sciences
New Roadmap

Semester	Credit Hours (Courses)
1	12 CH (4 Compulsory)
2	12 CH (4 Electives)
3	03 CH (Thesis)
4	03 CH (Thesis)
Total	30

Compulsory Courses

Course code	Course Title	Credit Hours
ENV 531	Environmental Analytical Techniques	3
ENV 540	Climate Change Adaptation and Mitigation	3
ENV 502	Environmental Management	3
ESC 701	Research Methodology	3

Elective Courses

Course code	Course Title	Credit Hours
ENV 530	Environmental Biotechnology	3
ENV 503	Energy and Environment	3
ENV 520	Solid and Hazardous Waste Management	3
ENV 513	Health, Safety and Environment	3
ENV 515	Environmental Risk Assessment and Management	3
GEO 520	Hydrochemistry and Groundwater Pollution	3
ENV 509	Population Dynamics and the Environment	3
ENV 510	Environmental Auditing	3
ENV 511	Environmental Economics	3
ENV 537	Environmental Engineering	3
ENV 514	Remote Sensing and GIS Applications in Environment	3
ENV 518	Watershed Management	3
ENV 519	Epidemiology	3
ENV 521	Marine Pollution	3
ENV 505	Environmental Policies and Laws	3
ENV 533	Advanced Environmental Chemistry	3
GEO 528	Groundwater Modeling	3
ENV 504	Environmental Impact Assessment	3
ENV 522	Disaster Management	3
ENV 507	Sustainable Development	3
ENV 541	Advances in Plant Ecology	3

COURSE CATALOGUE

Course Code	**ENV 540**
Course Title	**Climate Change Adaption and Mitigation**

Course Outline:

Climate Change, Cause & Effect of Climate Change, Climate Change Policy, Impacts of Climate Change in Pakistan, Green Economy, Carbon Footprint, Technological Development and Changing climate, Climate Change matters, Present rapid warming, Projection of future climate change, Uncertainty in climate change projections, Climate change impacts-reasons for concern, Impacts on natural systems, societal systems, human health and comforts, Reactions and attitudes to climate change: Adaptation, Mitigation options: increased energy efficiency, fuel substitution, nuclear power, hydropower, solar energy, wind power, biomass energy, tidal, wave and geothermal energy, hydrogen economy, changes in infrastructure and behavior.

Course Aims and Objectives:

The objective of this course is to provide a wide-ranging understanding on the impacts of climate change on society, understanding of adaptation and mitigation options in relation to climate change.

Course Outcomes:

Students will be able to learn the various mitigation and adaptation measures for climate change problem.

Reference Books/Materials:

1) William James Burroughs (2017) Climate change: A Multidisciplinary Approach, Cambridge University Press, Cambridge, UK.
2) Sharon L. Spray, Karen Leah McGlothlin, (2012) Global climate change, Rowman& Littlefield, Maryland, USA
3) Horace M. Karling, (2010) Global climate change, Nova Publishers, New York, USA

Course Code	**ENV 535**
Course Title	**Advances in Plant Ecology**

Course Outline:

Global aspects of plant ecology. Life history strategies of plants, survival and extinction. Plant population dynamics: Species richness, vegetation dynamics, fine–scale to large–scale dynamics. Leaf Energy Budgets: Effects of Radiation and Temperature. Life Cycles: annuals and perennials, environmental influences and plant adaptations. Biotic Influences: symbiotic associations, pathogenicity, parasitic associations and carnivory. Ecological Biochemistry: allelopathy and defense against herbivores. Plant invasions and its threats of plant diversity. Conservation, management and restoration of threatened plant communities.

Course Aims and Objectives:

This course is designed to update the students about recent developments in plant ecology and physiological modifications with reference to environment, its conservation and management.

Course Outcomes:

Students will be able to learn the various conditions that results in species extinction and also different conservation measures.

Reference Books/Materials:

1) Vegetation Ecology Ed. Maarel, ED. Blackwell Publishing, Oxford, UK. 2015.
2) Introduction to Plant Population Biology. Silvertown, J. & Charlesworth, D. Blackwell Publishing. Oxford UK. 2016.
3) Plant Ecology. Shulze, E.D; Beck, E & Muller-Hohenstein, K. Springer, Berlin. 2017.

Course Code	**ENV 510**
Course Title	**Environmental Auditing**

Course Outline:

Priority topics in environmental auditing, corporate auditing, product auditing and understanding the role of standards for environmental assessment and environmental management systems. Introduction to Environmental Auditing, types of audit and audit management systems, the Legal Context, Preaudit activities, audit specifications, obtaining information, Emissions and Other Impacts, Resource Use and Waste Minimization, checklists, open meeting, Corporate Auditing: Procedures and Methods, evaluation and audit results. Audit report writing, Environmental Impacts and Performance, Lifecycle Assessment, Sustainable Products and Services 'Standards' and Reporting

Course Aims and Objectives:

This module is intended to provide a broad understanding of environmental auditing, including an understanding of the increasing importance of corporate social responsibility and the use of standards for environmental management by companies. The legal and procedural context is focused with international standards and such those established by the International Organization for Standardization (ISO) or international labelling.

Course Outcomes:

After completing this module student should be able to define environmental auditing and describe the main components of the environmental auditing process, know the methods for auditing specific environmental issues associated with the activities of an organization and product/service. Understand key principles underpinning a range of environmental management tools and techniques, assess critically the use and application of environmental auditing and management tools.

Reference Books/Materials:

1) Humphrey N, Hadley M (2000) Environmental Auditing. Palladian Law Publishing Ltd, Bembridge, Isle of Wight.
2) Dagg S (2005) C108 Environmental Auditing. Module prepared for the Distance Learning Programme, Imperial College London.
3) Brady J (2011) The response of organizations. In: Brady J, Ebbage A, Lunn R (eds) Environmental Management in Organizations: The IEMA Handbook, 2nd edn. Earthscan, London, pp. 251–260

Course Code	**ENV 530**
Course Title	**Environmental Biotechnology**

Course Outline:

Introduction to biotechnology, Tools in environmental biotechnology, fundamentals of biological interventions, Recombinant DNA Technology, Genetic manipulations, GMOs: Release and Regulations, environmental applications of GMOs, biosafety concerns of GMOs, bio-strategies for pollution control, bioremediation, phytoremediation, biofilm, Biomarkers, Biosensor, Bioreactors. Ethic and legal problems in creations and use of transgenic organisms.

Course Aims and Objectives:

This course will provide sound technical foundation for using biotechnology in solving environmental issues and cleanup of the polluted environments.

Course Outcomes:

After completion of this course, students will be able to understand the significance, and application of biotechnology in the environment.

Reference Books/Materials:

1) Environmental Microbiology. 2ndEdition. 2010. Edited by Ralph Mitchell and Ji-Dong Gu. John Wiley & Sons, Inc., Hoboken, New Jersey.
2) Environmental Biotechnology: Concepts and Applications, Hans-Joachim, J. and Josef, W. (ed.). Wiley-VCH Verlag, Germany, 2005.
3) Biotechnology, Smith, J.E., 5thEd. Cambridge University Press, New York, USA, 2009.
4) National Biosafety Guidelines. National Biotechnology Commission, Government of Pakistan. 2005.
5) Environmental Biotechnology: Theory and Application. Gareth M. Evans and Judith C. Furlong. John Wiley & Sons Ltd, The Atrium, Southern
6) Gate, Chichester, West Sussex PO19 8SQ, England, 2003.

Course Code	**ENV 533**
Course Title	**Advanced Environmental Chemistry**

Course Outline:

Chemistry of atmosphere, Major layers in atmosphere, temperature changes in the atmosphere, units to describe atmospheric chemistry, chemical reactions in the atmosphere sources and effects of following pollutant on human health Carbon dioxide, Nitrogen oxides, Sulfur dioxide, Volatile organic compounds, automobile pollutants, Industrial smog, Photochemical smog, production of hydroxyl radical, their reaction with hydrocarbons, Indoor air pollution various indoor air pollutants, particulates, chemistry of ground level air pollution. Production of ozone in the stratosphere catalytic destruction of ozone, Hydroxyl Radical cycle, NO cycle, the chlorine cycle, Null cycles, Effects of ozone depletion on human health and environment, Green chemistry, its principles, Water pollution, Types of water pollutants oxidation Reduction reactions in aqueous systems. Suspended solids and sediments, Dissolved solids. Toxic organic compounds, pesticides, organochlorine insecticides, carbamates. Accumulation in biological systems. Biomagnification and Biodegradation. Toxic heavy metals and their Bioaccumulation.

Course Aims and Objectives:

This course is designed to provide knowledge about different chemical process occurring in the environment.

Course Outcomes:

Students will be able to learn various physical and chemical methods to minimize pollution and adverse effects of various pollutants on human health and toxicity.

Reference Books/Materials:

1) Environmental Chemistry. Ibanez, J.G., Hemandez-Esparaz, M., Doria- Serrano, C., Fregoso-Infante, A. and Singh, M.M., Springer, Germany.2018.
2) Principles of Environmental Chemistry, Girard, lE., 1stEdition. Jones and Barlett, USA, 2015.
3) 3. Environmental Chemistry. Baird Collin and Michael Cann. W.H. Freeman and Company, New York USA. 2008.

Course Code	**ENV 504**
Course Title	**Environmental Impact Assessment (3CH)**

Course Outline:

Introduction: principles, concepts and purposes of IEE and EIA and its significance for the society. Cost and benefits of EIA. Main stages in EIA process. Public consultation and participation in EIA process. Methods and techniques for impact prediction and evaluation. Integration during project life cycle. EIA review and post project analysis. EIA process management. Role of quality assurance and quality control in environmental analysis. EIA Regulations and guidelines in Pakistan.

Course Aims and Objectives:

The aim of this course is to enable the participants to build their capacity to integrate environmental concerns in project proposals.

Course Outcomes:

Students will be able to learn the principles, skills, procedures and practices of integrating environment in development through EIA; become aware of the legal and regulatory obligations of integrating environment in development projects; will familiarize with the techniques of getting public participation and integrate socio-economic aspects in development projects.

Reference Books/Materials:

1) Environmental Impact Assessment Handbook for Pakistan, Fischer, T.S. (ed.), 2014, Liverpool University Press, UK
2) Introduction to Environmental Impact Assessment, Glasson, J., Therivel, R., and Chadwick, A., Routledge, London, 2005.
3) EIA Manual: Training Resource Manual, Sadler, B., & McCabe, M., (ed.),2nd Edition, United Nations Environment Programme, 2002.
4) 4. Environmental Impact Assessment in Practice, Harrop, D.O. & Nixon, .A., National Book Foundation, Islamabad, 2000.

Course Code	**ENV 505**
Course Title	**Environmental Policies and Laws**

Course Outline:

Meaning and Scope of Environmental Planning and Management, development of concepts, Carrying capacity and sustainable development. Man-Environment Interaction in time and space. Relationship of culture, technology and resource use. Conservation Strategies; WCS, NCS, Provincial and Local Strategies. A detailed study of Environmental Problems of Pakistan, status of Terrestrial, Aquatic and Atmospheric Ecosystems. Treaties, Conventions and Protocols in Global, Regional and International Environmental Issues. Legislation an Environmental Protection with particular reference to Pakistan. Environmental control Policies, Instruments and methods. Role of Public awareness and community participation in environmental conservation and management. Organizational and Institutional Framework for Environmental Protection and Management: Scope and Status in Pakistan. Draft National Environmental Policy. Environmental institutions established for enforcement of environmental laws in Pakistan and their functions in federal and provincial level.

Course Aims and Objectives:

This course aims at giving an understanding of the role of state and its instruments in the governance of environment.

Course Outcomes:

Students will be able to learn about responsibilities of state and rights of its citizens to live in environmentally sound conditions to contribute in sustainable development.

Reference Books/Materials:

1) Environmental Laws and their implementation in Pakistan, Qadar, S. Law Books House, 2000.
2) Pakistan Environmental Protection Act, 1997, Government of Pakistan
3) Environmental Policies of Govt. of Pakistan.
4) SNBP Local Government Ordinance, 2001.
5) 5. Provincial Environmental Laws

Course Code	**ENV 507**
Course Title	**Sustainable Development**

Course Outline:

Introduction to Environment and Sustainable Development. Defining the concept of Sustainability, History and discourses of Sustainable Development. Environmental and resources problems, core environmental indicators, key environmental indicators, indicators for "environmental quality" and indicators for "resource evaluation", environmental pressure, environmental conditions, and societal responses. Development and Environmental Degradation. Sustainable Development of Natural Resources. Land Degradation: Deforestation and Desertification. Water Resources & Water Degradation: Global Climactic Change; Kyoto Protocol. Population, factors affecting population size, urbanization and urban growth, urban resources and environmental problems, population and consumption Population & Consumption: Poverty, Community Development and Participation, Role of the State and International Policy, Trade and Globalization. The Green Revolution

Course Aims and Objectives:

The primary objective of the course is to provide students with a broad understanding of environmentally sustainable development (development and it's linkage with environmental degradation), issues of environment and sustainable development, challenges faced by developing world and sustainable management of natural resources

Course Outcomes:

The students will be able to learn the principles of environment and sustainable development and the challenges faced by developing world and sustainable management of natural resources.

Reference Books/Materials:

1) "Principle of Environmental Science (Inquiry and Applications)" by William P. Cunningham and Mary Ann Cunningham. (3nd Edition, 2006).
2) "Environmental science" by G.T. Miller Jr (9th edition, 2003)
3) "Living in the Environment" by G.T. Miller Jr . (12th edition, 2002).
4) "Environmental Geology" by Edward A. Keller. (6th Edition, 2006).

Course Code	**ENV 522**
Course Title	**Disaster Management**

Course Outline:

Natural hazards and disasters: The need for hazard and disaster studies, Historical background on Hazard and Disaster research; Disaster its types: Natural *vs* Man-made; Flooding, Earthquake, Landslide; Natural cycles and their role, Prediction; Hazards, Risk and Vulnerability: Definitions and characterization, Different approaches and Indicators; Factors of vulnerability: Demographic factors, Socio-economic factors, Cultural factors, Political factors, Physical factors; The impact of natural disasters: Direct and short-term impact of disasters, Indirect and long-term consequences of catastrophies, Disaster as an opportunity for development; Disaster Management: Components of management, International phenomenon; Hazard and vulnerability reduction and Mitigation: hard and soft measures; Earthquake Management, Flood Management: Organizational Role; Role of Government and Non-Governmental Organizations (NGOs); Role of Media in Disaster Management; Techniques and methods to assess hazard, vulnerability and risk: Qualitative and Quantitative approaches; Disaster Management Trainings and Policies.

Course Aims and Objectives:

This course will provide know how in dealing with natural calamities and their management by encompassing the field of hazard and disaster studies. It discusses a wide range of aspects, i.e., assessment of factors which put societies in vulnerable situations to the disaster management continuum. To underline the importance of disasters in socio-economic development, this course also aims to make an assessment of the consequences of 'natural' catastrophic at both short and long terms. It finally tends to provide the students with basic knowledge on hazard reduction and vulnerability mitigation.

Course Outcomes:

Students will be able to learn the assessment of the consequences of 'natural' catastrophic at both short and long terms and in-depth knowledge on hazard reduction and vulnerability mitigation.

Reference Books/Materials:

1) Natural Disasters Alexander, D., Chapman & Hall, New York.
2) Rising from the Ashes: Development Strategies in Time of Disaster Anderson, M.B., and Woodrow, P.J, Westview Press, Boulder, UNESCO, Paris.
3) The Environment as Hazard Burton I., Kates, R.W., and White G.F., 2nd Edition, The Guilford Press, New York.
4) Disaster Management: A Disaster Manager's Handbook Carter N.W., ADB, Manila.

Course Code	**ENV 531**
Course Title	**Environmental Analytical Techniques**

Course Outline:

Introduction: Principles of physical, chemical and microbiological analysis of environmental pollutants. Sampling procedure for the examination of Water, Wastewater, Air and Solid Waste; sampling rules, sample collection and preservation. Sample preparation and Pretreatment, Laboratory Techniques and Field Monitoring for parameters of importance causing environmental pollution. Environmental Chemical Analysis; role and importance, classical methods: volumetric and gravimetric analysis., Microbiological analysis, Electroanalytical methods, Instrumental Techniques using Spectrophotometery, Chromatography, Atomic Absorption and Emission Analysis etc. Statistical Tools: Assessment and Interpretation of Results

Course Aims and Objectives:

The objective of this course is to impart skills and techniques necessary for measurement of different environmental pollutants.

Course Outcomes:

The basic concept of principles of instrumental techniques will be given to students.
This course will enable the students to carryout monitoring and evaluation.

Reference Books/Materials:

1) Environmental Engineering Laboratory. Ahmed, K.A one Publishers Lahore, Pakistan, 1998. \

2) Standard Methods for Examination of Water and Wastewater. L. S. Clesceri, A. E. Greenberg, A. D. Eaton. 20th Edition. APHA publisher, USA, 1998.

Course Code	**ENV 502**
Course Title	**Environmental Management (3CH)**

Course Outline:

Fundamental concepts of Environmental Management, Historical Development of environmental concerns, sustainable development concept. Environmental management of agriculture, forest, water, and land resources. Social, ethical and religious dimensions, economic and technological use. Policy and legal instrument for environmental management: institutional framework, role of public, private sector and civil society. Green manufacturing: marketing, green consumerism. Global efforts for managing environment: Environmental policy and Law. ISO Guidelines (I4000), Environmental Management System, Environmental Auditing, Corporate Social Responsibility

Course Aims and Objectives

The objective of this course is to give detail insight of Environmental Management. Sources of data, data collection and interpretation. Related Environmental regulations, Principles of cleaner production.

Course Outcomes:

After completion of a course, students will be able to apply the principles and tools of environmental management.

Reference Books/Materials:

1) EMS — an implementation Guide for Small and Medium sized Organizations NSF International Ann Arbor, Michigan-January 2001.
2) ISO 14000 – Meet the whole family, ISO Central Secretariat, Switzerland, 1998.
3) UNEP/IE (Industry and Environment), 1990b, Environmental auditing, Paris.
4) Inside ISO 14000: The Competitive Advantage of Environmental Management, Sayre, D, St Luise Press. USA. 1997

Course Code	**ENV 503**
Course Title	**Energy & Environment (3CH)**

Reviewed Course Outline:

Energy resources: Renewable & Non-Renewable, Fossil fuels and their environmental effects: Coal, Oil and Natural Gas, Greenhouse effect and acid rain etc. Nuclear energy, Renewable energy principles: Solar radiation characteristics; Active and Passive use of solar energy (water heating, air heating, crop dryers, space heating, water desalination, solar ponds and solar concentrators etc). Photovoltaic; Hydropower, Micro-hydroelectric plants; Wind power; Biofuels; Ethanol from Biomass; Wave, tidal and ocean thermal energy; Geothermal energy. Energy storage (batteries and fuel cells etc.): Hydrogen from renewable energy sources, Energy from waste, Energy efficiency and management.

Course Aims and Objectives:

This course is designed to create understanding of the significance of energy in our daily life, its supply position and merits and demerits of different energy resources.

Course Outcomes:

After completion of a course, students will be able to learn about different sources of energy and its role in environment.

Reference Books/Materials:

1) Towards a Sustainable Energy Future, OECD/IEA, Paris, 2001.
2) Environmental Science: Earth as a Living Planet, Botkin, D.B and Keller, E.A. 6th Edition. John Wiley and Sons. 2007.
3) Environmental Science: Systems and Solutions. McKinney, M.L., Schoch, R.M. and Yonavjak, L. 4th Edition. Jones & Bartlett Publishers, 2007.

Course Code	**ENV 511**
Course Title	**Environmental Economics**

Course Outline:

Introduction to environmental economics, Distinction between natural resource economics and environmental economics., framework of policies and approaches that accelerates progress toward sustainable development goals. Economic growth and development, environmental cost accounting, Externalities, Market Failure, Trade off, Carbon footprint assessment, carbon trading and carbon sequestration, REDD and REDD plus mechanisms. Evaluating the Environment and Benefit-cost Analysis: Measuring environmental benefits: contingent valuation, the travel cost method and the hedonic approach. Benefit cost analysis. Regulation, taxes and fees, Pollution charge, Ecosystem trading and valuation, Vulnerability, Role of Microfinance in Promoting Renewable Energy. Institutional Framework for Renewable Energy and community adaptation. . International environmental agreements: economics of international agreements, International Trade and the environment Entrepreneurship in Energy Solutions. Green economy and its relationship to Livelihood and Poverty Alleviation.

Course Aims and Objectives:

The objective of this course is to develop understanding of basic principles of green economy within the economic, energy and food security context of the country and the region. Sector-specific challenges and opportunities to advance low-carbon, resource efficient and socially inclusive development

Course Outcomes:

participants will be able to define the concept of a green economy and explain its value, distinguish relevant planning processes in support of a green transformation, Identify enabling conditions for greening national economies and discuss principal challenges and opportunities to advance environmental economics

Reference Books/Materials:

1) Markandya, Anil and Renat Perelet, et. al. Dictionary of Environmental Economics. London: Earthscan Publications, Ltd., 2002.
2) McCain, Roger A. Essential Principles of Economics: A Hypermedia Text. Drexel University. http://william-king.www.drexel.edu/top/prin/txt/EcoToC.htm
3) Hussen, Ahmed. Principles of Environmental Economics, 2e. New York, NY: Routledge, 2004.
4) Henderson, David R. The Concise Encyclopedia of Economics. The Library of Economics and Liberty, 2002. http://www.econlib.org/library/CEE.html

Course Code	**ENV 537**
Course Title	**Environmental Engineering (3CH)**

Course Outline:

Principles of Environmental Engineering: population, economic growth, industrialization, energy use. Physical and transport properties of mixtures, contaminant partitioning and transport in air, water and solids. Application of environmental principles, life cycle analysis, principles of environmental quality, standards and guidelines. Water and wastewater: characteristics and parameters, standard methods of analysis, treatment plants and systems. Industrial wastewater characteristics, treatment, treatment levels and available technologies. Sources and classification of atmospheric pollutants and particulates, health and ecological impacts. Gaussian diffusion model, lapse rate and stability conditions. Control of particulates: collection, mechanisms and efficiencies. Control of gases and vapors, adsorption, absorption, incineration, odor and gaseous pollutant control. Solid waste characterization and classification. 3R techniques Solid Waste Management, Soil and its quality, Contaminated site remediation,

Course Aims and Objectives:

1) To equip students with the understanding of basic principles of environmental engineering.
2) To familiarize with the study of environmental hazards, risks prevention, field monitoring, data collection and interpretation of risk management, engineering principles, Technologies and solutions to environmental problems.
3) To give the understanding of principles of environmental quality, standards and guidelines for various environmental parameters.

Course Outcomes:

On completion of this course, students are expected to be able to know about basic applications of environmental engineering, environmental remediation and treatment technologies and solution to the hazards.

Reference Books/Materials:

1) Environmental technologies (Engineering & Principles)

2) Environmental Engineering (Wiley)

Course Code	**ENV 519**
Course Title	**Epidemiology**

Course Outline:

Environmental risks to human health. Epidemics, endemics, and pandemics. Epidemiology triangle. Disease concepts: Communicable and noncommunicable diseases and conditions. Modes of disease transmission and chain of infection. Portals of entry to the human body. Zoonoses. Type of epidemiology: social, occupational, environmental, nutritional and infectious disease epidemiology. Occupational health and industrial hygiene. Disease surveillance and health impact assessment. Basic concepts: rates, ratios, proportions and relative risks. Measures of association and odds ratio analysis. Design strategies and experimental epidemiology: case-control studies, cohort studies, double-cohort studies. Role of confounding factors in causation of disease. Web of causation. Sensitivity and Specificity. Designing a randomized controlled trial. Ethics in epidemiologic research. Statistical Methods in Epidemiology: Sample size determination and statistical inference. Integrating toxicological and epidemiological data. Regression methods. Time-series, spatial analysis and meta-analysis in epidemiology. Field Epidemiology: Epidemiological field work in population-based studies. Exposure assessment, surveillance and screening methods. Examples of case studies: cardiovascular, cancer, asthma and vector borne diseases.

Course Aims and Objectives:

The objective of the course is to provide the student with insight in the principles and important issues of environmental epidemiology. This course will focus on assessment of disease burden, measurement of exposure and interpretation of mortality, morbidity concepts.

Course Outcomes:

Upon completion of this course, it is assumed that students will be able to comprehend emerging diseases in the context of climate change and global environmental change.

Reference Books/Materials:

1) Ahrens, W. and Pigeot, I. (2013). Handbook of Epidemiology. 2nd Ed. Springer, London. UK.
2) Merril, R. M. and Timmreck, T. C. (2016). Introduction to Epidemiology. (4th ed.). Jones and Barlett Publishers. Boston, USA.
3) Merril, R. M. (2008). Environmental Epidemiology: Principles and Methods. (4thed.). Jones and Barlett Publishers. Boston, USA.
4) Aschengrau, A. and Seage, G. R. 2003. Essentials of Epidemiology in Public Health. Jones & Bartlett Learning, 5 Wall Street Burlington, MA

Course Code	**ENV 514**
Course Title	**Remote Sensing and GIS Applications in Environment**

Course Outline:

Fundamentals of Remote Sensing. History and data collection, advantages and limitations of process. Energy Sources, energy matter interaction in the atmosphere. Aerial photography, history and platforms. Active and Passive remote sensing. Remote sensing of vegetation and landscape. Introduction to Photogrammetry, Satellite Imageries, Image Processing, Interpretation, Preparation of thematic maps. Fundamental of Geographic Information System (GIS). Integration with other technologies and its importance. Data acquisition, analysis and output. Types of data used in GIS. Cartography, map projection and coordinate systems. GIS applications in: Environmental protection and resource conservation, Environmental Impact Assessment (EIA), Agriculture, Forestry, Fishery and wildlife. Introduction to relevant Pakistani Institutions working in GIS

Course Aims and Objectives:

The main objective of the GIS/RS are to maximize the efficiency of decision making and planning, provide efficient means for data distribution and handling, eradication of the duplicated data, integration of information from many sources. Geographical information system (GIS) and remote sensing (RS) had been one of the key subprojects envisaged in the National Information System. The attempts of a digital description of that world create a computerized GIS which is usually a partial description of the world in relation with some feature tasks.

Course Outcomes:

Students will be able to apply the GIS and RS techniques in the monitoring of environment.

Reference Books/Materials:

1) A Primer of GIS-fundamentals Geographic and Cartographic Concepts, Harvey, F. Guilfoud press New York.
2) Dynamic Earth Environmental Remote Sensing Observations from shuttle Mission. Lulla, K and L. V. Dessinov. John Wiley and Sons.
3) Introduction to GIS. Campbell. Mc Graw Hill Education.
4) Remote Sensing of the environment: An Earth perspective. Jensen, R. Pearsons Education, Inc.
5) Remote Sensing for the Earth Sciences. A. Z. Rancez. John Wiley and Sons. Inc.

Course Code	**ENV 513**
Course Title	**Health Safety and Environment**

Course Outline:

Health, safety and environment: Hazards; Physical, mechanical, biological, chemical and psychological hazards and stress. Health and environment, Environmental safety, Hazards identification and risk assessment and management process. Work place environment: Occupational safety and health issues in industries, construction, agriculture and service sectors, Accidents, injuries and workplace fatalities statistics, Occupational safety and health management systems (international and national). Safety Management: Regulations of health, safety and environment. Internal control and management philosophy, Duties and rights, strategies and goals, Roles and responsibilities of occupational health and safety professionals. Key principles of management and HSE, Measures and models for HSE, Organizational environment, HSE statutes and regulations, Establishing HSE plans, Challenges of health within working environment, external environment and safety, Different tools and instruments. 85 Culture, Behavior, Interactions, participation and communication, health surveillance, injury reporting, Emergency response procedures; fires, spills, leaks etc., Preparedness and monitoring of adverse events and follow-ups, Case studies. Work place safety and health: Assessing current practices and promoting change in the profession, Personnel Protective Equipment, Formulation of Standard operating procedures, Human Factors and Ergonomic, Planning, decision making and problem solving.

Course Aims and Objectives:

The objective of this course to provide orientation to the students on importance of occupational safety, health and environment. Regulations and guidelines concerning HSE-work, Reporting of HSE problems and discrepancies, Reporting of HSE problems and discrepancies

Course Outcomes:

Students will have the necessary knowledge about HSE to ensure their own and other people's safety at working environment. This includes knowledge of the HSE-concept, objectives for the HSE work and how to behave safely in laboratories and during field work.
The theoretical and practical basic training in first aid and fire protection shall provide the students with a basis for correct handling of a fire or accident situation.

Reference Books/Materials:

1) Hand book of Environmental Health & Safety, principles and Practices By Herman Koren and Mechael Bisesi, Vol.1 , Lewis publishers.
2) English, P. F. 2012. Safety Performance in a Lean Environment: A Guide to Building Safety into a Process (Occupational Safety & Health Guide Series), CRC press. Taylor and Francis group. USA.
3) Salvendy, G. 2012. Handbook of Human Factors and Ergonomics. 4 th ed., John Willey Inc. New Jersey, USA.
4) OHSAS- BS 18001 Standard

Course Code	**GEO-527**
Course Title	**Hydro-chemistry and Groundwater pollution**

Course Outline:

Laws of chemistry related to water and its reaction with aquifers matrix, Principals and process controlling composition of natural water, Water Quality standard, Permissible value of physical and chemical characters for ground water, acceptable range and impacts of chemical pollutants Method of water sampling and analysis, Properties and chemical constituents of water, Presentation , evaluation, interpretation of water analysis data, Source, nature and effect of ground water contamination Movement and kinetics of inorganic and organic water pollutants, Bank filtration, Mass transport of solute and chemical processes occurring in aquifers, Seepage and drilling based contamination, Agricultural sources of water contamination. Impact of associated soil, climate and environmental activity on ground water composition. Land fill impacts, Chemical spill and leakage of underground tanks, Organic contamination dynamics, Saline water intrusion in coastal and estuaries zone, role of wet land in recharging, contamination and purification of associated ground water, Monitoring of well and boreholes, Physical methods to purify the water sources, Biological and chemical approaches to remediate the pollution, Impact assessment and predictions about source and extent of contamination

Course Aims and Objectives:

A basic hydrochemistry and pollution course dealing with the physical aspects of groundwater flow, chemical composition, contamination with kinetics and impact of contaminants. The objective is to get familiar with the theory of groundwater flow and aquifer storage, and follows with a review of typical hydrogeological environments.

Course Outcomes:

The student will attain an improved understanding for processes that control the composition of water in environments, describing the major hydrogeochemical processes and parameters that control metal mobility in an aquatic system. It will guide to understand movement of inorganic and organic contaminants in soil water and water atmosphere interaction during hydrological cycle. The student will have information about the differences in water composition that are observed in the environment as a result of differences in soil, geology, climate and chemical reactions

Reference Books/Materials:

1) Stumm, W. and Morgan, J.J. (1996) Aquatic Chemistry, 3rd ed. Wiley Intersciences, New York.
2) Appelo, C. Anthony J.; Postma, DiekeGeochemistry, groundwater and pollution 2. ed.: Leiden: Balkema, cop. 2005
3) Hatem El Meiri, Amor Ben Mousa, S. G,H, Saleem and K. Zouari (2017) Hydrochemical Investigation and quality assessment of ground water. DOI: 10.5772/intyechopn.72173

Course Code	**ENV-521**
Course Title	**Marine Pollution**

Course Outline:

Marine Science, study of marine biology (organism, fisheries and mangroves). Characteristics of marine water and sediment. chronic and acute inorganic and organic marine pollutants, Sources and effect of marine pollution on ecological changes. Effects of pollution discharges, oil spills, coastal development, beach erosion, eutrophication channel dredging and changing sea-level on marine environment and their control measures. Seawater intrusion. Modeling for marine pollution dispersion: role of organism, fisheries and mangroves. Coastal geology and estuarine ecology. Marine resources and coastal management. Control of pollution in marine and coastal environments Pollution Management, oil spills contingency plan and combating techniques.

Course Aims and Objectives:

To develop a basic understanding of marine pollution, its sources, impact of pollutants on the biotic and abiotic environment impacting the marine recourses.
Develop a clear understanding of pollution control and management techniques.

Course Outcomes:

The course will give an idea of marine pollution, sources and types of pollutants
The students will have knowledge of effective management strategies of marine pollution

Reference Books/Materials:

1) Managing Ocean Environments in a Changing Climate: Sustainability and Economic Perspectives Kevin J. Noone' Ussif Rashid SumailaRobert J. Diaz 2013.
2) Marine Pollution and Human Health (Issues in Environmental Science and Technology) R E Hester, R M Harrison RSC Publications 2011
3) Marine Pollution and Its Control (McGraw-Hill series in water resources and environmental engineering) by Paul L. Bishop (1982).
4) Protecting the Marine Environment from Land-Based Sources of Pollution: Towards Effective International Cooperation by Daud Hassan (2006).

Course Code	**ENV 509**
Course Title	**Population Dynamics and the Environment**

Course Outline:

World Population: current scenario and future trends. Framework for understanding population-environment nexus, population size and environment, population distribution and environment. Population composition and environment, population growth and climate change, population growth and land use change, research need for correlation studies. Poverty-population-environment linkages in the context of migration and urbanization. Population-development nexus: integrating environment and development. Response to demographic crisis: Government responses, Individual attitudes and perceptions, sustainable approach to population stabilization, Population dynamics in Pakistan, Pakistan's Biocapacity, resource consumption & crisis.

Course Aims and Objectives:

This course will provide the conceptual framework to the students for understanding of complex web of multiple dimensions of environmental issues linked with population and development

Course Outcomes:

Students will be able to learn the role of population growth in causing and solving environmental problems.

Reference Books/Materials:

1) Botkin D. & Keller E., 2016. *Environmental Science: Earth as Living Planet. 8*th ed. John Wiley and Sons

2) Cunningham W.P., & Saigo, B.W., 2017. *Environmental Science*, 6th Ed. McGraw-Hill.

Course Code	**ESC-701**
Course Title	**Research Methodology**

Course Outline:

Purpose of Research; Research Project Conceptualization, Choice of Methods; Elements of a Research Proposal, Operationalization choices and illustrations. Research Design: formulation of research design, pretesting of research instruments and procedures, units of Analysis, time dimension; Experimental design and use of indicators in research, Survey Research: Guidelines for asking question and questionnaires construction, Self-administered questionnaires, Interview and other survey methods; their strength and weaknesses. Sampling: the logic of sampling, concepts and terminologies, population and sampling frames, types of sampling design. Field Studies: Steps in the conducting field study; Evaluation Research: How to carry out evaluation research; Analytical tools in research: qualitative and quantitative methods; Statistical Analyses: Univariate, Bivariate and Multivariate analyses

Course Aims and Objectives:

The objective of this course is to equip the students with the skills to undertake a project by planning, designing and defining a research problem; and select indicators and parameters of research and its methodologies.

Course Outcomes:

At the end of this course, the students should be able to understand some basic concepts of research and its methodologies; identify appropriate research topics; select and define appropriate research problem and parameters. The students will learn how to prepare a project proposal (to undertake a project), organize and conduct research (advanced project) in a more appropriate manner.

Reference Books/Materials:

1) Students project in Environmental Science, Harrad,S., Batty,h., Diamon, M. and Arhonditsis, G, John and sons Ltd., Chichester, England, 2018.
2) Designing and Conducting Mixed Methods Research, Creswell, J. W. & Plano Clark, V.L. Thousand Oaks, Sage CA, USA, 2017.
3) The Craft of Research by Wayne C. Booth, 2ndEdition, Univ. of Chicago Press. USA, 2003.
4) Case Study Research: Design and Methods, Robert Yin, 3rdEdition, Sage Publishers. USA, 2003.

Course Code	**ENV-520**
Course Title	**Solid and Hazardous waste Management**

Course Outline:

Hazardous Wastes: Sources, Classification, Characteristics, and Generation. On-site handling and storage, collection, transfer, recycling and disposal techniques of municipal Solid Waste, Characterization of solid waste, Sampling methods, land filling, thermal conversion and composting. Waste to Energy, Concept of integrated solid waste management: existing practices and their hazards. Economic evaluation of the systems. Hospital waste Management. Hazardous waste management, E-waste and Special waste Management, Recent technologies used for solid waste management

Course Aims and Objectives:

The students will learn the types, handling and management systems of solid wastes.
To give the concept of waste to energy conversion and the importance of waste as energy resource

Course Outcomes:

The course will give an idea of safe disposal and effective management strategies of solid and hazardous waste. The energy recovery from solid waste and the application of 3 Rs concept will be delivered.

Reference Books/Materials:

1) 1.Principles and Applications of Microbiology. Salivia, D.M., J.J. Fuhrman, G.P. Hartel and A.D. Zuberer.2 nd Ed. Prentice Hall, Upper Saddle River, NJ, USA. 2005.
2) 2. Organic Waste Recycling: Technology and Management. Polprasent, C. IWA, London, UK. 2007.

Course Code	**ENV 518**
Course Title	**Watershed Management**

Course Outline:

What is watershed, how watershed works, parts of watershed, natural changes within watershed. Current issues in water management. characteristics of effective management, watershed. Physical features and land forms, climate, soil, infiltration and runoff, stream flow, groundwater, water quality, plant and animal communities, land use, social and economic systems, valued features and activities. Land use Planning and Management: evolution of land use planning Identifying current users, need for public involvement, public involvement techniques and processes. Agricultural Resources Management: Existing situation of agriculture sector in Pakistan, agriculture products and their share in GDP, problem in agriculture, agriculture chemicals, their pros and cons, national agriculture policy, management options. Developing workable management options: simple and detailed assessment methods, costing and financing, quantifying intangibles, legal and institutional administrative concerns, planning for watershed, choosing and implementing the best plan, case studies

Course Aims and Objectives:

This course will be directed at investigating the social, environmental and economic aspects of watershed Management, To train students on the identification, occurrence and distribution of natural resources, their current status and threats. Use of interdisciplinary approach for sustainable management of the natural resources.

Course Outcomes:

Students will be able to learn the various interdisciplinary approach for sustainable management of the of watershed.

Reference Books/Materials:

1) "Principle of Environmental Science (Inquiry and Applications)" by William P. Cunningham and Mary Ann Cunningham. (8th Edition, 2010).
2) "Living in the Environment" by G.T. Miller Jr . (17th edition, 2012).
3) "Natural Resource Conservation" by P.R Trivedi (7st edition, 2014)

Course Code	**ENV 515**
Course Title	**Environmental Risk Assessment and Management**

Course Outline:

Environmental risk assessment and management; the what's, whys and how's a historical perspective: Risk assessment to human health from chemicals in the environment. Risk assessment to ecological systems from chemicals, from biological introductions (excluding genetically modified organisms). Evaluation of the likelihood of, major accidents in industrial processes, Assessing risks to ecosystems and human health from genetically modified organisms. Retrospective assessment, eco-epidemiology and ecological monitoring. Hazard identification, dose and exposure assessment, risk quantification, Epidemiology and environmental risk assessment. Risk assessment in legislation: Application of risk assessment in policy and legislation in developed and developing countries. Balancing risks with other considerations: The psychology of risk and uncertainty, the economics of risk. Valuing risks. Natural hazards, risk analysis and risk management. Risk management: Principles, approaches and concepts: Corporate chemical management; a risk-based approach. Environmental risk assessment in business. Risk assessment and management for water treatment and disposal. Risk assessment and management in the exploitation of the seas. Risk assessment and management for inland waters. Environmental risk assessment in development programmes, the experience of World Bank. Risk communication. A framework for sustainable product development

Course Aims and Objectives:

The course aims to review the forms of hazards and their associated risks, define the elements of risk assessment and describe the types of information needed for each element of risk assessment.

Course Outcomes:

Students will be able to learn the ways to risk identification, estimation of magnitude of the potential risks and illustrate different approaches of exposure assessment, the principles of risk management and control strategies and outline the approaches to managing the environmental emergencies.

Reference Books/Materials:

1. Environmental Risk Analysis. (2001). Larche, I. and Paleologos, E. K. McGraw-Hill NY, USA.
2. Occupational Health Hazards and Remedies. (2002). Mohapatra, R. Jaypee Brothers Medical Publishers Pvt. Ltd., India.
3. Biosafety Management: Principles and Applications. (2000). Tarynor, P. L. Virginia Polytechnic Institute Publications. USA.
4. Environmental Risk Evaluation of Polluted Soils. (2000). Riviere, J. Oxford and IBH Publishing Company Pvt. Ltd. India.
5. Environmental Hazards: Plants and People. (2000). Iqbal, M., Srivastava, P. S.and Siddiqi, T. O. CBS Publishers and Distributors, India.

Master of Science (MS) Geology
Roadmap Amendments

Description	Existing	Proposed
Total number of credit hours	30	30

	Existing Roadmap	Proposed Roadmap
Semester	Credit Hours (Courses)	Proposed
1	12 CH (2 Compulsory + 2 Electives)	12 CH (4 Compulsory courses)
2	12 CH (2 Compulsory + 2 Electives)	12 CH (4 Elective courses)
3	03 CH (Thesis)	03 CH (Thesis)
4	03 CH (Thesis)	03 CH (Thesis)
Total	30	30

Compulsory Courses

Course code	Course Title	Credit Hours	Amendments
GEO 503	Advanced Petroleum Geology	3	Contents Revision
GEO 501	Global Tectonics	3	Contents Revision
GEO 512	Mineral Prospecting and Exploration	3	Contents Revision
ESC 701	Research Methodology	3	Contents Revision

Elective Courses

Course code	Course Title	Credit Hours	Amendments
GEO 548	Advanced Seismic Stratigraphy	3	Contents Revision
GEO 505	Advanced Sedimentology	3	Contents Revision
GEO 506	Hydrocarbon Geochemistry	3	Contents Revision
GEO 507	Basin Analysis	3	Contents Revision
GEO 508	Stratigraphy and Petroleum Prospects of Pakistan	3	Contents Revision
GEO 510	Development of Groundwater Resources	3	Contents Revision
GEO 531	Advanced Structural Geology	3	Contents Revision
GEO 520	Rock Mechanics	3	Contents Revision
GEO 521	Soil Mechanics	3	Contents Revision
GEO 522	Geochemical Exploration	3	Contents Revision
GEO 523	Isotope Geochemistry	3	Contents Revision
GEO 524	Clastic Sedimentology	3	Contents Revision
GEO 525	Carbonate Sedimentology	3	Contents Revision
GEO 526	Clay Mineralogy	3	Contents Revision
GEO 527	Hydrochemistry & Groundwater Pollution	3	Contents Revision
GEO 528	Groundwater Modeling	3	Contents Revision
GEO 529	Industrial Mineralogy	3	Contents Revision
GEO 530	Advanced Marine Geology	3	Contents Revision
GEO 534	Reservoir Geology	3	Contents Revision
GEO 535	Applied Mineralogy	3	Contents Revision
GEO 530	Fundamentals of Gemology	3	Contents Revision
GEO 537	Advanced Engineering Geology	3	Contents Revision

ENV 537	Environmental Engineering	3	Contents Revision
ENV 513	Health Safety and Environment	3	Contents Revision
GEO 536	Advanced Igneous Petrology	3	Contents Revision
GEO 538	Advanced Metamorphic Petrology	3	Contents Revision
GEO 539	Ore Geology	3	Contents Revision
GEO 546	Advanced Biostratigraphy	3	Contents Revision
~~GEO 502~~	~~Geophysical Exploration Methods~~	3	Course Removed
~~GEO 519~~	~~Coal Geology~~	3	Course Removed
~~GEO 523~~	~~Climate Change~~	3	Course Removed
~~ENV 522~~	~~Natural Disaster Management~~	3	Course Removed
~~ENV 504~~	~~Environmental Impact Assessment~~	3	Course Removed
~~GEO 511~~	~~GIS Applications in Geology~~	3	Course Removed
GEO 545	Petrophysical Analysis	3	Contents Revision
GEO 541	Applications of GIS in Geosciences	3	**New Course Added**
GEO 603	Engineering Geophysics	3	**New Course Added**
GEO 604	Machine Learning	3	**New Course Added**
GEO 605	Applications of Geostatistics in Geosciences	3	**New Course Added**
GEO 606	Reservoir Geomechanics	3	**New Course Added**
GEO 607	Unconventional Hydrocarbon Resources	3	**New Course Added**
GEO 608	Practical Applications of Geosciences Softwares	3	**New Course Added**
THS 701	MS Thesis	6	Existing

Master of Science (MS) Geology
New Roadmap

Semester	Credit Hours (Courses)
1	12 CH (4 Compulsory courses)
2	12 CH (4 Elective courses)
3	03 CH (Thesis)
4	03 CH (Thesis)
Total	30

Compulsory Courses

Course code	Course Title	Credit Hours
GEO 503	Advanced Petroleum Geology	3
GEO 501	Global Tectonics	3
GEO 512	Mineral Prospecting and Exploration	3
ESC 701	Research Methodology	3

Elective Courses

Course code	Course Title	Credit Hours
GEO 541	Applications of GIS in Geosciences	3
GEO 548	Advanced Seismic Stratigraphy	3
GEO 505	Advanced Sedimentology	3
GEO 506	Hydrocarbon Geochemistry	3
GEO 507	Basin Analysis	3
GEO 508	Stratigraphy and Petroleum Prospects of Pakistan	3
GEO 547	Drilling Operations and Well Site Geology	3
GEO 510	Development of Groundwater Resources	3
GEO 531	Advanced Structural Geology	3
GEO 520	Rock Mechanics	3
GEO 521	Soil Mechanics	3
GEO 522	Geochemical Exploration	3
GEO 523	Isotope Geochemistry	3
GEO 524	Clastic Sedimentology	3
GEO 525	Carbonate Sedimentology	3
GEO 526	Clay Mineralogy	3
GEO 527	Hydrochemistry & Groundwater Pollution	3
GEO 528	Groundwater Modeling	3
GEO 529	Industrial Mineralogy	3
GEO 530	Advanced Marine Geology	3
GEO 534	Reservoir Geology	3
GEO 535	Applied Mineralogy	3
GEO 530	Fundamentals of Gemology	3
GEO 537	Advanced Engineering Geology	3

ENV 537	Environmental Engineering	3
ENV 513	Health Safety and Environment	3
GEO 536	Advanced Igneous Petrology	3
GEO 538	Advanced Metamorphic Petrology	3
GEO 539	Ore Geology	3
GEO 546	Advanced Biostratigraphy	3
GEO 512	Mineral Prospecting and Exploration	3
GEO 603	Engineering Geophysics	3
GEO 604	Machine Learning	3
GEO 605	Applications of Geostatistics in Geosciences	3
GEO 606	Reservoir Geomechanics	3
GEO 607	Unconventional Hydrocarbon Resources	3
GEO 608	Practical Applications of Geosciences Software's	3
THS 701	MS Thesis	6
	Any other relevant course from Geophysics/Environmental Science	

COURSE CATALOGUE

Course Code	**GEO 503**
Course Title	**Advanced Petroleum Geology**

Course Outline:

Introduction of Petroleum Geology; History of petroleum Exploration; Basic concepts of Geological and Geophysical methods in Petroleum Exploration and Exploitation; Petroleum System & its components; Theories of petroleum source and thermal maturity/generation; Kerogen and its types; Pathways of hydrocarbon/petroleum migration; Accumulation of Hydrocarbon in reservoirs and the nature of traps & seals; Basic Concepts of reservoir types (Clastic, Carbonates, Fractures, Tight & Self contained) and their properties; Tools used to study reservoir / source/trap for the prospect generation; Practical approach for the prospect generation (geological mapping, geophysical evaluation, analogue data/information & well logs); Biomarkers and Geochemical correlations of reservoir to reservoir / source to reservoir; Risk analysis of geological factors components of a petroleum system; reserve estimation; Case histories of oil/gas fields from any basin of Pakistan or related research papers review.

Course Aims and Objectives:

This course is designed to cater the petroleum industry approach and practice regarding the evaluation of petroleum geology. This will certainly help to learn major concepts related to geological factors / components and their impact in generation, migration/relocation, accumulation / preservation of hydrocarbon. The will also give a practical approach to appraise and estimate all the parts of petroleum system.

Course Outcomes:

On completion of the course, students are expected to get a good knowledge of key concepts regarding,

1) Hydrocarbon habitat and exploration approaches
2) Petroleum Play and its components; Organic matter deposition, Hydrocarbon generation, migration, distribution and preservation in a petroleum basin. Reservoir types and their properties
3) Types, usage and display of subsurface geological data and the limits on the reliability of such data
4) Description and evaluation of relatively simple subsurface datasets from wells and evaluate these data to conduct a geological evaluation of a field and undertake a reserves calculation

Reference Books/Materials:

1) Petroleum Geology by F.K. North
2) Petroleum Geology Manual by Baker Hughes INTEQ
3) Petroleum Geology by R.E. Chapman
4) Petroleum Geology of Pakistan by Iqbal B. Qadri
5) Petroleum Geosciences by Knut Bjorlykke
6) Startigraphy of Pakistan by Syed Ibrahim Shah.

Course Code	**GEO 501**
Course Title	**Global Tectonics (3 CH)**

Course Outline:

Geological, geochemical and geophysical evidence related to the contemporary concepts of plate tectonics and mantle convection; Kinematics and dynamics of plate motions; Description, evolution and causes of movements between lithospheric plates; Seismicity, geological processes and tectonics of plate boundaries; Wilson cycle in detail. Continental rift and drift; Major tectonic features of the Earth's crust; Tectonics and orogenies; Orogenic belts; Plumes; Plate tectonic evolution and geological processes of ocean basins, sea-floor spreading, magnetic anomalies, subduction zones, island arcs, rises, trenches and transforms; Geochemical and thermal evolution of the Earth; Dynamics of processes and physical properties of the Earth's interior including mantle dynamics and thermal convection; Modern analogues for plate tectonic phenomena; Plate tectonic framework of Pakistan; Implications of plate tectonics; Seismicity and active fault system of Pakistan.

Course Aims and Objectives

The course presents a broader global view of plate tectonics processes, including plate kinematics, the nature of plate boundaries, the forces responsible for those processes and the implications of plate tectonics. It will develop a concept of current global geography in the context of global tectonic processes

Course Outcomes:

1) To acquire Knowledge about plate tectonics that control large-scale structures of the Earth.
2) To understand the causes and impact of natural calamities such as earthquakes, tsunamis, land sliding and climate change and their mitigation

3) To understand geotectonic framework of Pakistan

Reference Books/Materials:

1) Global Tectonics 3rd Edition by Philip Kearey, Keith A. Klepeis, Frederick J. Vine (2009), Wiley-Blackwell publisher
2) Geology and tectonics of Pakistan by Kazmi and Jan (1997)
3) Plate Tectonics: How it works by A. Cox and R.B. Hart (1991), Wiley-Blackwell publisher
4) Regional Geology and Tectonics by Nicola Scarselli, Jurgen Adam et al (2020), Elsevier Science publisher
5) Research papers related to global tectonics

Course Code	**GEO 545**
Course Title	**Petrophysical Analysis (3 CH)**

Course Outline:

Introduction well logs and Petrophysics; Basic Wireline logging methods (electrical, radioactive, nuclear, acoustic and mechanical logs) and logging procedures; Application and use of open hole and cased hole logs for evaluating/estimating the Petrophysical properties of reservoir; Qualitative and Quantitative interpretation of well logs (lithology identification, shale content, porosities measurement fluid saturation, permeability, identification of pay intervals, well correlation based on the log characters/signatures and determination of lateral variations of Petrophysical parameters using well correlation etc.); Identification of Facies and evaluation of Depositional environments using wireline logs; Application of image logs and their analysis; Application of conventional logs in evaluation of unconventional reservoirs (Tight & Self Contained/shale reservoirs); Application of core analysis and its integration in Petrophysical analysis; Software based quick look Petrophysical interpretation in Geographix/Tecklog/Vizdom solutions VGS.

Course Aims and Objectives:

The aim of this course is to convey conceptual understanding of wireline logging techniques, logging procedures under certain well bore conditions/environments. This course will also communicate practical evaluation of these mentioned logs for the measurement/estimation of petrophysical evaluation of reservoir rocks for further testing and completion.

Course Outcomes:

1) Familiarize with key concepts of the wireline logging techniques and their applications.
2) Identify the factors affecting the log quality and their remedial measures.

3) Able to describe the behavior of different curves on different wireline logs regarding rock characteristics
4) Use of key concepts about the interpretation of different wireline logs to evaluate the lithology, depositional environments and hydrocarbon availability & its quantification.

Reference Books/Materials:

1) The Geological Interpretation of well logs by Malcolm Rider, edition II, 2002
2) Basic Well Log analysis for Geologist by George Asquith & Charls Gibson
3) Log Interpretation Principles/Applications by Schlumberger 1991

Course Code	**GEO-533**
Course Title	**Research Methodology (3CH)**

Course Outline:

Introduction to Research; Research paradigms; Research Design & Methods; Scientific Research; Research Question; Literature Review; Selecting the Research Method (s); Field Surveys; Data Collection; Sampling; Analytical tools; Research Proposal Writing Techniques; Research Presentation Techniques; Thesis manuscript writing; Funding acquisition; Soft skills development.

Course Aims and Objectives:

This course is designed to expose students to advance research in their field of interest and put their research in publishable format.

Course Outcomes:

At the end of semester, the students should be able to:

1) Understand research methods
2) Literature review of their research projects

3) Develop their research plan
4) Prepare their thesis proposals
5) Prepare presentations
6) Prepare publications
7) Develop soft skills- Resume writing, job interviews etc.

Reference Books/Materials:

There is no specific text book for this course, however, following books are suggested for reference.

1) Dawson, C., 2004, Practical Research Methods; A user friendly guide to mastering research. Published by three Newtec. Place, Magdalen Road, Oxford OX4 IRE, UK. Pp. 169.
2) Kothari, C. R., 2004, Research Methodology; Methods and Techniques (2nd edition), New age International (P) Limited Publishers, New Delhi, India. Pp. 414.
3) Blaxter, L., Hughes, C., and Tight, M., 2006, How to Research (3rd Edition). Open University Press, Berkshire, England. Pp. 306.
4) Jones, J. C., 2015, Concepts in Scientific Writing. Bookboon.com. Pp. 70

Course Code	**GEO 541**
Course Title	**Applications of GIS in Geosciences (3 CH)**

Course Outline:

Introduction to the GIS; Data exploration and preparation for GIS studies; Uses of GIS in hydrocarbon exploration, and in geological studies; Spatial Interpolation; GIS in flood management; Terrain Processing; GIS for watershed delineation; Geospatial Analysis, field development and planning; Analyzing Surfaces, spatial analysis for creating contours, hillshades and calculating viewshed; Map Algebra, working with NoData values, doing conditional processing, and merging multiple Rasters together.

Course Aims and Objectives:

The main focus of this course is to develop understanding of advanced concepts and techniques used in modeling geographic reality and analysis of geo-data. Educate students to explore issues, problem solve, and evaluate situations in a spatial context. It is focused to develop students' GIS and spatial analysis skills, allowing them to become independent learners able to solve complex spatial problems

Course Outcomes:

Students will acquire the advanced knowledge of GIS and will use GIS to:

1) Explore mapped data and Relate GIS with remote sensing technologies
2) Analyze spatial data and perform spatial analysis, using GIS analysis tools and develop and manage geodatabases
3) Create maps, images and apps to communicate spatial data in a meaningful way to others

Reference Books/Materials:

1) Introduction to GIS and Remote sensing by Kang-tsung Chang , 9th edition
2) Campbell, J. B., & Wynne, R. H. (2011). Introduction to Remote Sensing. Guilford Press.
3) Geographic Information Systems and Science, Longley, P., Goodchild et al, 2005, Wiley.

Course Code	**GEO 548**
Course Title	**Advanced Seismic Stratigraphy**

Course Outline:

Introduction to sequence and seismic stratigraphy; Philosophy and history of sequence stratigraphy; Fault mechanical stratigraphy; Vail and Galloway sequence theory; Hierarchy and application; Sequence models; Basin development; sediment deposition and accommodation concepts; Geophysical fundamentals; Examples of operational sequences; Basin related depositional systems; Chronostratigraphy construction and interpretation; Sea level curves; Orders of cyclicity; Carbonate and Siliciclastic sequences; System Tracts; Stratigraphic surfaces; Seismic facies; Paleo-environmental analysis; Geohistory reconstruction; Biostratigraphic signature; Sequences in Deep marine, Shallow

marine, Shelfal, Deltaic and Neritic Environment; Hydrocarbon traps related geometries; Seismic truncations; Data Integration at seismic, log, core and outcrop scale; Demarcation of stratigraphic surfaces on integrated data sets; Static and dynamic models; Optimizing exploration.

Course Aims and Objectives:

Students will be able to:

1) understand the use of sequence stratigraphy as a tool in basin exploration, and describe related workflow structure, ensure accurate stratigraphic breakdown of well data, manipulate and use a full dataset in an integrated project: well log, outcrop
2) Development of sedimentary basins, and their sedimentary infill, with emphasis on depositional processes/environments and resultant stratigraphic architecture.
3) Understand the sequence and sedimentology in a temporal and spatial perspective.

Course Outcomes:

After taking this course you will know:

1) General principles of sequence stratigraphy and their applications in depositional environments and basin types with main processes and products in a range of depositional environments.
2) Spatial and temporal development in sedimentary basins, with a predictive perspective on determining facies distribution.
3) Seismic expression of various strata and their sequence stratigraphic expression.

Reference Books/Materials:

1) Siliciclastic Sequence Stratigraphy - Concepts and Applications" by H.W. Posamentier and G.P. Allen, 2000; SEPM Concepts in Sedimentology and Paleontology Series 7, Society for Sedimentary Geology, 204 pages.
2) Seismic and Sequence Stratigraphy and Integrated Stratigraphy: New Insights and contributions by Gemma Aiello edition I.2017
3) The Sedimentary Record of Sea-Level Change by Angela L.Coe, cmabridge uni press 2nd edition,2003
4) Sequence Stratigraphy and Facies Associations (Special Publication 18 of the IAS) Henry W. Posamentier,haq and Allen,
5) Seismic Stratigraphy and Depositional Facies Models by P.C.H Veeken, 1st edition
6) Seismic Stratigraphy, Basin Analysis and Reservoir Characterisation by P.C.H Veeken, volume 37

Course Code	**GEO 505**
Course Title	**Advanced Sedimentology (3 CH)**

Course Outline:

Concept of facies and the connection between tectonics and deposition; Facies and facies associations of various environment; ancient deposits; Methods of study of sedimentary rocks; Accommodation and shoreline shifts; Sediment mobility under unidirectional, bidirectional and gravitational currents; Bed-form geometry; Spatial distribution; Types of contacts in the clastic sedimentary rock record; Time attributes of stratigraphic surfaces; Concept of hierarchy in the rock record; Depositional systems on large and small scales; Detailed depositional systems, Fluvial systems, Aeolian systems, Estuarine systems, Deltaic system, Shallow-water systems, Deep-water systems; Subsurface reservoir geometry and flow properties; Morphology, Modern analogues; Sedimentary textures; Sedimentary structures and flow regimes in the context of each sub environment; Petroleum system characteristics; Stratigraphic stacking patterns in modern and ancient depositional system.

Course Aims and Objectives:

The course will help in enhancing the concept of facies and the connection between tectonics and deposition. The students will be able to discuss the processes acting, and the resulting facies and facies associations in modern depositional environments. Further, they will learn how facies and facies associations can be used in the interpretation of ancient deposits from all continental and marine environments will be examined.

Course Outcomes:

1) Describe and interpret sediments from all sedimentary environments.
2) Locate, synthesize and interpret data, information and observations on marine sedimentary successions at an advanced level.
3) Apply knowledge and appropriate techniques, including those associated with fieldwork, to interpret the geological importance of marine and terrestrial sedimentary populations at an advanced level.

Reference Books/Materials:

1) Lindholm, R. (2012). A practical approach to sedimentology. Springer Science & Business Media.
2) Potter, P. E., Maynard, J. B., & Pryor, W. A. (2012). Sedimentology of shale: study guide and reference source. Springer Science & Business Media.
3) Perry, C., & Taylor, K. (Eds.). (2009). Environmental sedimentology. John Wiley & Sons.
4) Nichols, G. (2009). Sedimentology and stratigraphy. John Wiley & Sons.

Course Code	**GEO 506**
Course Title	**Hydrocarbon Geochemistry**

Course Outline:

Study of organic carbonaceous materials in relation to the genesis and modification of fossil fuel and ore deposits. Biological origin of the organic matter with emphasis on contributions of microorganisms to the nature of these deposits. Biochemical and thermal changes which convert the organic compounds into hydrocarbon, oil shale, tar sand, coal and other carbonaceous matter. Principal analytical techniques used for the characterization of organic matter in the geosphere and for evaluation of oil and gas source potential. Organic matter in hydrocarbon generation. Kerogen and its types. Thermal maturation modeling of hydrocarbon source rocks; subsidence history, thermal history. Depositional settings of hydrocarbon source beds; hydrocarbon types; rock pyrolysis; hydrocarbon generation, expulsion and secondary migration. Evaluation of source rock potential. Labs will emphasize source rock evaluation, and oil source rock and oil correlation methods.

Course Aims and Objectives:

To have a basic understanding of the hydrocarbon system, hydrocarbon as a resource, and the value chain. Have a basic understanding of a broad array of tools used in the search for and production of hydrocarbon reserves. Understand how geologists conduct the search for hydrocarbon resources through the value chain or the life cycle of a hydrocarbon resource. This will include the processes involved and actual examples.

Course Outcomes:

On completing the programme students should learn:

1) An advanced knowledge and understanding of the origin of hydrocarbon source rocks and
2) of the processes of oil and gas generation in sedimentary basins
3) Understanding of the processes influencing hydrocarbon migration and trapping
4) Understanding of the geochemistry of hydrocarbon reservoirs
5) An understanding of the geochemistry of molecular marker compounds in sediments and crude oils - their uses and limitations
6) An understanding of the principles, applications and limitations of the main analytical techniques used in hydrocarbon geochemistry, and an advanced understanding of some of these techniques.

Reference Books/Materials:

1) Hydrocarbon Geochemistry and Geology by John Hunt.
2) The Biomarker Guide: Volume 1, Biomarkers and Isotopes in the Environment and Human History 2nd Edition, Kindle Edition by K. E. Peters (Author), C. C. Walters (Author), J. M. Moldowan (Author).
3) The Biomarker Guide, Volume 2: Biomarkers and Isotopes in the Hydrocarbon Exploration and Earth History (The Biomarker Guide 2 Volume Hardback Set) 2nd Edition by K. E. Peters (Author), C. C. Walters (Author), J. M. Moldowan (Author).
4) Hydrocarbon Formation and Occurrence: A New Approach to Oil and Gas Exploration Book by Bernard P. Tissot and Dietrich H. Welte.

Course Code	**GEO 508**
Course Title	**Stratigraphy and Petroleum Prospects of Pakistan (3 CH)**

Course Outline:

Introduction to Stratigraphy and Facies analysis; Lithostratigraphy; Biostratigraphy; Controls of sedimentary environments on the development of hydrocarbon and coal resources; Sedimentary basins of Pakistan; Brief review of Stratigraphy of Pakistan; Potential source rocks of Pakistan, Potential reservoir rocks of Pakistan; Trapping mechanism in different sedimentary basins of Pakistan; Unconventional hydrocarbon prospects of Pakistan; Review of case histories for Conventional and Unconventional hydrocarbon prospects of Pakistan.

Course Aims and Objectives:

To provide theoretical knowledge to the student and practical application of the subject in the industry. Main focus of the course is on the development of hydrocarbon resources in different depositional environments. Introduce the students with the Petroleum Prospects of Pakistan including Conventional and Unconventional.

Course Outcomes:

1) Be able to apply this understanding to the description of sedimentary rocks in order to deduce depositional processes and environments.
2) To produce better useful petroleum stratigrapher working hand in the field and able to work in the industry.
3) Apply this understanding for the analysis of the petroleum prospects in the subsurface using geophysical data.

Reference Books/Materials:

1) Stratigraphy of Pakistan, By Shah, S. M. I., 2009. Geological Survey of Pakistan. Memoir, Vol. 22.
2) Stratigraphy and Historical Geology of Pakistan by Kazmi, A. H. and Abbasi, I. A., 2008, Graphic Publishers, Karachi, Pakistan.

Course Code	**GEO 507**
Course Title	**Basin Analysis (3CH)**

Course Outline:

Basin formation in various types of geotectonic setting; Basin infill dynamics; Subsidence history and consequences for reservoir and source rock development and the petroleum system; Mechanisms of sedimentary basin formation by stretching, strike-slip, flexure and compression; Effects of mantle dynamics; Basin infill mechanisms and depositional systems; Basin stratigraphy, subsidence and thermal history; Changes of reservoir and petrophysical parameters during burial and tectonic processes; Application to the petroleum system Leading towards the play concept; Sedimentary basins of Pakistan; Sedimentary basin and their formation processes; A review of petroleum systems of pakistan with respect to basin analysis.

Course Aims and Objectives:

This course will deal with the concrete theoretical foundation building regarding basin studies along with Practical approach to learn about different basins and their formation processes, depositional patterns and filling of basin with sediments.

Course Outcomes:

After studying the course students will be able to

1) To fully understand and get equipped with regional petroleum play assessment of basins along with its theoretical background.
2) To give a quantitative as well as qualitative fundament for analyzing sedimentary basins, particularly from seismic data
3) To integrate the data set to develop static and dynamic basin models

Reference Books/Materials:

1) Basin Analysis: Principles and Application to Petroleum Play Assessment, 3rd Edition by Philip A. Allen, John R. Allen, 2013
2) Physical Principles of Sedimentary Basin Analysis, by Magnus Wangen, 2010
3) AAPG memoir 60: The petroleum system from source to trap by Leslie b. Morgan and Wallace G Dow
4) Seismic stratigraphy, basin analysis and reservoir characterizations' by p. C. Veeken

Course Code	**GEO 547**
Course Title	**Drilling Operations and Well Site Geology (3 CH)**

Course Outline:

Well Planning and its pre-requisites; Drilling of a well (Vertical & Directional); Drilling Rig Types; Components of a drilling Rig and their Operation (Derrick/Mast, Sub-structure, Hoisting, Rotary, Circulatory, Well Control, Bits etc.); Introduction to Drilling Fluids, Their Types & Selection; Casing, Casing Design and casing /cementing operation; Coring, its requirement, Types & Operation; Fishing; Mud Logging and its benefits; Lag Time Calculation; Drill Return (Cuttings) collection/ Sampling; Master Log and recorded parameters with their interpretation; Visual and microscopic analysis of cuttings at well site for lithological identification, porosity measurement, fluorescence/oil shows and formation tops; Chromatographic Analysis and interpretation of Gas Shows; Wireline logging Operations and their quality control; Measurement while drilling and its utilization; Well Testing (DST, MDT etc.); Perforation & Completion of a successfully tested well.

Course Aims and Objectives:

This course describes the complete package of well site operations required for a well site geologist to interpret/evaluate drilling as well as mud logging parameters with a very effective & practical approach.

Course Outcomes:

On completion of the course, students are expected to:

1) Familiarize with key concepts of Well Planning and its drilling according to the analysed, estimated and prognosed parameters.
2) Have basic knowledge about drilling fluid, its system and selection as per prognosed drilling as well as formation / reservoir pressure parameters.
3) Monitoring & Quality control of all well site operations, their outcomes, issues with them and their possible solutions.

Reference Books/Materials:

1) The Wellsite Guide (An Introduction to Wellsite Geological Operations) by Bernhard W. Seubert
2) Wellsite Geology (Reference Guide) by Baker Hughes INTEQ
3) The Online Mud Logging Handbook by Alun Whittaker
4) Properties of Petroleum Fluids (2nd Edition) by W.D. McCain
5) Field Methods for Petroleum Geologists by Fakhry A. Assaad
6) Introduction To Oil Well Drilling (International Edition) by Natraj Vaddadi
7) Oilwell Drilling Engineering : Principles and Practice by H.Rabia
8) Working Guide to Drilling Equipment and Operations by William Lyons

Course Code	**GEO 510**
Course Title	**Development of Groundwater Resources (3 CH)**

Course Outline:

Introduction to Groundwater, types of aquifer, Karez, groundwater resources of Pakistan; An introduction to geophysical and geochemical methods of exploration for planning, and design of regional water resources investigations; Groundwater Exploration, reconnaissance survey, surface investigation methods, subsurface investigations including test drilling, drilling methods, resistivity logging, radiation logging, temperature logging, velocity measurement and other methods; Groundwater Management, groundwater monitoring, observation network, water table fluctuation, selection of sites for the observation network, installation of observation wells and piezometers; Conjunctive use of surface and groundwater; Groundwater recharge; Groundwater balance; Groundwater quality; Case histories in the sustainable management of ground-water resources.

Course Aims and Objectives:

The course should enable students to:

The aim of this course is to impart knowledge about the importance and physical distribution of groundwater resources at the global scale with a special emphasis on Pakistan under drivers or climate change. Methods for the groundwater quantitative and qualitative assessment and for evaluation of the interactions between groundwater discharge and ecosystems. Substantiable Groundwater Management.

Course Outcomes:

1) The students will be able to impart knowledge about the importance and physical distribution of groundwater resources at the global scale with a special emphasis on Pakistan under drivers or climate change.
2) The students will be able to understands the exploration methods for the groundwater quantitative and qualitative assessment and for evaluation of the interactions between groundwater discharge and ecosystems.
3) The students will be able to develop Substantiable Groundwater Management plan.

Reference Books/Materials:

1) Anderson, M and Woessner, William: Applied Groundwater Modelling, Simulation of Flow and Advective Transport, 381 pages, Academic Press; 1st edition (1991) ISBN-10: 0120594854, ISBN-13: 978-0120594856
2) Freeze, R .A. and J.A. Cherry (1979): Groundwater.- Prentice-Hall, Englewood Cliffs

3) Fetter, C.W. (2001): Applied Hydrogeology.- Prentice Hall, Englewood Cliffs Fetter, C.W. (1993): Contaminant Hydrogeology. - Macmillan Publishing Company, New York; S.

Course Code	**GEO 531**
Course Title	**Advanced Structural Geology (3 CH)**

Course Outline:

Structural Geology and Tectonics; Deformation of earth´s lithosphere; Theoretical aspects of rock deformation; Quantitative aspects of stress and strain analyses; The broad spectrum of deformation complexities in contractional, extensional and strike-slip regimes at various scales; Rheological properties of the lithosphere; Brittle and plastic deformation processes at the microscale and macroscale; Interaction between climate and tectonic; Practices in exploration software, MOVE; Geometric and kinematic modeling of brittle structures.

Course Aims and Objectives:

The course includes a quantitative approach of stress and strain in various tectonic setting, advanced aspects of rock deformation and rheology in the light of brittle, ductile and plastic deformation processes, an appraisal of the spectrum of complex deformation geometries, approaches of balancing and restoring deformation, as well as aspects of climate-tectonic interaction.

Course Outcomes:

The student will be able to

1) Recognize moderately complex structures and can relate these to specific deformation regimes as well as quantitatively describe stress and strain
2) Know that tectonic styles can result from a combination of endogenous and exogenous processes
3) Discuss aspects in structural geology and tectonics with respect to the regional geology of Pakistan

Reference Books/Materials:

1) Bond, C.E., Lunn, R.J., Shipton, Z.K., and Lunn, A.D., 2012, What makes an expert effective at interpreting seismic images? Geology, v. 40, p. 75-78, doi:10.1130/G32375.1
2) Bond, C.E., Gibbs, A.D., Shipton, Z.K., and Jones, S., 2007, What do you think this is? "Conceptual uncertainty" in geosciences interpretation: GSA Today, v. 17, no. 11, p. 4-10.
3) Pilkey, O.H. and Pilkey-Jarvis, L., 2007, Useless arithmetic: why environmental scientists can't predict the future: New York, Columbia University Press, 230 p.

Course Code	**GEO 520**
Course Title	**Rock Mechanics (3CH)**

Course Outline:

Introduction to Rocks: Nature of rock **; Classification and Index properties of Rocks:** Geological classification of rocks, Index properties of rock systems (Porosity, Density, Hydraulic permeability and conductivity, Strength, Slaking and durability, Sonic velocity), Classification of rock masses for engineering purposes **; Rock Strength and Failure Criterion:** Modes of rock failure, Common laboratory strength tests, stress-strain behavior in compression, Rock strengths, Stress-Strain curve, Mohr-Coulomb failure criterion, Anisotropic rocks **; Planes of Weaknesses in Rocks ; Rock Support and Reinforcement**

Course Aims and Objectives:

Aims and objectives of the course are as follows:

1) To develop the understanding of rock varieties and their response against varieties of stresses.

2) To develop the skills for proper data collection, interpretation and classification.

3) To develop the better understanding of excavation and support designs.

Course Outcomes:

On successful completion of course student will be able to

1) Identify the rock variety on the basis of its geomechanical behavior and its response against variety of forces.
2) Identify the objectives of geotechnical data collection and rock mass classification methods and can easily collect the data for geotechnical dataset.
3) Identify the principles of rock mechanics and excavation designs to develop excavation proposals for geologic environments i.e. stratified, massive, blocky or faulted lithology.

Reference Books/Materials:

1) Introduction to rock mechanics 2nd edition by Richard E. Goodman

Course Code	**GEO 521**
Course Title	**Soil Mechanics (3CH)**

Course Outline:

Introduction: Introduction and concepts of soil mechanics**; Composition and Particle Sizes of Soils:** Composition of soils, Determination of particle size, Soil characterization on particle sizes, comparison of fine and coarse grained soils in engineering use**; Classification and Index properties of Rocks:** Phase relationship, Physical properties of soils, Index properties of find grained soils, Atterberg limits, Classification systems for soil**; Soil Investigation:** Purpose and phases of soil investigation, Soil exploration methods. Soil identification in field, Numbers and Depth of boreholes, Soil sampling, Groundwater conditions, Field tests and Laboratory tests**; Soil Compaction:** Behavior of soil in compression, factors affecting compaction, Laboratory and field determination of soil compaction

Course Aims and Objectives:

Aims and objectives of the course are as follows:

1) To develop the understanding of soil index properties.
2) To develop the skills for proper data collection, interpretation and classification.
3) To develop the better understanding of soil investigation techniques both used in filed and laboratory.

Course Outcomes:

On successful completion of course student will be able to

1) Identify the soil variety on the basis of its index properties.
2) Identify the data collection and rock mass classification methods and can easily collect the data for geotechnical dataset.
3) Identify the principles of soil mechanics and can identify the locations with the potential of slope failure problems.

Reference Books/Materials:

1) Principles of geotechnical engineering, 5th edition by Braja, M. D., 2001, Brooks / Cole.
2) Soil Mechanics: Concepts and applications, 2nd edition, by Powrie, W., 2004, Taylor & Francis.
3) Geotechnical Engineering: Principles and practices of soil mechanics

Course Code	**GEO 522**
Course Title	**Geochemical Exploration (3CH)**

Current Course Outline:

Basic principles for geochemical exploration. Geochemical dispersion, geochemical mobility and association of elements. Classification of mineral deposits. Types of geochemical anomalies in bed-rock residual and overburden, drainage sediments, and natural waters. Orientation surveys. Role of path finder elements in mineral exploration. Decay pattern in stream sediments. Statistical interpretation of geochemical data. Geochemical methods and selection of sediments in mineral exploration with emphasis on litho stream sediments and soil survey. Geochemical evaluation and appraisal of ore deposits.
Lab. Preparation of histogram, frequency diagram sand geochemical maps.

Course Aims and Objectives
Aim:

To enable students to acquire technical knowhow for geochemical exploration and to analyze, explain and apply the geochemical processes controlling the geochemical anomalies
Objectives:

1. To enable students to understand applied geochemistry to target ore deposits
2. To enable students to know different field and laboratory techniques to analyze minerals and rocks
3. To interpret field and lab data for targeting possible geochemical anomalous zones

Course Outcomes:

The course is designed to impart practical knowledge to the students to understand the basics of geochemistry and its applications. Geochemical exploration is an integrated study combined with mineral prospecting and exploration. After acquiring knowledge in geochemical exploration, the students will be able to use different geochemical techniques required for specific ore deposits. The ores are mineralized in rocks and/or deposited as placer deposits. The ultimate goal is to target mineralized zones as resources for societal needs.

Reference Books/Materials:

1. Rock Geochemistry in Mineral Exploration by G.J.S Govett (1983)

2. Geochemistry in Mineral Exploration: Harper's Geoscience Series by **Herbert Edwin Hawkes (Author), John Stuart Webb (Author), Carey Croneis (Editor) (2012),** Literary Licensing, LC publisher
3. Geochemical Exploration, Volume 17 by G.R. Parslow (1984), Elsevier Science publisher
4. Practical problems in exploration geochemistry by A.A. Levinson et al (1987), Thomson Applied Publication

Course Code	**GEO 523**
Course Title	**Isotope Geochemistry (3CH)**

Course Outline:

Principles of stable isotopes geochemistry; stable isotopes in the atmosphere and hydrosphere; stable isotope variations in various types of rocks and weathering and diagenetic processes; carbon and sulphur-isotope studies of organic matter; fossil fuels and related materials, applications in burial and tectonic evolution. On the other hand radioactive decay introduction, decay mechanisms (beta, positron, electron capture, alpha), fission, rates of radioactive decay, half-life, decay series and secular equilibrium, applications of natural radioactivity and units of radioactivity; an introduction to isotopic dating methods and radiogenic isotope as tracers of geological processes**:** introduction, K-Ar, Ar40-Ar39, Rb-Sr, Sm-Nd, U-Th-Pb (concordia, discordia, zircons, isochrons), extinct radio nuclides, fission tracks, cosmogenic nuclides and C14 dating, heterogeneity of the earth's mantle, Nd and Sr isotope compositions of the ocean. Laser probe isotope geochemistry and dating techniques. Data oriented exercises; Discrimination diagrams and interpretation; mass spectrometry of stable isotopes and radioactive nuclides.

Course Aims and Objectives:

To impart the basic understanding of the stable and radiogenic isotope geochemistry to the students. Radiogenic isotopes have very useful contribution in dating techniques. Stable isotopes can reveal the genesis of various types of rocks and minerals.

Course Outcomes:

The students would learn about the isotopes in general and stable and radioactive isotopes in particular, used in earth sciences. This subject would also enable the students to understand the geological process and related minerals deposits, their origin and emplacement in particular geological environment.

Reference Books/Materials:

1. Attendorn H. G. and Bowen R. N. C. (1987) Radioactive and Stable Isotope Geology. Chapman and Hall, London. QE501.4. N9 B69.
2. Barrie A. and Prosser S. J., (1996) Automated analysis of light-element stable isotopes by isotope ratio mass spectrometry. In: Mass Spectrometry of Soils (eds: T. W. Boutton and S. Yamasaki). Marcel Dekker Inc. New York, p 1-46. S593.M4415.
3. Boutton T. W. and Yamasaki S. editors (1996) Mass Spectrometry of Soils. Marcel Dekker Inc, New York. S593.M4415.
4. Coleman D. C. and Fry B. editors (1991) Carbon Isotope Techniques. Academic Press Inc. San Diego. QH 324.3.C37.

5. Faure G., (1986) Principles of Isotope Geology. John Wiley and Sons, New York.
6. Hoefs J., (1997) Stable Isotope Geochemistry. Springer, Berlin. QE515.H67
7. Knowles R. and Blackburn T. H. editors (1993) Nitrogen Isotope Techniques. Academic Press, Inc. San Diego. QH324.35.N1 N57.
8. Lajtha K. and Michener R. H. editors (1994) Stable Isotopes in Ecology and Environmental Science. Blackwell Scientific Publishing. QH541.15.S68 L35.
9. Longstaffe F. J., (1987) Stable isotope studies of diagenetic processes. In: Stable Isotope Geochemistry of Low Temperature Fluids (ed. T. K. Kyser) Mineralogical Association of Canada, Saskatoon, May 1987. Volume 13, p 187-257. QE501.4.N9 S725.
10. Longstaffe F. J. (1989), Stable isotopes as tracers in clastic diagenesis. In: Short Course in Burial Diagenesis (ed. I. E. Hutcheon) Mineralogical Association of Canada, Montreal, May 1989. volume 15, p 201-277.
11. Sharp Z. (2007) Principles of Stable Isotope Geochemistry. Pearson Prentice Hall, New York. Valley J. W. and Cole D. R. editors (2001) Stable Isotope Geochemistry. Mineralogical Society of America, Reviews in Mineralogy and Geochemistry, volume 43. QE501.4.N9 S724.
12. Attendorn H. G. and Bowen R. N. C, 1987, Radioactive and Stable Isotope Geology. Chapman and Hall, London. QE501.4.N9 B69 Boutton T.W. and Yamasaki S. editors, 1996, Mass Spectrometry of Soils. Marcel Dekker Inc, New York. S593.M4415.
13. Dicken A.P., 1995, Radiogenic Isotope Geology. Cambridge University Press. QE501.4.N9 D53 Coleman D. C. and Fry B. editors, 1991, Carbon Isotope Techniques. Academic Press Inc. San Diego. QH 324.3.C37 .
14. Faure G., 1986, Principles of Isotope Geology. John Wiley and Sons, New York. Knowles R. and Blackburn T. H. editors (1993) Nitrogen Isotope Techniques. Academic Press, Inc. San Diego. QH324.35.N1 N57.
15. Lewis C. L. E. and Knell S. J. editors, 2001, The Age of the Earth: From 4004 BC to AD 2002. The Geological Society of London. QE508.A33.
16. Longstaffe F. J., 1987, Stable isotope studies of diagenetic processes. In: Stable Isotope Geochemistry of Low Temperature Fluids (ed. T. K. Kyser) Mineralogical Association of Canada, Saskatoon, 1987. Volume 13, p 187-257. QE501.4.N9 S725.
17. Longstaffe F. J., 1989, Stable isotopes as tracers in clastic diagenesis. In: Short Course in Burial Diagenesis (ed. I. E. Hutcheon) Mineralogical Association of Canada, Montreal, 1989, volume 15, p 201-277.

Course Code	**GEO 524**
Course Title	**Clastic Sedimentology (3CH)**

Course Outline:

Texture of clastic sedimentary rocks. Sedimentary structures, their classification, and hydrodynamic conditions. Pealeo current analysis and provenance of elastic rocks. Sedimentary environment sand facies. Continental environments: Deserts, rivers lakes, glaciers and wind. Transitional environments; Delta, estuary,inter deltaic complexes. Marine environments: shelf, slope and deep marine. Diagenesis of clastic rocks.

Lab. Petrographic study of elastic rocks. Heavy mineral analysis. Recording, plotting and analysis of Paleocurrent data. Field techniques for study of elastic sedimentary rocks.

Course Aims and Objectives:

This objective of this course is to acquire knowledge about texture and classification of sedimentary rocks, Sedimentary environments and facies analysis, Paleocurrent analysis and Diagenesis and provenance analysis of clastic rocks

Course Outcomes:

After studying clastic sedimentology students will be able to

1) Understand about various clastic rocks and their diagenesis
2) Understand the classification and depositional system of clastic rocks
3) Know about the sediments play in global climate system as well as how energy and other resources come from clastic rock.

Reference Books/Materials:

1) Sedimentary Environments and Facies by Reading, H. G., 1986, Blackwell Scientific Publications.
2) Ancient Sedimentary Environments by Selley, R. C., 1978, Chapman and Hall.
3) Origin of Sedimentary Rocks by Blatt. H., Middleton, G and Murrey, R., latest Ed., Prentice Hall.
4) Depositional Sedimentary Environments by Renieck, H. E. and Singh, I. B., 1980, Springer-Verlag.

5) Sand and Sandstones by Pettijohn by F.J., Potter, P. E. and Sever, R., latest Edition., Springer Verlag.
6) Principles of Sedimentology by Friedman, G. M. and Sanders, J. E., 1978, John Wiley and Sons.
7) Petrology of Sedimentary Rocks by Boggs Jr. S., 1992, Merril Publishing Co.
8) Sedimentary Rocks by Pettijohn, F. J., latest Ed., Harper and Row.
9) Depositional Systems, A Genetic Approach to Sedimentary Geology by Davis, R. A. Jr., 1983. Prentice-Hall.
10) Sedimentary Petrology, An Introduction by Tucker, M. E., 1981, Black Well Scientific Publications Osney Mead.
11) Terrigenous Clastic Depositional Systems, Application to Petroleum, Coal and Uranium Exploration by Galloway, W. E. and Hobday, D. K., 1983, Springer-Verlag, New York, Inc.
12) A Practical Guide to the Study of Glacial Sediments by David J. Evans, 2004, Oxford University Press.
13) Microfacies of carbonate rocks. Analysis, interpretation and application by Flugel, E., 2004, Springer

Course Code	**GEO 525**
Course Title	**Carbonate Sedimentology (3CH)**

Current Course Outline:

Carbonate mineralogy and chemistry: structure of aragonite, calcite and dolomite, trace elements and isotopes, Dolomite and dolomitization models: Modern and ancient examples Dolomitization reactions, trace element geochemistry of dolomites, dolomite petrography. Depositional textures and structures: Carbonate constituents, algal stromatolites. Classification of carbonates by Folk and Dunham. Porosity types. Concept of micro facies and micro facies types of Wilson. Major controls on carbonate sedimentation. Depositional processes and facies in carbonate rocks. Carbonte depositional models, platforms, rimmed shelves, ramps, epeiric plat forms and isolated platforms. Cyclicity in carbonates. Modern carbonate environments of Bahamas, Florida and Persion gulf. Carbonted positional systems; Lacustrine, shoreline, peritidal reefs, shallow and deep water. Diagnetic processes: sequences and models.
Lab. Identification of carbonate sediments in hand specimen and thin sections. Microfacies interpretations Staining and XRD techniques.

Course Aims and Objectives:

This objective of this course is to study carbonate rocks and the processes associated to it. Study the different depositional systems of carbonate rocks and diagenesis

Course Outcomes:

After studying clastic sedimentology students will be able to

1. To know about carbonate mineralogy and chemistry
2. Understand classification, and depositional models,

3. Understand microfacies, cyclicity in carbonates, carbonate depositional systems.

Reference Books/Materials:

1. Carbonate Sediments and their Diagenesis by Bathurst, R. G., latest Edition., Elsevier.
2. Marine Carbonate by Milliman, J. D., 1974, Springer-Verlag.
3. Carbonate Depositional Environment by Scholle, P. A. Bebout, D. G. and Moore, C. H., AAPG Mem.
4. Carbonate Sedimentology by Tucker, M. E. and Wright, V. P., 1990, Blackwell Scientific Publications.
5. Carbonate Depositional Environments by Scholle, P. A.,, Bebout, D. G. and Moore, C. H., 1993, Mem. Am. Assoc. Petrol. Geol.

Course Code	**GEO 526**
Course Title	**Clay Mineralogy (3CH)**

Course Outline:

Introduction, structure and classification of clay minerals; introduction to analytical methods for clay separation and their identification; origin and diagenesis; clay minerals during diagenesis and low-grade metamorphism; paleothermometery; geological significance in petroleum industry; depositional environments; clay minerals and sedimentation; significance of clay minerals in soils, drilling fluids and reservoirs; industrial applications. Economic clay deposits of Pakistan Identification of clay minerals by XRD and XRF techniques; data-oriented exercises.

Course Aims and Objectives:

Clay minerals make an important resource in making medicines, pottery, drilling fluids etc. The main objective of this course is to get the students know the importance of clay minerals and their uses in various industries.

Course Outcomes:

The students would learn about different clays minerals and their parent rocks, mineralogical and chemical composition and distribution in Pakistan.

Reference Books/Materials:

1. Clay minerals by Grim R. E., 1986, McGraw-Hill, New York.

2. X-RayIdentification and crystal structure of clay minerals by Brown G., latest edition, Min. Soc. London.

3. Crystal Structure of Clay Minerals and their X-Ray Identification by Brindley and Brown, 1980, Min Soc. London.

4. X-Ray Diffraction and the Identification and Analysis of Clay Minerals by Moore and Renolds, 1989.

Course Code	**GEO 520**
Course Title	**Hydrochemistry and Groundwater Pollution (3CH)**

Course Outline:

Laws of chemistry related to water and its reaction with the aquifer material; Principles and processes controlling composition of natural water; Sources, Nature and effects of groundwater contamination; Mass transport of solutes and chemical processes occurring in aquifers; apply the principles of low temperature geochemistry, including the interactions between groundwater, the geological environment, and anthropogenic waste to interpret hydrochemical data; Saline intrusions in coastal and estuarine sediments; Fundamental Concepts of Groundwater Flow, Transport and Contamination. Basic to Advanced Principles in Groundwater Pollution and Hydrology. Water-Quality Standards (EPA), Plan groundwater sampling, develop monitoring programmes as well as sampling and sample preparation procedures; use interpretation programmes to present and interpret hydrochemical data and to solve problems.

Lab Work: Ground water sampling for chemical analysis.

Course Aims and Objectives:

1) Natural groundwater quality and principles of contaminant transport and common remediation techniques.
2) Ground water sampling for chemical analysis and interpretation methods.
3) The student with an integrated understanding of groundwater chemistry and contaminant hydrogeology as preparation for a career as a geohydrologist or geohydrochemisty

Course Outcomes:

1) Students will understand about Natural groundwater quality and principles of contaminant transport and common remediation techniques.
2) Students will understand Ground water sampling for chemical analysis and interpretation methods.
3) Students will also be prepared to provide expert hydrochemical input to the industry.

Reference Books/Materials:

1) Appelo, C.A.J. and Postma, D., 2004. Geochemistry, groundwater and pollution. CRC press
2) Emmanuel Olutayo, Martins Olorunfemi. 2018. Geophysical and Hydrochemical Investigations of Groundwater Pollution. LAP LAMBERT Academic Publishing

Course Code	**GEO 528**
Course Title	**Groundwater Modeling (3 CH)**

Course Outline:

Purpose of groundwater modelling; Conceptual model, conceptualization of aquifer-aquitard systems; Specification of boundary conditions; Hydrological stresses; Design of numerical model, finite-difference solutions of flow problems; Steady versus unsteady model; One layer versus multi-layer model; Lay-out of grids; Stress period/time steps; Model inputs, initial conditions; boundary conditions; Hydrogeological parameters, model calibration procedures and validation, selection of model code; Model prediction, purpose of prediction; Simulation of scenarios; Determination of capture zones; Introduction to MODFLOW; Exercises and case study.

Course Aims and Objectives:

Upon completion, the participant should be able to: Describe process and procedures of applied groundwater modelling. Construct numerical groundwater models using popular modelling tools with hands-on exercises. Use groundwater models to simulate groundwater flow, contaminant transport, and saltwater intrusion with hypothetical examples. Apply groundwater models for groundwater resources management and protection in real-world case studies.

Course Outcomes:

At the conclusion of this course, the student will:

1) Have a better understanding of basic components of a groundwater modeling ;
2) Be familiar with most common solution methods used in groundwater modeling; and
3) Be able to define boundary conditions and to perform calibration for the computer models.

Reference Books/Materials:

1) Applied Hydrogeology, Author: C.W. Fetter Jr.
2) Fundamentals Of Groundwater Modelling, Authors: Husam Baalousha
3) Applied Groundwater Modeling: Simulation of Flow and Advective Transport: Authors: Mary P. Anderson, William W. Woessner

Course Code	**GEO 529**
Course Title	**Industrial Mineralogy (3CH)**

Course Outline:

Physical and chemical properties of minerals; relationship between the structure, chemistry and properties of various rocks and minerals. Mechanisms of mineral nucleation and crystal growth; importance of kinetics in mineral formation. Exploration and Exploitation techniques; sands and gravels, hard rock aggregates, dimension stone, slate, limestone and dolomite, magnesite, clays (common clay/shale, kaolin, bentonite, and fuller's earth), silica sand, dunite and serpentinite, feldspars, nepheline syenite; natural abrasive raw materials, gypsum, anhydrite, chromite, barite and gemstones including diamond and their industrial uses. Mineralogy and chemistry of raw materials for cement, glass, agriculture, chemical and refractories; industrial minerals and their environmental impacts; risk assessment and economic evaluation. Economic potential of industrial rocks and minerals in Pakistan. Interpretation of geological maps in terms of their industrial rock and mineral potential; use of resource map of various types to suggest potential areas of worth, reserve estimation; risk analysis

Course Aims and Objectives:

The use of industrial rocks/minerals has increased manifold in recent years. This course is designed to introduce students to common rocks/minerals being utilized in the industries.

Course Outcomes:

The outcomes of this course are to understand physical and chemical properties of industrial rocks and minerals, kinematics of the mineral formation, beneficiation processes of various industrial minerals and rocks.

Reference Books/Materials:

1. Applied Mineralogy by Jones, M. P., 1987, Graham and Trotman.
2. X-ray diffraction and the identification and analysis of clay mineral by MOORE, D. M. and Reynolds, Jr., R. C., 1989, Oxford University Press.
3. Minerals and rocks for industry by Ahmad, Z. and Siddiqi, R. A., 1992, Geological survey of Pakistan, Quetta.
4. Geology of the Industrial Rocks and Minerals by BATES, R. L., 1960. Dover

5. Mineral Resources and Their Management by Lunden, J. B.,1985,

6. Refractories for Iron and Steel making by Chesters, J. H., 1974, the Metals Society.

7. Industrial Geology by Knill, J. L., 1978, Oxford University Press.

8. Mineral Processing Technology by Wills, B. A., 1988, Pergamon Press.

Course Code	**GEO 530**
Course Title	**Advanced Marine Geology (3 CH)**

Course Outline:

Evolution of ocean basin and marine Environment; Types of marine/ocean basins; Concept of Oceanography; Modern and ancient deep-marine processes; Deposits and environments; Physical and Biological processes in shallow and deep-marine environments; Key Concepts and Techniques in Oceanographic data analysis and Sediment transport processes; Sediments and facies, beds, their sedimentary characteristics and interpreted depositional processes; Deep-water ichnology; Trace-fossil assemblages as palaeo-environmental indicators; Mineral resources of sea; Time-space integration including sedimentary marine deposition; Statistical properties of sediment; Gravity flow deposits; mass transport Deposits; Bed thickness distributions; Sea bed morphology; Sediment drifts and abyssal sediment waves, Contourites; Submarine fans and related depositional systems; Interpretations of sub-environments; Offshore data processing; Integration and dominant geological processes; GIS and remote sensing concepts in marine tomography; Climate processes; Interactions and impacts of climate change.

Course Aims and Objectives:

Students will have a clear overview of how ocean basins form and change in time also they will understand the dynamics of the earth's crust and its importance for geomorphology and evolution. Types of sediments and rocks, the reason for the existence of oceans and continents and the spatio-temporal dynamics of marine sedimentary and igneous processes. Climatic variations over the period of time. Numerous case-studies demonstrated in the class will illustrate concepts such a plate tectonics via island formation, and sedimentology via discussion of attractive sedimentary systems, such as coral reefs. Students will have a broad understanding of geological ocean dynamics

Course Outcomes:

1) A solid grounding in marine geology and the driving forces behind, consequences, and importance of sea-level changes in the geological record.
2) Be able to describe sediments found in different water depths and settings, and understand the sedimentary processes leading to their deposition.
3) Be able to describe the main geological and geophysical techniques for observing the seabed and sub-seabed. Impacts of climate change and global warming

Reference Books/Materials:

1) Kevin T. Pickering & Richard N. Hiscott (Deep Marine Systems, to be published by Wiley-Blackwell in late 2014)
2) Haq, B. U., & Milliman, J. D. (1985). Marine geology and oceanography of Arabian Sea and coastal Pakistan.
3) Wright, D. J., & Barlett, D. J. (Eds.). (1999). Marine and coastal geographical information systems. CRC press.
4) BUL-The Sea Floor An Introduction to Marine Geology By E. Seibold W. H. Berger. 3rd Ed 1996

Course Code	**GEO 534**
Course Title	**Reservoir Geology (3CH)**

Course Outline:

Reservoir rock types, Clastics, carbonates, and non-marine reservoirs; Introduction to deposition of reservoir rocks; Reservoir properties; Depositional and digenetic controls; Fluid properties and their saturation; Hydrocarbon distribution and fluid contacts; Reservoir zonation and thickness mapping; Reservoir pore spaces configuration; Mapping reservoir heterogeneity; Field observations to understand reservoir; Migration of hydrocarbons from source rock to reservoir; Estimation and calculation of reservoir volumetrics; Material balance and production decline curve methods; Appraisal and development of reservoir basic concepts.

Course Aims and Objectives:

Students will know about different type of reservoir rocks, fluid properties and its impact on reservoir rocks. Reservoir heterogeneity and reserves estimation.

Course Outcomes:

Students will be able to understand

1) Different types of reservoir rocks, their properties, different depositional environments,
2) Fluid properties and their saturations, reserve estimation methods.
3) Reservoir heterogeneity appraisal and development of reservoir basic concepts.

Reference Books/Materials:

1) Elements of Petroleum Geology by Richard C. Selley, Stephen A. Sonnenberg
2) Sandstone Petroleum Reservoirs by John H. Barwis, John G. McPherson, Joseph
3) Basin Analysis Principles and Application to Petroleum Play Assessment by Philip A. Allen

Course Code	**GEO 535**
Course Title	**Applied Mineralogy (3CH)**

Course Outline:

Introduction to applied mineralogy. Sampling of mineralogical material. Fractionation of mineral particles. Mineral identification. The polarizing microscope in applied mineralogy. X-rays, electron beams and miscellaneous methods of mineralogical analysis. Systematic mineralogy, textures and optical properties of ore minerals and industrial minerals. Mineralogical aspects of refractories, slags, ceramics, and concretes. Fluid inclusion studies. Mineralogical applications in mineral exploration, mineral processing, beneficiation, tailings, acid rock drainage.

Course Aims and Objectives:

The main aim and objective of this course is to impart knowledge of the applied mineralogy in terms of identification of minerals using different techniques in the best interest of the society.

Course Outcomes:

After completion of the course, the students will develop skills to identify minerals and their use in mineral industry.

Reference Books/Materials:

1. Applied Mineralogy, A Quantitative Approach by Jones, M. P., 1987, Graham and Trotman.

2. X-ray diffraction and the identification and analysis of clay mineral by MOORE, D. M. and Reynolds, Jr., R. C., 1989, Oxford University Press.

3. Minerals and rocks for industry by Ahmad, Z. and Siddiqi, R. A., 1992, Geological survey of Pakistan, Quetta.

4. Geology of the Industrial Rocks and Minerals by BATES, R. L., 1960

5. Applied Mineralogy, Application in Industry and Environment by Mukerjee, Swapna., 2011. Springer

6. Applied Mineralogy in Mining Industry by William Petruk., 2000. Elsevier Science

Course Code	**GEO 532**
Course Title	**Fundamentals of Gemology (3CH)**

Course Outline

Gems; basic properties, hardness scale, Nature of light, laws of reflection and refraction, refractive indices, refractometers. Polarized light, uses of polariscope. Pleochroism, Dichroscope, Electrical, magnetic and thermal properties of minerals. Specific gravity and methods of determinations. Colour and causes of colour in gemstones. Gemological instrument, hand lens, microscope, gemological microscope, polarizing microscope, special optical properties, chatoyancy, asterism, luminescence play of colors, labradorescence. Inclusions and study of inclusions. Emission and absorption spectroscopy and spectroscopes. Classification of gemstones, systematic description of crystallography, physical properties, optical properties, absorption spectra, chemical properties, special gemological features, diagnostic features and occurrences of common and less common gemstones. Lab. Uses of various instrument needed in gemstones identification. Identification of rough and cut gemstones by physical and optical properties. Occurrence and origin of gemstone deposits of Pakistan

Course Aims and Objectives

Aims:

This aim of Fundamental of Gemology course is to impart knowledge to students to enable them to apply this knowledge in their professional career.

Objectives:

1. To teach and train students in the field of Gemology,
2. To impart hands on training in the identification of natural, synthetic and treated gemstones
3. To familiarize the students to know the occurrence and origin of the gemstone deposits of Pakistan

Course Outcomes:

Mineral deposits are classified as metallic minerals, industrial minerals, mineral fuels and gemstones. The students who acquire knowledge in the course of Fundamental of Gemology will be able to identify real, synthetic and treated gemstones. They will also acquire knowledge about the mode of occurrence of gemstones and their origin and also the guidelines for exploring various gemstones. They can be professionals to contribute to the economy of the country.

Reference Books/Materials:

1. Gems and Gemmology of Pakistan by Tahseenullah Khan and Allah Bakhsh Kausar (2010), Geological Survey of Pakistan Special Publication

2. Gem Testing. Rev. by E. A. Jobbins. 10th Edition Anderson, Basil W. (1990), Butterworth, London.

3. The Spectroscope and Gemmology by Anderson, Basil W and James Payne (1998), Gemstone Press, Woodstock, VT.

4. Diamonds. 2nd Edition by Bruton, Eric. (1978), Chilton Book Co., Radnor, PA

5. Gems and Gemology in Review: Treated Diamonds (2008), Gemological Institute of America, Carlsbad, CA.

6. Gems: Their Sources, Description and Identification. (2006) 6th ed. Ed. by Michael O'Donoghue. Butterworth-Heinemann, Boston.

7. Photoatlas of Inclusions in Gemstones by Gübelin, Eduard J. and John I. Koivula (2004), [Volume 1]. 4th Ed., Opinio Publishers, Basel.
8. Gemstones by Hall, Cally (2000), Dorling Kindersley, London; New York.

9. Identification of gemstones by O'Donoghue, Michael and Louise Joyner. (2003),Butterworth Heinemann, Oxford.

Course Code	**GEO 537**
Course Title	**Advanced Engineering Geology (3CH)**

Course Outline:

Engineering properties of rocks, Rock mechanics, Soil mechanics, Engineering geology and earth processes, especially Earthquake, volcanic and landslide processes; Site investigation, Water resources, reservoirs and dams, the foundation of dam bridges and roads, Geological factors in engineering work, Geological investigations, Tunnels and underground excavations, Underground mining methods, Open pit mining techniques.

Course Aims and Objectives:

The main aim and objectives of the course are as follows:

1) To develop better understanding of geological materials i.e. rocks and soils and their interaction with the engineering structures.
2) To develop the ability to identify the areas with the potential of geo-hazards and to minimize the impact of those geo-hazards on engineering structures.
3) To develop a better understanding of engineering structures i.e. dams, tunnels and bridges

Course Outcomes:

After successful completion of course, student will be able to:

1) Identify rocks and soils and their interaction with the engineering structures.
2) Identify the areas with the potential of geo-hazards and can suggest remedial or preventive measures to minimize the loss of life and property.
3) Identify the geological parameters of an area and suggest proper site selection for critical structures i.e. dams, bridges and tunnels.

Reference Books/Materials:

1) Attewell, P. B. and Farmer, I. W., 1976. Principles of Engineering Geology. John Willey & sons; New York.
2) Beavis, F.C., 1985. Engineering Geology. Blackwell Scientific Publications, Melbourne.
3) Legget, R. F., 1962. Geology and Engineering. McGraw-Hill; New York.

Course Code	**ENV 537**
Course Title	**Environmental Engineering (3CH)**

Course Outline:

Principles of Environmental Engineering: population, economic growth, industrialization, energy use. Physical and transport properties of mixtures, contaminant partitioning and transport in air, water and solids. Application of environmental principles, life cycle analysis, principles of environmental quality, standards and guidelines. Water and wastewater: characteristics and parameters, standard methods of analysis, treatment plants and systems. Industrial wastewater characteristics, treatment, treatment levels and available technologies. Sources and classification of atmospheric pollutants and particulates, health and ecological impacts. Gaussian diffusion model, lapse rate and stability conditions. Control of particulates: collection, mechanisms and efficiencies. Control of gases and vapors, adsorption, absorption, incineration, odour and gaseous pollutant control. Solid waste characterization and classification. 3R techniques Solid Waste Management, Soil and its quality, Contaminated site remediation.

Course Aims and Objectives:

1) To equip students with the understanding of basic principles of environmental engineering.
2) To familiarize with the study of environmental hazards, risks prevention, field monitoring, data collection and interpretation of risk management, engineering principles, Technologies and solutions to environmental problems.
3) To give the understanding of principles of environmental quality, standards and guidelines for various environmental parameters.

Course Outcomes:

1) On completion of this course, students are expected to be able to know about basic applications of environmental engineering, environmental remediation and treatment technologies and solution to the hazards.

Reference Books/Materials:

1) Environmental technologies (Engineering & Principles)
2) Environmental Engineering (Wiley)

Course Code	**ENV 513**
Course Title	**Health Safety and Environment (3 CH)**

Course Outline:

Depth and breadth of knowledge in safety, health, and environment; The emergence of voluntary standards and codes of conduct, including international standards, coupled with the need to manage costs and limited resources, sustainability through the use of integrated environmental, health and safety management systems, which are woven into key business processes; Environmental management, occupational health, and workplace safety; Effective management of complex environmental health and safety issues; Air emissions, wastewater, solid and hazardous waste; Regulations and guidelines concerning HSE-work; Systematic HSE work, Reporting of HSE problems and discrepancies; Risk Assessment; HSE responsibilities, roles and resources.

Course Aims and Objectives:

An understanding of health and safety law, liability and enforcement. An explanation of the principles of health and safety management in the workplace and an understanding of who should be responsible for different aspects of health and safety. A practical explanation of risk assessment and what constitutes a suitable and sufficient assessment. A broad knowledge of the typical hazards in a workplace and how these should be managed.

Course Outcomes:

1) Identify a variety of biological, chemical and physical hazards and recommend prevention and control measures, including confined space entry.
2) Identify applications of environmental health and safety protocols and procedures.
3) Develop emergency response plans for accidental occurrences, such as chemical spills.

Reference Books/Materials:

1) Nicholas P.Cheremisin off Madelyn L. Graffia, Environmental and Health and Safety Management.
2) Peng He. Li Fa Xin , Practical books of the HSE Health and Safety and Environmental Management System: Risk Assessment of Application and Practice (Vol.1)

Course Code	**GEO 536**
Course Title	**Advanced Igneous Petrology (3 CH)**

Course Outline:

Igneous rocks associations; Petrogenesis of igneous rocks; Petrogenetic provinces; Basaltic provinces; Granite-Granodiorite provinces and mafic and ultramafic complexes. Tectonism-magmatism relationship; Magmatism at convergent and divergent plate boundaries; Intracontinental hotspots; Continental rift related magmatism; ophiolitcs; Mantle magma systems and source of magma; Physio-chemical factors in magmatic evolution.

Course Aims and Objectives:

This course aims at the process involved in the formation of igneous rocks, and the environments where they form. Study sources of magma and its associated processes

Course Outcomes:

At the end of the course students will be able to

1. Define Mantle-magma systems and source of magma.
2. Evaluate petrogenic provinces.
3. Define the ophiolite.

Reference Books/Materials:

1. Igneous Petrology by Hill, A., 1987. Longman Scientific and Technical.
2. Petrology: Igneous, Sedimentary and Metamorphic by Ehlers, E.G. and Blatt, H.W.H., 1982, W. H. Freeman and Co.
3. Petrology: Igneous and Metamorphic Rocks by Hyndman, D.W., 1972, McGraw-Hill.
4. Igneous and Metamorphic petrology by Best, M.G., 1982, W.H., 1982, W. H. Freeman and Co.
5. Igneous and Metamorphic Petrology by Turner, F.J. and Verhoogen, J. 1960, McGraw-Hill.
6. Igneous Petrogenesis by Wilson, M., 1989, Unwing Hyman. 39
7. Igneous Petrogenesis by Carmichael, I.S.E., Turner, F.J. and Verhoogen, J., 1974, McGraw-Hill.
8. Igneous Petrology by McBirney, A.R., 1984, Freeman Cooper and Co.
9. Introduction to Igneous and Metamorphic Petrology by Winter, J.D., 2001, Prentice Hall.

Course Code	**GEO 538**
Course Title	**Advanced Metamorphic Petrology (3CH)**

Course Outline:

Metamorphic reactions and role of fluids. Concept of iso-grades and iso-reactions grades. Very low grade an ocean floor metamorphism. Contact and regional metamorphism. Metamorphism series. P-T gradients, mineralogical characteristics of individual facies. Progressive and Regressive metamorphism of pclitcs. Basic rocks and carbonates. High grades metamorphism, anatexis and migmatites. Tectonic of regional metamorphic belts. Paired metamorphic belts. Metamorphic structure of continental crust. Metasomatic processes.

Course Aims and Objectives:

This course is about the detailed study of metamorphic rocks. The pressure and temperature at which these rocks are formed are evaluated. Study metamorphic facies.

Course Outcomes:

At the end of the course students will be able to

1. Define characteristics of metamorphic reactions and role of liquids and differentiate different types of metamorphic facies series.
2. Evaluate tectonics of regional metamorphic belts; paired metamorphic belts.
3. Define different types of metamorphic structures of continental crust.

Reference Books/Materials:

1. Petrology: Igneous, Sedimentary and Metamorphic by Ehlers, E. G. and Blatt, H. W. H., 1982, W. H. Freeman and Co.
2. Igneous and Metamorphic Petrology by Hyndman, D. W., 1972, McGraw-Hill.
3. Igneous and Metamorphic Petrology by Best M. G.,1982, W. H. Freeman and Co.
4. Metamorphic petrology by Turner, F. J., 1981, McGraw-Hill.
5. Metamorphism and Plate Tectonics Regimes by Ernst, W. G. 1975, Dowden, Hutchisnson and Ross, Inc.
6. Petrology of the Metamorphic Rocks by Mason, R., 1981, George Allen and Unwin/Thomas Murby.
7. Introduction to Igneous and Metamorphic Petrology by Winter, J. D., 2001, Prentice Hall.

Course Code	**GEO 539**
Course Title	**Ore Geology (3CH)**

Current Course Outline:

Magmatic deposits: The ultramafic-mafic Cr-Ni-PGE deposits the mafic- ultramafic Fc-Ni-Cu sulphide deposits, the quartz monzonite-granodiorite Cu-Mo sulphide deposits, the anorthositegabbro Fe-Ti deposits. Porphyry type deposits. Ores associated with carbonatites. Hydrothermal vein deposits. Iron and manganese concentration of sedimentary affiliation. Stratiform and strata bound sulphides deposits. Ores formed by metamorphic and metasomatic processes. Tectonic setting and mineralization.

Lab. Identification of ores in hand specimens. Ore microscopy Case studies of ore deposits of Pakistan.

Course Aims and Objectives

Aims:

The course is designed to impart knowledge to students regarding the geology of ore minerals, their origin, occurrence and identification for exploitation

Objectives:

1. To know geology and origin of the ore minerals
2. To know their occurrences and economic viability
3. To know lab techniques for the identification of ore minerals both metallic and non-metallic

Course Outcomes:

The student will be able to identify geological, mineralogical, textural and ore minerals of the ore deposits. Students will also acquire basic knowledge on economic geology and the utilization of ore minerals for the betterment of the society.

Reference Books/Materials:

1. Ore Deposit Geology and its influence on mineral exploration by Richard Edwards and Keith Atkinson (1986), Chapman and Hall publisher
2. Ore Deposit Geology by John Ridley 7th Ed (2019), Cambridge University Press publisher
3. Ore Deposits: Origin, Exploration, and Exploitation by Sophie Decrée and Laurence Robb (2019), American Geophysical Union
4. Journal of Ore Geology Reviews
5. Journal of economic Geology

Course Code	**GEO 546**
Course Title	**Advanced Biostratigraphy (3 CH)**

Course Outline:

Index fossils, biozone and, index fossils of Pakistan, animal and plant fossils, stratigraphic distribution, age determination, correlation, sequence boundaries and their correlative conformities, application in establishing paleoecology and paleoenvironments, collection and extraction.

Practical Work

Characterization of physical parameters, material and methods, sampling techniques, section measurement, labelling and storing, cataloging and shelving, faunal preservation techniques, thin section preparation, treatments of planktons, microfossils extraction.

Course Aims and Objectives:

The course is aimed to provide students with a better understanding of one of the most valuable tools in stratigraphic and paleoenvironmental analyses. The course will introduce the major marine and non-marine taxonomic groups used in biostratigraphic and paleoenvironmental studies and what we know about them – their stratigraphic range, modes of life, and environmental preferences. Case studies will be used to illustrate the application of microfossils to biostratigraphic and paleoenvironmental problems in preparation for research in biostratigraphy.

Course Outcomes:

At the end of this course, the students will be able to make a micro-paleontological sampling in the field, to identify the major strata's containing microfossil groups and criteria for their recognition, and to understand their applications in paleobiology, paleoecology, paleogeography, paleoclimatology and paleo-oceanography.

Reference Books/Materials:

1) Introduction to Marine Micropaleontology (Bilal U. Haq, Anne Boersma)
2) Biostratigraphy: microfossils and geological time by McGrowan, B., 2005, Cambridge University press, London.
3) Non marine Permian biostratigraphy and biochronology by Lucas, S.G., Cassinis, G. and Schneider, J.W., 2006, Geological Society of London, London.
4) Applied micropaleontology by Jenkins, D.J., 1993. Kluwer Academic publishers, Netherlands.
5) Recent developments in applied biostratigraphy by Powell, A. J. And Ridding, J. B., 2005. Geological Society of London and British Micropaleontological society, London.
6) Paleozoic vertebrate biostratigraphy and biogeography by Long, J.A., 1994. John JHopkins University Press, MD, USA.
7) Discover the mysterious world of fossils in close-up their origin, formation and extraordinary variety by Taylor, P.D., 2000. D.K. Eyewitness Books.

8) Plankton stratigraphy by Bolli, H.M., Saunders, J.B. and Perch-Neilsen, K., 1985. Cambridge University Press.

Course Code	**GEO 512**
Course Title	**Mineral Prospecting & Exploration (3 CH)**

Course Outline:

Mineral prospecting methods. Mineral deposit economics, target selection, deposit modeling, exploration technology, international exploration, environmental issues, program planning, proposal development. Geochemical prospecting methods. Geochemical behavior of common ore elements, development of primary and secondary haloes around ore deposits. Distribution of detrital material and solutions by streams, glaciers, etc. Dispersion of trace metals from mineral deposits and their discovery. Principles and application of primary dispersion to the search for metallic mineral deposits. Secondary dispersion processes (mechanical and chemical) applied to the search for metalliferous mineral deposits. Field methods of analysis for trace amount of metals. Labs consists of analysis and statistical interpretation of data from soils, stream sediments, vegetation, and rock in connection with field problems. Individual special investigations of a laboratory or field problem in exploration geochemistry. The mineralogy of economic deposits. Mineral deposit geology and models. Mineral exploration data and evaluation techniques. Project evaluation

Course Aims and Objectives

Aims:

The course aim is to train students to discover and exploit economically viable mineral deposits that can benefit the country.

Objectives:

1. To impart knowledge about economic geology in terms of prospecting and exploration of minerals and familiarize them with the geological processes responsible for mineralization.
2. To impart knowledge for understanding different field and laboratory techniques required for mapping, prospecting and analysis.
3. To train the students for the identification of metallic and industrial minerals and to prepare projects.

Course Outcomes:

The course is designed to impart practical knowledge to the students to understand the basics of economic geology in terms of acquiring knowledge in the fields of ore and industrial minerals. They will know how to explore economically viable ore resources and how to prepare development projects. They will also study some case studies related to important mega mines. Their ultimate aim will be to discover and exploit economically viable mineral deposits to the benefit of society.

Reference Books/Materials:

1. Introduction to mineral exploration Edited by Charles J. Moon, Michael E.G. Whateley and Anthony M. Evans (2012), Blackwell publisher
2. Mineral Exploration, 2nd Edition Principles and Applications by Swapan Haldar (2018), Elsevier publisher
2. Mineral Deposit Evaluation- A Practical Approach by Alwyn E. Annels (1991), Chapman & Hall Publisher.
3. An introduction to economic geology and its environmental impact by Anthony M. Evans (1997), Wiley-Blackwell publisher

4. Gems and Gemology in Pakistan by Tahseenullah Khan and Allah Bakhsh Kausar (2010), Geological Survey of Pakistan
5. Journal of Economic Geology
6. Research papers on economic geology

Course Code	**GEO 603**
Course Title	**Engineering Geophysics (3 CH)**

Course Outline:

Introduction to environmental and engineering problems as well as geophysical technique; Relevant physical properties of rocks and soil; Seismic reflection, Optimum window and optimum offset techniques; Field procedure, techniques, and instrumentation; Data correction and interpretation; Seismic refraction, Interpretation techniques such as GRM and others; Electrical Images, 2D Resistivity Modelling; Finite difference method; 2D electrical imaging exploration and multi electrodes, Data collection and interpretation; Introduction to 3D electrical imaging; Relevant topics such as GPR and others; Field examples for environmental, engineering and hydrogeology; Latest research articles related the subject will be discussed in class.

Course Aims and Objectives:

The students should understand to expose you to the geophysical methods that geologists and geophysicist use to examine several different geological and environmental problems. Furthermore, it is expected to perform field examples processing and interpretation for environmental, engineering and hydrogeology. The students should understand the relevant physical properties of rocks and soil. The students should able to perform simple geophysical computations and data interpretation. Furthermore, it is expected that they should know how to do geological interpretations based on geophysical data.

Course Outcomes:

1) The students will be able to understand how geophysics data is used to map the near surface geological conditions and fields examples interpretations.
2) The students will be able to understand the main relevant physical properties of rocks and soil.
3) The students will be able to perform simple geophysical computations and data interpretation. Furthermore, it is expected that they should know how to do geological interpretations based on geophysical data.

Reference Books/Materials:

1) Philip Kearey, Michael Brooks, Ian Hill: An Introduction to Geophysical Exploration, Wiley-Blackwell, 2002.
2) Dorbin, M. B. and Savit, C. H.: Introduction to Geophysical Prospecting (4th edition), McGraw-Hill, 1998.
3) Telford, W. M., Geldart, L. P. and Sheriff, R. E.: Applied Geophysics (2nd edition), Cambridge University Press, 1990.
4) Reynolds, J. M.: An Introduction to Applied and Environmental Geophysics, Wiley, 1998.

Course Code	**GEO 604**
Course Title	**Machine Learning (3 CH)**

Course Outline:

Introduction to Machine Learning; Types, Supervised, Unsupervised; Model Representation; Cost Function; Supervised learning, Generative/discriminative learning, parametric/nonparametric learning, neural networks, and support vector machines; Gradient Descent; Gradient descent for Linear Regressions; Clustering, dimensionality reduction, kernel methods; Machine learning for seismic interpretation, fault extraction, horizon mapping, surface generation, facies analysis through supervised and unsupervised methods.

Course Aims and Objectives:

Machine Learning has made a huge impact on helping operating companies improve operational efficiency, eliminate unplanned downtime, improve safety, and overall reduce costs. Based on fundamental knowledge of computer science principles and skills, probability and statistics theory, and the theory and application of linear algebra. This course provides a broad introduction to machine learning and statistical pattern recognition.

Course Outcomes:

1) Students will have an understanding about applications of machine learning, such as to robotic control, data mining
2) How machine learning will help in understanding complex geophysical processes.
3) How to extract geophysical properties through machine learning

Reference Books/Materials:

1) Moseley, B., and Krischer, L., 2020, Machine Learning and Artificial Intelligence in Geosciences, Elsevier Science.
2) Langer, H., Falsaperla, S., and Hammer, C., 2019, Advantages and Pitfalls of Pattern Recognition: Selected Cases in Geophysics, Elsevier Science.
3) Misra, S., Li, H., and He, J., 2019, Machine Learning for Subsurface Characterization, Elsevier Science.
4) Alexej Gvishiani, Jacques O. Dubois., 2013, Artificial Intelligence and Dynamic Systems for Geophysical Applications, Springer Science & Business Media,

Course Code	**GEO 605**
Course Title	**Applications of Geostatistics in Geosciences (3 CH)**

Course Outline:

Introduction to Geostatistics; Computer application in geo-statistics; Collection and editing of data, primary data and secondary data; Measures of central tendency or averages, types of averages, arithmetic mean, median, mode, empirical relation between mean, median and mode; Relative merits and demerits of various averages; Measures of dispersion range, semi-interquartile range or quartile deviation, mean deviation, standard deviation, skewness; Correlation and simple regression, coefficient of correlation, scatter diagram, rank correlation, regression; Geo-statistical analysis, variogram calculation, interpretation, linking variogram behaviour with physical causes (geology, sampling); Extension variances and estimation variances/simple calculations in one and two dimensions; Global reserve/resource estimation; Optimal estimation and introduction to kriging.

Course Aims and Objectives:

This unit is designed to provide students with an introduction to the geostatistical techniques used in estimation from spatial data. Applications will be mainly in the areas of mining, petroleum, soil science and environmental management.

Course Outcomes:

On successful completion of this course, students will be:

1) Apply the concepts of spatial variability to geological, geomechanical and/or environmental variables,
2) Calculate variograms for simple one- and two-dimensional data sets
3) Assemble models to experimental variograms and interpret model parameters and Evaluate simple calculations of estimation variances
4) Formulate and solve kriging equations

Reference Books/Materials:

1) Hohn, M. (2013). *Geostatistics and petroleum geology*. Springer Science & Business Media.
2) Wackernagel, H. (2013). *Multivariate geostatistics: an introduction with applications*. Springer Science & Business Media.
3) Chilès, J. P., & Delfiner, P. (2012). Geostatistics: Modeling Spatial Uncertainty. Wiley Publishing.
4) Armstrong, M. (2012). *Basic Linear Geostatistics*. Springer Science & Business Media.

Course Code	**GEO 606**
Course Title	**Reservoir Geomechanics (3 CH)**

Course Outline:

Introduction to reservoir Geomechanics; Structural Geology, Fault Classification; Stress and strain analysis; Tectonic stress, Review of Earth Stresses; Stresses in various types of basins; Determining initial stress conditions in typical reservoir cases; Mechanical Behavior of Reservoir Rocks, stress-strain-yield properties of reservoir rocks; poorly consolidated sandstones; Diagenetic processes in reservoir rocks; Transport Properties of Reservoir Rocks; Thermal conductivity and expansion properties of rocks and minerals; Effect of high temperatures on clay minerals and hydrous minerals; Permeability vs. effective stresses in porous media; Fractured media. Pore Pressure Prediction.

Course Aims and Objectives:

This course is interdisciplinary and encompasses the different geological and geophysical disciplines including fields of rock mechanics and structural geology. Also deals with the geomechanical problems that arise during the exploitation of oil and gas reservoirs. This course will also cover Pore pressure, estimation of hydrocarbon column heights, determination of optimally stable well trajectories, casing set points and mud weights, changes in reservoir performance during depletion, and production-induced faulting and subsidence.

Course Outcomes:

1) Relevancy of Geomechanics throughout the reservoir life-cycle
2) Applications of the principles of geomechanics to solve real-world problems and reduce risk
3) How to be proactive instead of reactive towards geomechanical issues

Reference Books/Materials:

1) Zoback, M.D., 2010. Reservoir geomechanics. Cambridge University Press.
2) Zoback, M.D. and Kohli, A.H., 2019. Unconventional reservoir geomechanics. Cambridge University Press.
3) Zhang, J.J., 2019. Applied Petroleum Geomechanics. Gulf Professional Publishing.
4) Nauroy, J.F., 2011. Geomechanics applied to the petroleum industry. Editions Technip.

Course Code	**GEO 607**
Course Title	**Unconventional Hydrocarbon Resources (3 CH)**

Course Outline:

Introduction to unconventional hydrocarbon resource; An overview of unconventional hydrocarbon resources in Pakistan; Classification of unconventional hydrocarbon resources; Geologic and geographic occurrences; Recovery technology and economics of unconventional hydrocarbon resources; Characterization of unconventional resources; Exploration; Development; Laboratory methods; Geomechanics; Geochemical methods; Well completion; Hydraulic fracturing; Environmental issues; Seismic and geostatistical estimation methods.

Course Aims and Objectives:

The course is designed to expose attendees to the understanding and application of the latest approaches, techniques and requirements being applied to reserves evaluation within unconventional resources. Focus is given to actions and methodologies that are necessary to enhance the reserve categorization. The course is designed to expose attendees to the understanding improvements in techniques such as horizontal drilling and hydraulic fracturing have increased access to unconventional hydrocarbon resources, ushering in the "shale boom" and disrupting the energy sector.

Course Outcomes:

1) The students will be able to the understanding and application of the latest approaches, techniques and requirements being applied to reserves evaluation within unconventional resources.
2) The students will be able to the understanding methodologies that are necessary to enhance the reserve categorization.
3) The students should know and understand the methods for production of viscous oil and the methods for recovery of gas from rocks with very low permeability.

Reference Books/Materials:

1) Arthur, M.A. and Cole, D.R., 2014. Unconventional hydrocarbon resources: prospects and problems. Elements, 10(4), pp.257-264.
2) Reza Barati, Mustafa M. Alhubail. 2020. Unconventional Hydrocarbon Resources: Techniques for Reservoir Engineering Analysis ISBN: 978-1-119-42032-3 American Geophysical Union

Course Code	**GEO 608**
Course Title	**Practical Applications of Geosciences Software's**

Course Outline:

Introduction to software used in different industry. How to create and manage a project including establishing project boundaries, choosing an X/Y projection. the use of authors, CRS and its types. Culture (geographic layer) input: creating and entering culture data on the base map including formatted and unformatted data entry and the importing of ESRI shape files. Well data input: using file sources such as HIS Energy and ascii formatted data; loading of well locations, deviation surveys, formation tops, log curves, and local and shared Time-Depth information. Using the SEG-Y Viewer to examine 2D and 3D trace header data. 2D and 3D data loading from files and the use of Share/Copy feature for seismic data. Introduction Review basic concepts: Waves; Wavelet; Seismic sections 2D vs. 3D; Seismic display, slice, 2D and 3D view, Volume concept, Slicing the data volume, Dynamic range and data loading, Polarity and colour Character and zero phase, Colour principles, Interpretative value of colour, Interpretation procedure/workflow, Synesthetic seismogram, Structural interpretation, Fault recognition and mapping, Horizon mapping and procedures, Visualization and auto tracking. Direct contouring and the importance of the strike perspective, Maps and its types. Depth conversion and procedures. Composite displays. Advantage and disadvantages of different displays, Subtle structural features. Stratigraphic interpretation. Seismic facies analysis. Internal reflection configuration. External geometry of seismic facies units. Recognition of characteristic shape. Methods of making horizon slices. Unconformity horizon slices; Seismic attribute analysis.

Small project based on available data.

Course Aims and Objectives:

1) Course will help the students to use different software.
2) This course provides a broad introduction and application of datasets used for G and G industry.
3) Course will help to give awareness t the student to get familiar with state-of-the-art technology used by different industries in the world.

Course Outcomes:

The following outcomes will achieve from the course.

1) Students get awareness about different applications of softwares used for seismic and well data interpretation.
2) Students will understand about usage of different software.
3) Students learn about different data formats used to create projects.
4) Graduate can work more scientific way to perform their research.

Reference Books/Materials:

1) Bacon, M., Simm, R., and Redshaw, T., 2007, 3-D Seismic Interpretation, Cambridge University Press.
2) Herron, D. A., and Latimer, R. B., 2011, First Steps in Seismic Interpretation, Society of Exploration Geophysicists.
3) Brown, A. R., Geologists, A. A. P., and Geophysicists, S. E., 2011, Interpretation of Three-Dimensional Seismic Data, Seventh Edition: AAPG Memoir 42, 7th Edition/SEG Investigation in Geophysics, No. 9, Published jointly by American Association of Petroleum Geologists and the Society of Exploration Geophysicists.

Master of Science (MS) Geophysics
Roadmap

Description	Existing	Proposed
Total number of credit hours	30	30

	Existing Roadmap	Proposed Roadmap
Semester	**Credit Hours (Courses)**	**Proposed**
1	12 CH (2 Compulsory + 2 Electives)	12 CH (4 Compulsory courses)
2	12 CH (2 Compulsory + 2 Electives)	12 CH (4 Elective courses)
3	03 CH (Thesis)	03 CH (Thesis)
4	03 CH (Thesis)	03 CH (Thesis)
Total	30	30

Compulsory Courses

Course code	Course Title	Credit Hours	Amendments
GEO 503	Advanced Petroleum Geology	3	Contents Revision
GEO 504	Advanced Sequence Stratigraphy	3	Course Removed
GEO 548	Advanced Seismic Stratigraphy	3	New Course Added
GEO 540	Advanced Seismic Techniques	3	Contents Revision
ESC 701	Research Methodology	3	Contents Revision

Elective Courses

Course code	Course Title	Credit Hours	Amendments
GEO 518	3D Seismic Interpretation	3	Contents Revision
GEO 517	Seismic Data Analysis	3	Contents Revision
GEO 515	Exploration Geophysics	3	Contents Revision
GEO 544	Borehole Geophysics	3	Contents Revision
GEO 513	Advanced Seismology	3	Contents Revision
GEO 543	Advanced Earthquake Seismology	3	Contents Revision
GEO 507	Basin Analysis	3	Contents Revision
GEO 534	Reservoir Geology	3	Contents Revision
GEO 545	Petrophysical Analysis	3	Contents Revision
GEO 531	Advanced Structural Geology	3	Contents Revision
GEO 508	Stratigraphy and Petroleum Prospects of Pakistan	3	Contents Revision
GEO 514	Mining Geophysics	3	Contents Revision
GEO 542	Geodesy	3	Contents Revision
GEO 510	Development of Groundwater Resources	3	Contents Revision
GEO 528	Groundwater Modeling	3	Contents Revision
GEO 530	Advanced Marine Geology	3	Contents Revision

ENV 513	Health Safety and Environment	3	Contents Revision
GEO 505	Advanced Sedimentology	3	Contents Revision
GEO 501	Global Tectonics	3	Contents Revision
~~GEO 511~~	~~GIS Applications in Geology~~	3	**Course Removed**
~~GEO 502~~	~~Geophysical Exploration Methods~~	3	**Course Removed**
~~GEO 512~~	~~Mineral Prospecting and Exploration (MPE)~~	3	**Course Removed**
~~GEO 519~~	~~Coal Geology (CG)~~	3	**Course Removed**
~~GEO 524~~	~~Clastic Sedimentology~~	3	**Course Removed**
~~GEO 525~~	~~Carbonate Sedimentology~~	3	**Course Removed**
~~ENV 523~~	~~Climate Change~~	3	**Course Removed**
~~ENV 504~~	~~Environmental Impact Assessment~~	3	**Course Removed**
~~GEO 516~~	~~Applied Environmental Geophysics~~	3	**Course Removed**
~~GEO 509~~	~~Well Site Geology~~	3	**Course Removed**
GEO 547	Drilling Operations and Well Site Geology	3	**New Course Added**
GEO 541	Applications of GIS in Geosciences	3	**New Course Added**
GEO 549	Near Surface Geophysics	3	**New Course Added**
GEO 601	Gravity and Magnetic Exploration Methods	3	**New Course Added**
GEO 602	Electrical Exploration Methods	3	**New Course Added**
GEO 603	Engineering Geophysics	3	**New Course Added**
GEO 604	Machine Learning	3	**New Course Added**
GEO 605	Applications of Geostatistics in Geosciences	3	**New Course Added**
GEO 606	Reservoir Geomechanics	3	**New Course Added**
GEO 607	Unconventional Hydrocarbon Resources	3	**New Course Added**
GEO 608	Practical Applications of Geosciences Software's	3	**New Course Added**
THS 701	MS Thesis	6	Existing

Master of Science (MS) Geophysics
New Roadmap

Semester	Credit Hours (Courses)
1	12 CH (4 Compulsory Courses)
2	12 CH (4 Elective Courses)
3	03 CH (Thesis)
4	03 CH (Thesis)
Total	30

Compulsory Courses

Course Code	Course Title	Credit Hours
GEO 503	Advanced Petroleum Geology	3
GEO 548	Advanced Seismic Stratigraphy	3
GEO 540	Advanced Seismic Techniques	3
ESC 701	Research Methodology	3

List of Elective Courses

Course code	Course Title	Credit Hours
GEO 518	3D Seismic Interpretation	3
GEO 517	Seismic Data Analysis	3
GEO 515	Exploration Geophysics	3
GEO 544	Borehole Geophysics	3
GEO 513	Advanced Seismology	3
GEO 543	Advanced Earthquake Seismology	3
GEO 507	Basin Analysis	3
GEO 534	Reservoir Geology	3
GEO 545	Petrophysical Analysis	3
GEO 531	Advanced Structural Geology	3
GEO 508	Stratigraphy and Petroleum Prospects of Pakistan	3
GEO 509	Drilling Operations and Well Site Geology	3
GEO 514	Mining Geophysics	3
GEO 542	Geodesy	3
GEO 549	Near Surface Geophysics	3
GEO 510	Development of Groundwater Resources	3
GEO 528	Groundwater Modeling	3
GEO 530	Advanced Marine Geology	3
ENV 513	Health Safety and Environment	3
GEO 505	Advanced Sedimentology	3
GEO 501	Global Tectonics	3
GEO 511	Applications of GIS in Geosciences	3
GEO 601	Gravity and Magnetic Exploration Methods	3
GEO 602	Electrical Exploration Methods	3
GEO 603	Engineering Geophysics	3
GEO 604	Machine Learning	3
GEO 605	Applications of Geostatistics in Geosciences	3

GEO 606	Reservoir Geomechanics	3
GEO 607	Unconventional Hydrocarbon Resources	3
GEO 608	Practical Applications of Geosciences Softwares	3
THS 701	MS Thesis	6
Any other relevant course from MS Geology and MS Environmental Science disciplines		

COURSE CATALOGUE

Course Code	**GEO 540**
Course Title	**Advanced Seismic Techniques**

Course Outline:

Gridding Techniques; Spatial-Temporal Velocity Interpolation; Triangulated Velocity Models; Horizon Formation/Structurally Interpolated Velocity Models; Drift Correction; Forward Modeling; Horizon/Window based Seismic Attributes; Horizon Attribute based Seismic Modeling**;** Hilbert Transform & Complex Trace Analysis; Post Stack Seismic Attributes; Amplitude versus Offset/Angle; Seismic Inversion/Reverse Modeling.

Course Aims and Objectives:

This course is focused to familiarize students with advance seismic techniques that are being used in Oil Industry and to develop understanding of modeling/Gridding, linear interpolation/extrapolation techniques. The course will familiarize students with Reservoir Characterization Techniques such as AVO/AVA, Inversion, Post Stack Attributes

Course Outcomes:

1. Students would be able to transform seismic data in time domain to frequency domain
2. Students would be able to carry out modeling on any given data set using triangulation gridding techniques
3. Students would be able to harmonize sonic and checkshot data for modeling purposes
4. Students would be able to utilize Seismic Attributes, AVO/AVA and Seismic Inversion techniques for Reservoir Characterization
5. Students would be able to execute modeling and reservoir characterization related workflows on modern Softwares

Reference Books/Materials:

1) 3D Seismic Interpretation by M. Bacon - Cambridge University Press
2) Interpreting Seismic Data by J. A. Coffeen
3) Chiburis, E, Leany, S, Skidmore, C, Franck, C, and McHugo, S. Hydrocarbon detection with AVO. Netherlands: N. p., 1993. Web.
4) Barclay, F. & Bruun, A. & Rasmussen, K.B. & Alfaro, J.C. & Cooke, A. & Cooke, D. & Salter, D. & Godfrey, R. &
5) Lowden, D. & McHugo, S. & Özdemir, H. & Pickering, S. & Pineda, F.G. & Herwanger, Jorg & Volterrani, S. &
6) Murineddu, A. & Rasmussen, A. & Roberts, R.. (2008). Seismic inversion: Reading between the lines. Oilfield Review. 20. 42-63.

Course Code	**GEO 518**
Course Title	**3D Seismic Interpretation (3 CH)**

Course Outline:

2D seismic data interpretation, Importance and its limitations. Introduction, Importance, Application of 3D Seismic Interpretation, Practical workflow, Quality control of survey and processing, Seismic data type, SEG-Y data, navigation file, CRS, loading and QC of seismic and well data. Importance and its limitations, Mis-ties computations. Digitization and Map constructions. Calibration of well and seismic data, synthetic seismogram. Identification of reflectors and mapping of horizons and faults. Different types of maps, (Time, thickness, Isopach, time slices, and iso-stratal maps). Velocity analysis and depth conversion. Advance 3D Interpretation techniques; Horizon based seismic trace attributes, AVO Analysis, Seismic Inversion, Direct Hydrocarbon Indicators.

Course Aims and Objectives:

The students are introduced to methodologies and strategies for interpretation of 3D seismic data. Students will know how to do interpretation, what are the basics and practicality to start seismic interpretation, workflow and advance interpretation methods.

Course Outcomes:

1) They will develop skills in structural and stratigraphic interpretation.
2) Students will acquire knowledge about seismic amplitude reflections from lithological boundaries within the subsurface.
3) Students will understand basics and practical seismic data interpretation

Reference Books/Materials:

1) Seismic Amplitude by Rob Simm and Mike Bacon
2) Three-Dimensional Seismic Interpretation by Alstair Borwn
3) 3D seismic Interpretation by Mike Bacon
4) Seismic Data Interpretation and Evaluation for hydrocarbon Exploration and Production by Nanda

Course Code	**GEO 517**
Course Title	**Seismic Data Analysis (3 CH)**

Course Outline:

Introduction of Seismic Data Processing; Seismic imaging techniques; Significance of Seismic Data Analysis in hydrocarbon exploration; the basic principles of the methods used in analyzing digital signals for geophysical applications; The latest trend in Seismic Data Analysis; Discrete data analysis with emphasis on seismic problems. Z-transforms, discrete Fourier transforms, digital filtering, Convolution and Deconvolution, autoregressive-moving average models, spectral analysis, missing data, model fitting, and two-dimensional and multi-channel analysis; Migration and its types; Practical experience in computer processing of seismic reflection data and related examples. The latest research articles (from SEG, AAPG, EAGE, First Break etc.) related the subject recommend discussing in class

Course Aims and Objectives:

The course emphasizes for each process and various existing underlying geophysical models. This course is designed to provide basic background and training for the processing of digital seismic data, particularly used by the petroleum industry. The emphasis is placed on the principles and practicality of the major processing methods, statics, deconvolution, velocity analysis, stacking, and migration.

Course Outcomes:

1) At the end of the course the participants will have obtained an understanding and appreciation of the many alternative processing approaches that are representative for the practice of current seismic data processing.
2) This course provides the participants with a working knowledge of the different processing methods and enables them to assess the quality of a processing result.
3) At the end of the course the participants will have obtained an understanding on the principles and practicality of the major processing methods, statics, deconvolution, velocity analysis, stacking, and migration.

Reference Books/Materials:

1) Zhou, H.W., 2014. Practical seismic data analysis. Cambridge University Press.

2) Yilmaz, Ö., 2001, Volume 1. Seismic data analysis: Processing, inversion, and interpretation of seismic data. Society of exploration geophysicists.

3) Yilmaz, Ö., 2001, Volume 2. Seismic data analysis: Processing, inversion, and interpretation of seismic data. Society of exploration geophysicists.

Course Code	**GEO 515**
Course Title	**Exploration Geophysics (3CH)**

Course Outline:

Introduction of Geological and Geophysical techniques; Physical characteristics of the Earth's lithosphere; Applications of geophysical methods, seismic, gravity, magnetic, resistivity, telluric, magnetotelluric, self-potential and GPR methods; Detection and exploration of natural resources; Mapping of natural resources; Limitations in Geophysical methods; Case Studies of Geophysical methods.

Course Aims and Objectives:

This course aims to introduce students to the techniques used to measure and map geologic, geophysical and geochemical characteristics of the lithosphere, with applications to mineral and energy exploration. It also aims to provide students with the theoretical background to each technique, the methods of data collection, analysis and interpretation and an appreciation of the exploration scenarios in which each technique may apply.

Course Outcomes:

1) This course will take a generic view, about different geophysical methods to understand economical natural resources
2) The course will be divided into modules covering geophysical exploration techniques commonly used in minerals and energy exploration, (gravity, magnetic, electrical, electro-magnetic and seismic surveys).
3) Students will be able to analyze and interpret all the studied geophysical data sets.

Reference Books/Materials:

1) An Introduction to Geophysical Exploration by P. Keary, M. Brooks and I. Hill
2) Introduction to mineral exploration (Moon, Whateley and Evans), 2nd Ed, 2006, Blackwell Publishing
3) Geophysics for the Mineral Exploration Geoscientist (Dentith and Mudge), 2014, Cambridge University Press

Course Code	**GEO 544**
Course Title	**Borehole Geophysics (3CH)**

Course Outline:

Introduction to Borehole geophysics; Rheology and wave propagation in inhomogeneous and fluid saturated porous materials; Borehole seismic methods; Checkshot, Acquisition, Processing and Analysis; Vertical Seismic Profiling and its types, Acquisition, Processing and Analysis, P and S wave transformations and analysis; Cross well seismic and travel time tomography; Introduction to well logging; Quality control of log data; Log Data Interpretation, Caliper, SP, gamma ray logs, sonic logs,

density, neutron, resistivity, NMR and Image logs; Pore Pressure Prediction; Fundamentals of Rock Physics; Core and core analysis.

Course Aims and Objectives:

This course will enable the students to understand about the role of borehole geophysics in oil and gas industry by covering the fundamentals of petrophysics and its use in the analysis of cores and geophysical well logs for reservoir characterization and hydrocarbon assessment. The objective of this course is to enable students to learn about borehole geophysics builds that link between rock physics, well logging and surface seismic. The students are also required to apply some of these concepts analytically and numerically to familiarize their use in practical applications.

Course Outcomes:

On completion of the course, students are expected to be able to:

1) To understand the theoretical basis and practical limitations of logging tools. And evaluate reservoir intervals defined in clastic and shaly sandstone systems.
2) Integrate all other available data with wireline log data, including mud logs, sample descriptions, VSP, and core.
3) Illustrate the principle petrophysical differences between conventional reservoirs and unconventional shale reservoirs.

Reference Books/Materials:

1) Ellis, Darwin V, & Singer, Julian M. (2007). Well Logging for Earth Scientists (2 ed.). Dordrecht, The Netherlands: Springer
2) Labo, J. (1987). A Practical Introduction to Borehole Geophysics: An Overview of Wireline Well Logging Principles for Geophysicists: Society of Exploration Geophysicists.
3) Sayers, Colin M. (2010). Geophysics under stress: Geomechanical applications of seismic and borehole acoustic waves: Society of Exploration Geophysicists and European Association of Geoscientists & Engineers.Principles of Electric Methods in Surface and Borehole Geophysics, Volume 44 by Alex Kaufman B. Anderson

Course Code	**GEO 513**
Course Title	**Advanced Seismology (3 CH)**

Course Outline:

Introduction to seismology; Applications of Seismology; Theory of Elasticity; Seismic Energy Sources; Geologic significance from P-wave and S-wave velocity; Wave Propagations; Overview of surface wave methods; Teleseismic Body-Wave; Reflection and Transmission; Seismic Anisotropy; Raypath geometry in Anisotropic Materials; Detection and recording of seismic waves; Stress-Displacement Fields, Equivalent Forces & Moment Tensors; An Introduction to Seismogram Computation; Receiver functions; Travel Time Computations; Seismic site characterization; Seismic zonation,; Estimating

phase velocity and subsurface structure; Earthquake Effects and Hazards; Interpretation Techniques; Case studies

Course Aims and Objectives:

This course will focus on a detailed study of methods for computing seismograms in vertically stratified media (plane layers, spheres & spherical shells). After studying the course, students will have knowledge about Fourier analysis, differential equations, and matrix methods, and some experience in computer programming (or MATLAB scripting). This course will enable the students to understand the applications of seismology for both earthquake studies and hydrocarbon exploration and also to determine the potential risks due to earthquakes and microzonate those areas accordingly

Course Outcomes:

On completion of the course, students are expected to be able to:

1) Understand the ground movement due S-wave velocity polarization and surface methods
2) Working of sensors and seismograph and their configuration, analysis of different modes of interpretation on MATLAB
3) Role of multicomponent seismology in petroleum exploration and microtremors to reveal the subsurface structure

Reference Books/Materials:

1) Stein, S. and M. Wysession, (2003). An Introduction to Seismology, Earthquakes, and Earth Structure, Blackwell Publishing.
2) Gubbins, D. (2004). Time Series Analysis and Inverse Theory for Geophysicists, Cambridge University Press.
3) Kramer, S.L., (1996). Geotechnical Earthquake Engineering, Prentice Hall.
4) Shearer, P. M. (2011). Introduction to Seismology, 2nd edition

Course Code	**GEO 543**
Course Title	**Advanced Earthquake Seismology (3CH)**

Course Outline:

Seismology, Introduction, its branches and applications; Useful definitions in earthquake seismology; Earthquake Effects and Hazards; Overview of surface wave methods; Principles of microtremor survey method; Geologic significance from P-wave and S-wave velocity; Estimating phase velocity and subsurface structure; Seismic zonation; Seismic site characterization; Peak ground acceleration (PGA); Seismic risk analysis (SRA); Seismic hazard assessment (SRA); Deterministic Seismic Hazard

Assessment (DSHA); Probabilistic Seismic Hazard Assessment (PSHA); Research papers and case histories.

Course Aims and Objectives:

This course will enable the students to understand the applications of seismology for earthquake studies The objective of this course is to enable students to acquire the knowledge of earthquake seismology. The students are also required to apply some of these concepts to determine the potential risks due to earthquakes and microzonate those areas accordingly

Course Outcomes:

On completion of the course, students are expected to be able to:

1) Understand the methodologies adopted for seismic risk assessment with Peak ground acceleration (PGA) and its applications
2) Advanced methods used for evaluation of earthquake hazards with microzonation and macrozonation
3) Use of microtremors to reveal the subsurface structure

Reference Books/Materials:

1) Micro-Earthquake Seismology and Seismotectonics of South-Asia by J.R. Kayal
2) Surface Wave Methods for Near-Surface Site Characterization by Foti et al.
3) Manual for zonation on seismic geotechnical hazards (Revised version), ISSMGE,1999

Course Code	**GEO 514**
Course Title	**Mining Geophysics (3 CH)**

Course Outline:

Mineral prospecting and exploration methods; Mineral deposits, economics, target selection, deposit modeling, exploration technology, environmental issues, program planning; Geochemical prospecting methods; Geochemical behavior of common ore elements; Distribution of detrital material and solutions by streams and glaciers; Dispersion of trace metals from mineral deposits and their discovery; Principles and application of primary dispersion of metallic mineral deposits; Geophysical methods for exploration and mining; Methods for metalliferous mining; Geophysical prospecting; Electromagnetic, Resistivity, Induced Polarization, Self-Potential, Radiometric, Gravity and Magnetic methods applied for metallic mineral deposits; Airborne, electromagnetic surveys; site design; theoretical basis for each technique, the instrumentation used; Working Conditions, data collection, processing and interpretation procedures; Deposition of coal; Seismic methods for identifying coal, iron and copper sulphides; Review of geophysical research conducted in Pakistan; Specified assignments/projects

Course Aims and Objectives:

The Mining Geophysics will focus on geology, mining methods, exploration technology, surveying, and computer applications for mining operations and mineral explorations. Students learn hands-on science and mining skills

Course Outcomes:

Mining Geophysics concentrates how to apply the knowledge for example in exploration, mapping and management of natural resources, and in environmental and engineering studies. In the life cycle of a mine, geophysics plays an important role in all stages: before opening the mine in mineral exploration and resource assessment, during active mining operations in exploration for additional resources and environmental monitoring, and after the closure of the mine in environmental monitoring and mapping of potentially contaminated areas.

Reference Books/Materials:

1) Glazer, S. N., 2016, Mine Seismology: Data Analysis and Interpretation: Palabora Mine Caving Process as Revealed by Induced Seismicity, Springer International Publishing.
2) Kaufman, A. A., Alekseev, D., and Oristaglio, M., 2014, Principles of Electromagnetic Methods in Surface Geophysics, Elsevier Science.
3) Schön, J. H., 2015, Physical Properties of Rocks: Fundamentals and Principles of Petrophysics, Elsevier Science.
4) Dentith, M., and Mudge, S. T., 2014, Geophysics for the Mineral Exploration Geoscientist, Cambridge University Press.

Course Code	**GEO 542**
Course Title	**Geodesy (3 CH)**

Course Outline:

Introduction to geodesy; Shape of earth; Topography; Geodetic datum; Geoid; Ellipsoid; Defining the ellipsoid by the numbers; Coordinates; Astronomic, Geodetic and Geocentric; Datums and types of datums; Map projections, from glob to map; Commonly used projections; Cylindrical, Mercator projection and Transverse Mercator; Developable surfaces; Coordinate origin; Perspective projections; Properties of projections; Scale; Standard lines; Small and large scales; Scale factor; Shape and Area;

Major and minor lines; Introduction to co-ordinate system; Global systems, Latitude longitude, Height, UTM zones and benefits; Universal polar stereographic net; UPS coordinates; Reference systems; Military grid reference systems, Local systems, National grid systems, Public land survey system. Case history from Pakistan

Course Aims and Objectives:

The fundamentals and modern concerns of geodesy, recent developments and applications of global and satellite geodesy; the geometry of the ellipsoid; The principles of various global/satellite geodetic techniques; Determination of geographical and map projection coordinates from geodetic observations; and the concept of a geodetic datum and how to transform coordinates from one datum to another.

Course Outcomes:

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

1) Understand how the earth's gravity field affects surveying observations, and how these observations can be reduced from the earth's topography to the map. Locate and use web-based resources for the latest developments in geodesy.
2) Demonstrate a basic understanding of the geometry of the ellipsoid and of map projections.
3) Demonstrate their understanding of the Geocentric Datum of Pakistan

Reference Books/Materials:

1) Torge, W., & Müller, J. (2012). Geodesy. Walter de Gruyter.
2) Sciences of Geodesy-II: innovations and future developments. Springer Science & Business Media.(Ed.II). (2012).
3) Lu, Z., Qu, Y., & Qiao, S. (2014). Geodesy. Berlin, Heidelberg: Springer Berlin Heidelberg.
4) Xu, G. (Ed.). (2010). Sciences of geodesy. Springer.
5) Meyer, T. H. (2018). Introduction to geometrical and physical geodesy: foundations of geomatics. Esri Press.

Course Code	**GEO 549**
Course Title	**Near Surface Geophysics (3 CH)**

Course Outline:

Introduction to environmental explorations; Principles behind geophysical measuring techniques; Techniques with relation for improved understanding of the near surface geology; Seismic methods; Electrical methods, profiling, vertical sounding, 2D and 3D measurements; Electromagnetic methods, Slingram, VLF, TEM; Ground Penetration Radar; Radiometry and Well Logging; Applications of geophysical methods in contaminant plumes, conduits, fractures, voids, aquifers, buried containers, waste pits, ordnance, landfill delineation.

Course Aims and Objectives:

The students will understand to the geophysical methods that geologists and geophysicist use to examine several different geological and environmental problems. The students will understand the main principles behind geophysical measuring techniques. The students will be able to perform simple geophysical computations. Furthermore, it is expected that they will know how to do geological interpretations based on geophysical data.

Course Outcomes:

1) The students will be able to understand how geophysics data is used to map the near surface geological conditions.
2) The students will be able to understand the main principles behind geophysical measuring techniques and their application to solve near surface problems.
3) The students will be able to perform simple geophysical computations. Furthermore, it is expected that they should know how to do geological interpretations based on geophysical data.

Reference Books/Materials:

3) Reynolds, J.M., 2011. An introduction to applied and environmental geophysics. John Wiley & Sons.

Course Code	**GEO 601**

Course Title	**Gravity and Magnetic Exploration Methods (3 CH)**

Course Outline:

Introduction; Newtons law of Gravitation; The Geoid, Instruments used in Gravity and magnetic exploration; Survey Techniques employed; Types of Gravity and Magnetic Surveys; Methodology used to carry out Gravity and Magnetic Surveys; Reduction of Gravity and Magnetic data; Corrections used to correct gravity and magnetic data; Regional and Residual separation techniques for gravity and magnetic data; Interpretation of Gravity and Magnetic data and generation of theoretical and field curves; Depth Rules for Gravity and magnetic methods; Estimating the shape and size of the body.

Course Aims and Objectives:

This course will enable the students to understand the basic concepts, principles and applications of gravity and magnetic exploration techniques used in Exploration of different structure, ores, minerals etc. Familiarize the students with different parameters measured and calculated using Gravity and Magnetic Exploration Techniques and to use them for the interpretation of different lithologies, structures, minerals and ore bodies.

Course Outcomes:

On completion of the course, students are expected to be able to:

1) Identify key concepts of the gravity and magnetic exploration techniques.
2) Describe the behavior of different subsurface bodies, minerals, ores etc.
3) Identify the factors affecting the gravity and magnetic surveys.
4) Use, key concepts about the interpretation of Gravity and Magnetic exploration methods.

Reference Books/Materials:

1. Li, Yaoguo; Krahenbuhl, Richard, Gravity and Magnetic Methods in Mineral and Oil & Gas Exploration and Production.

Course Code	**GEO 602**
Course Title	**Electrical Exploration Methods (3 CH)**

Course Outline:

Electrical resistivity method, Mechanisms of conduction, Ohms law, Archies law, Electrode Configurations (Wenner Configuration, Schlumberger Configuration, Dipole-Dipole Configuration, Pole-Dipole Configuration, Pole-Pole Configuration), Choice of Array, Refraction of Current Path, Electrical Reflection Co-efficient Survey Types, interpretation of Electrical Resistivity Data, Curve Matching Technique to interpret resistivity data, Application of Electrical Resistivity Data; Electric exploration methods, Charge body potential Method, Spontaneous Potential method, Induced Polarization Method, Electromagnetic Method, Telluric Method, Magnetotelluric Method, Principle, Mechanism, Important Consideration, Sources of Noise, Instrumentation, Field Procedure, Survey design, Interpretation, Advantages, Disadvantages, Limitations, Applications.

Course Aims and Objectives:

The objectives of this course are to: introduce students to electrical resistivity prospecting methods and their applications in investigating subsurface conditions, and provide students with opportunities to develop basic acquisition, processing and interpretation skills using the electrical methods.

Course Outcomes:

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

1) Understand the various electrical prospecting methods applicable in geophysical exploration.
2) Explain the basic principles of Self Potential, Induced Polarization and Electrical Resistivity Methods.
3) Explain the field procedures applicable to each method.

Reference Books/Materials:

1) Reynolds J.M. (1998). An Introduction to Applied and Environmental Geophysics. Published by John Wiley & Sons Ltd, West Sussex, England. 800p.
2) Keary P., Brooks, M. and Hill I. (2002). An Introduction to Geophysical Exploration, Third Edition, Blackwell Science Ltd. Oxford, England 281p.

Appendage 2303

Cryptography and Network Security	
Course Code:	EET-462
Credit Hours:	3+0
Pre-requisite:	-
Objectives:	Cryptography is becoming increasingly important to enhance security in connection with data storage, communication and various kinds of electronic transactions. The sole concept of this course is to familiarization the students with the concepts of encryption and network security.
Course Learning Outcomes (CLOs):	CLO 1: [C2] **Describe** the basic cryptography related concepts. CLO 2: [C4] **Analyze** some commonly used cryptographic primitives and protocols CLO 3: [C3] **Implement** the encryption algorithms on plain text and explore the limitation of the protocols
Course Outline:	• Network attacks • Classic Encryption Techniques • DES • AES • Block Ciphers-Modes of Operations • Stream Ciphers and Random Numbers • Public Key Cryptography • Message Digest • SSL • User Authentication-Kerberos • IPSec • IDS • PGP and SMIE
Resources:	Text Book: • Cryptography and Network security, William Stalling, 8th Edition Reference Book: • Network Security essentials, William Stallings, 5th Edition

CLOs	MAPPED PLO	LEVEL	CONTRIBUTION
CLO1: Describe the basic cryptography related concepts.	PLO 1	C2	3
CLO2: Analyze some commonly used cryptographic primitives and protocols.	PLO 5	C4	3
CLO 3: Implement the encryption algorithms on plain text and explore the limitation of the protocols	PLO 4	C3	2

Grading Rubric

Assessment Method	CLO 1	CLO 2	CLO3
Final Exam	X	30	20
Midterm Exam	5	15	X
Assignments	5	10	5
Quizzes	2.5	5	2.5
Total (100)	12.5	70	17.5

Introduction to Blockchain	
Course Code:	EET-459
Credit Hours:	3
Pre-requisite:	Nil
Objectives:	Blockchain is a distributed and a decentralized database technology that is behind every cryptocurrency. This course explores the fundamentals of the public, transparent, secure, immutable and distributed database called blockchain. Blockchains can be used to record and transfer any digital asset not just currency. This course will introduce students to the workings and applications of this potentially disruptive technology. They will be able to understand the underlying technology of transactions, blocks, proof-of-work, and consensus building in Blockchain. Finally, by the end of this course the students will be able to design and implement new ways of using Blockchain for applications other than cryptocurrency.
Course Learning Outcomes (CLOs):	**CLO 1:** (C1): **Define** and **identify** the core components deployed in Blockchain Technology **CLO 2:** (C2): **Classify** the Blockchain protocols and **compare** the functionality of employed security and privacy techniques in various generations and implementations of Blockchain Technology. **CLO 3:** (C4)**: Analyze** and **categorize** the emerging and state-of-art applications/use cases of Blockchain Technology.

Course Outline:	• Blockchain Overview • Blockchain Protocols • Blockchain Evolution • Blockchain Types • Hash Cryptography • Digital Transactions • Blocks and Blockchain • Consensus Building • Mining in Blockchain • Blockchain Security and Privacy • Smart Contracts • Distributed Applications • Blockchain Platform: Bitcoin • Blockchain Platform: Ethereum • Blockchain Applications/Use Cases
Resources:	**Text Books:** • **Introduction to Blockchain and Ethereum,** First Edition September 2018 by Fatima Castiglione Maldonado **Reference Books:** • **Introduction to Blockchain Technology,** First Edition October 2019 by Tiana Laurence
Tools:	• Solidity Language • Ganache • Python Language • Digital Wallets: Meta Mask

Mapping of CLO to PLOs

Contribution: Average: 1, Moderate:2, Strong:3

CLOs	MAPPED PLO	LEVEL	CONTRIBUTION
CLO 1: (C1): **Define** and **identify** the core components deployed in Blockchain Technology	PLO 1	C1	2
CLO 2: (C2): **Classify** the Blockchain protocols and **compare** the functionality of employed security and privacy techniques in various	PLO 2	C2	3

generations and implementations of Blockchain Technology.			
CLO 3: (C4)**:** **Analyze** and **categorize** the emerging and state-of-art applications/use cases of Blockchain Technology.	PLO 4	C4	2

Grading Rubric

Assessment Method	CLO 1	CLO 2	CLO 3
Final Exam	5	25	20
Midterm Exam	12	8	X
Assignments	5	10	5
Quizzes	2.5	5	2.5
Total (100)	**24.5**	**48**	**27.5**

Course Title: Microelectronics Technology
Course Code: EEL-470
Credit Hours: 1
Prerequisite: Electronic Devices & Circuits, Electronic Circuit Design

Description:

The lab is design to develop understanding of students on Arduino, Raspberry pi, FPGA and to enable them to design different applications using these platforms.

Course Learning Outcomes (CLO) & Program Learning Outcomes (PLO) Mapping:

S. No	CLOs	Taxonomy Level	PLOs	Level of Emphasis	Knowledge Profile
1	To **present** and communicate lab results based on the understanding of experimental concepts and lab performance.	A2	10	2	N/A
2	To **produce** the integrated circuits design through modern CAD tool along with its limitations.	P4	5	2	6
3	To **practice** microelectronic circuits using different configuration of MOSFETs amplifiers and Current Mirrors.	P3	2	1	4
4	To **adapt** basic application-based circuits at integrated level particularly RF front-end modules by employing appropriate single-ended and/or differential amplifier topologies, along with mixing and/or oscillatory circuits.	P6	4	3	8
5	To **perform** the lab task as an individual or as a team member and show the dedication & commitment towards submission of lab files and project reports.	A5	9	2	N/A

Experiments:

- Introduction to Cadence Virtuoso Tool for IC Designing
- Simulating DC operating point of MOSFETs in saturation region using Cadence 65-nm CMOS Technology
- Behavior of 65-nm RF-CMOS transistor
- Common Source Amplifier Circuit

- Simple MOS Current Mirror Circuit
- Cascode Current Mirror Circuit
- Source Follower
- Differential Amplifiers
- LNA Basics and Simulations
- Single Ended Low Noise Amplifier (LNA)
- Simple Differential Input Mixer
- Mixer Basics and Simulations
- Gilbert Mixer
- Power Amplifiers

Appendage 2304

PROPOSED CBT OF ALL ENGINEERING AND COMPUTING PROGRAMS

Subject name	Subject topic	Difficulty Level	Questions	Total
English	English Comprehension	Easy	8	15
		Moderate	4	
		Difficult	3	
English	English Grammar	Easy	8	15
		Moderate	4	
		Difficult	3	
Maths	Algebra	Easy	10	20
		Moderate	5	
		Difficult	5	
Maths	General Maths	Easy	15	25
		Moderate	5	
		Difficult	5	
Analytical		Easy	6	15
		Moderate	5	
		Difficult	4	
Physics		Easy	6	10
		Moderate	2	
		Difficult	2	
		Total	**100**	**100**

Appendage 2307

BS ENVIRONMENTAL SCIENCES

Intake Spring 2019

Semester - 1

Sr. #	Approved Road map as per 31st ACM		Crd Hr.	Courses offered in Spring 2019	Crd Hr.	Status	Remarks/ Remedy
1	PAK 101	Pakistan Studies	2	Pakistan Studies	2	OK	
2	ISL 101	Islamic Studies	2	Islamic Studies	2	OK	
3	ENG 103	English I	3	English I	3	OK	
4	MAT105 BIO 105	Mathematics OR Fundamentals of Biology	0	Fundamentals of Biology	0	Not Ok	Only "Fundamental of Biology" was offered. Mathematics was not offered.
5	CSC 105	Introduction to Computers	3	Introduction to Computers	3	OK	
6	PHY 101	Physics	3	Physics	3	OK	
7	GEO 105	Physical & General Geology	3	Physical & General Geology	3	OK	

Semester - 2

Sr. #	Approved Road map as per 31st ACM		Crd Hr	Courses offered in Fall 2019	Crd Hr	Status	Remarks/ Remedy
1	CHM 105	Chemistry	3	Chemistry	3	OK	
2	ENG 104	English –II	3	English -II	3	OK	
3	MAT 115	Calculus & Analytical Geometry	3	Calculus & Analytical Geometry	3	OK	
4	GEO 110	Fundamental of Geography & Geomorphology	3	Fundamental of Geography & Geomorphology	3	OK	
5	ENV 105	Introduction to Environmental Sciences	3	Introduction to Environmental Sciences	3	OK	
6	ENV 110	Environmental Biology	3	Environmental Biology	3	OK	
7				(MAT105) Mathematics	0		Missed in first semester and hence offered in second semester

Semester - 3

Sr. #	Approved Road map as per 31st ACM		Crd Hr.	Courses offered in Spring 2020	Crd Hr.	Status	Remarks/ Remedy
1	ENG 232	Oral Communication	3	Oral Communication	3	OK	
2	HSS 111	Introduction to IR / Humanities	3	(HSS 107) Introduction to Psychology	3	Not OK	The offered course is part of courses to be offered in 4th semester.
3	MAT 205	Statistics	3	Statistics	3	OK	
4	ENV 210	Environmental Chemistry	3	Environmental Chemistry	3	OK	
5	ENV 205	Fundamentals of Ecology	3	Fundamentals of Ecology	3	OK	
6	ENV 230	Environmental Issues	3	Environmental Issues	3	OK	

Semester – 4

Sr. #	Approved Road map as per 31st ACM		Crd Hr.	Courses offered in Fall 2020	Crd Hr	Status	Remarks/ Remedy
1	ENV 215	Social Theory of Environment	3	Social Theory of Environment	3	OK	
2	ENV 220	Environmental Microbiology	3	Environmental Microbiology	3	OK	
3	ENV 225	Applied Ecology	3	Applied Ecology	3	OK	
4	HSS 107	Introduction to Psychology	3	(HSS 201) Intro to Anthropology		Not OK	The offered course is not part of approved roadmap. (HSS 201) Intro to Anthropology may be approved to become the part of BS (ES) for affected batch.
5	ENV 236	Introduction to Climate Change	3	Introduction to Climate Change	3	OK	
6	ENV 245	Introduction to Oceanography	3	Introduction to Oceanography	3	OK	

Semester – 5 (Current Semester)

Sr. #	Approved Road map as per 31st ACM		Crd Hr.	Courses offered in Spring 2021	Crd Hr.	Status	Remarks/ Remedy
1	ENV 305	Environmental Monitoring	3	Environmental Monitoring	3	OK	
2	ENV 310	Environmental Toxicology	3	Environmental Toxicology	3	OK	
3	ENV 315	Environmental Management System	3	Environmental Management System	3	OK	
4	ENV 320	Environmental Biotechnology	3	Environmental Biotechnology	3	OK	
5	ENV 335	Analytical Techniques in Environmental Sciences	3	Analytical Techniques in Environmental Sciences	3	OK	
6	GEO 305	Environmental Geology	3	Environmental Geology	3	OK	

Intake Fall 2019

Semester – 1

Sr. #	Approved Road map as per 31st ACM		Crd Hr.	Courses offered in Fall 2019	Crd Hr.	Status	Remarks/ Remedy
1	PAK 101	Pakistan Studies	2	Pakistan Studies	2	OK	
2	ISL 101	Islamic Studies	2	Islamic Studies	2	OK	
3	ENG 103	English I	3	English I	3	OK	
4	MAT105 BIO 105	Mathematics OR Fundamentals of Biology	0	Mathematics AND Fundamentals of Biology	0	OK	
5	CSC 105	Introduction to Computers	3	Introduction to Computers	3	OK	
6	PHY 101	Physics	3	Physics	3	OK	
7	GEO 105	Physical & General Geology	3	Physical & General Geology	3	OK	

Semester – 2

Sr. #	Approved Road map as per 31st ACM		Crd Hr.	Courses offered in Spring 2020	Crd Hr.	Status	Remarks/ Remedy
1	CHM 105	Chemistry	3	Chemistry	3	OK	
2	ENG 104	English –II	3	English -II	3	OK	
3	MAT 115	Calculus & Analytical Geometry	3	Calculus & Analytical Geometry	3	OK	

4	GEO 110	Fundamental of Geography & Geomorphology	3	Fundamental of Geography & Geomorphology	3	OK	
5	ENV 105	Introduction to Environmental Sciences	3	Introduction to Environmental Sciences	3	OK	
6	ENV 110	Environmental Biology	3	Environmental Biology	3	OK	

Semester – 3

Sr. #	Approved Road map as per 31st ACM		Crd Hr.	Courses offered in Fall 2020	Crd Hr.	Status	Remarks/ Remedy
1	ENG 232	Oral Communication	3	Oral Communication	3	OK	
2	HSS 111	Introduction to IR / Humanities	3	(HSS 201) Intro to Anthropology	3	Not OK	The offered course is not part of approved roadmap. (HSS 201). Intro to Anthropology may be approved to become the part of BS (ES) for affected batch.
3	MAT 205	Statistics	3	(ENV 245) Introduction to Oceanography	3	Not OK	The offered course was to be offered in 4th semester
4	ENV 210	Environmental Chemistry	3	Environmental Chemistry	3	OK	
5	ENV 205	Fundamentals of Ecology	3	Fundamentals of Ecology	3	OK	
6	ENV 230	Environmental Issues	3	Environmental Issues	3	OK	

Semester – 4 (Current Semester)

Sr. #	Approved Road map as per 31st ACM		Crd Hr.	Courses offered in Spring 2021	Crd Hr.	Status	Remarks/ Remedy
1	ENV 215	Social Theory of Environment	3	Social Theory of Environment	3	OK	
2	ENV 220	Environmental Microbiology	3	Environmental Microbiology	3	OK	
3	ENV 225	Applied Ecology	3	Applied Ecology	3	OK	

4	HSS 107	Introduction to Psychology	3	Introduction to Psychology	3	OK	
5	ENV 236	Introduction to Climate Change	3	Introduction to Climate Change	3	OK	
6	ENV 245	Introduction to Oceanography	3	(MAT 205) Statistics	3	Not OK	The offered course was to be offered in 3rd semester

Intake Spring 2020

Semester – 1

Sr. #	Approved Road map as per 31st ACM		Crd Hr.	Courses offered in Spring 2020	Crd Hr.	Status	Remarks/ Remedy
1	PAK 101	Pakistan Studies	2	Pakistan Studies	2	OK	
2	ISL 101	Islamic Studies	2	Islamic Studies	2	OK	
3	ENG 103	English I	3	English I	3	OK	
4	MAT105 BIO 105	Mathematics OR Fundamentals of Biology	0	Mathematics AND Fundamentals of Biology	0	OK	
5	CSC 105	Introduction to Computers	3	Introduction to Computers	3	OK	
6	PHY 101	Physics	3	Physics	3	OK	
7	GEO 105	Physical & General Geology	3	(ENV 105) Introduction to Environmental Sciences	3	Not OK	The offered course was to be offered in 2nd semester

Semester – 2

Sr. #	Approved Road map as per 31st ACM		Crd Hr.	Courses offered in Fall 2020	Crd Hr.	Status	Remarks/ Remedy
1	CHM 105	Chemistry	3	Chemistry	3	OK	
2	ENG 104	English –II	3	English -II	3	OK	
3	MAT 115	Calculus & Analytical Geometry	3	Calculus & Analytical Geometry	3	OK	
4	GEO 110	Fundamental of Geography & Geomorphology	3	Fundamental of Geography & Geomorphology	3	OK	
5	ENV 105	Introduction to Environmental Sciences	3	(GEO 105) Physical & General Geology	3	Not OK	The offered course was to be offered in 1st semester
6	ENV 110	Environmental Biology	3	Environmental Biology	3	OK	

Semester – 3 (Current Semester)

Sr. #	Approved Road map as per 31st ACM	Crd Hr.	Courses offered in Spring 2021	Crd Hr.	Status	Remarks/ Remedy

1	ENG 232	Oral Communication	3	Oral Communication	3	OK	
2	HSS 111	Introduction to IR / Humanities	3	Introduction to IR	3	OK	
3	MAT 205	Statistics	3	Statistics	3	OK	
4	ENV 210	Environmental Chemistry	3	Environmental Chemistry	3	OK	
5	ENV 205	Fundamentals of Ecology	3	Fundamentals of Ecology	3	OK	
6	ENV 230	Environmental Issues	3	Environmental Issues	3	OK	

Intake Fall 2020

Semester - 1

Sr. #	**Approved Road map as per 31st ACM**		**Crd Hr.**	**Courses offered in Fall 2020**	**Crd Hr.**	**Status**	**Remarks / Remedy**
1	PAK 101	Pakistan Studies	2	Pakistan Studies	2	OK	
2	ISL 101	Islamic Studies	2	Islamic Studies	2	OK	
3	ENG 103	English I	3	English I	3	OK	
4	MAT105 BIO 105	Mathematics OR Fundamentals of Biology	0	Mathematics AND Fundamentals of Biology	3	OK	
5	CSC 105	Introduction to Computers	3	Introduction to Computers	3	OK	
6	PHY 101	Physics	3	Physics	3	OK	
7	GEO 105	Physical & General Geology	3	(ENV 105) Introduction to Environmental Sciences	3	Not OK	The offered course was to be offered in 2nd semester

Semester – 2 (Current Semester)

Sr. #	**Approved Road map as per 31st ACM**		**Crd Hr.**	**Courses offered in Spring 2021**	**Crd Hr.**	**Status**	**Remarks / Remedy**
1	CHM 105	Chemistry	3	Chemistry	3	OK	
2	ENG 104	English –II	3	English -II	3	OK	
3	MAT 115	Calculus & Analytical Geometry	3	Calculus & Analytical Geometry	3	OK	

4	GEO 110	Fundamental of Geography & Geomorphology	3	Fundamental of Geography & Geomorphology	3	OK	
5	ENV 105	Introduction to Environmental Sciences	3	(GEO 105) Physical & General Geology	3	Not OK	The offered course was to be offered in 1st semester
6	ENV 110	Environmental Biology	3	Environmental Biology	3	OK	

Appendage 2308

Annex 'A' to Academics Directorate
Letter BU-D-Acad/38th ACM/(1)/2021/87
Dated: 02 March 2021

NEW PROGRAMME PROPOSAL

A. ACADEMIC DETAILS	
1	**Faculty/Department:** Faculty of Engineering Sciences ./ Department of Computer Sciences
2	**Title of the Programme: PhD (CS)**
3	**Mission of the Programme:**
4	**Objectives of the Programme:** The key objectives of the PhD (CS) program include the following. 1. To prepare scholars to have an understanding of the processes of research which will enable them to independently make original, creative and useful research contributions in their respective areas of research. 2. To prepare scholars to effectively convey technical contributions through written and oral communication. 3. To enable scholars to carry out research independently as well as in teams. 4. To acquaint scholars with and enable them to apply professional code of ethics in their research endeavors.
5	**Outcomes of the Programme:** Students graduating from the PhD (CS) program are expected to: 1. Demonstrate comprehensive in-depth knowledge of the theory, methods and algorithmic principles in the relevant area of study. 2. Apply the theoretical knowledge and concepts to find answers to research questions. 3. Carry out skilled research, identify, comprehend and synthesize relevant literature, select appropriate techniques and tools to solve the research problem, analyze data produced by experiments and research and, draw meaningful conclusion from the realized results. 4. Critically analyze relevant works and demonstrate creativity and innovation by generating new ideas. 5. Demonstrate their ability to further the frontier of knowledge in at least one sub-area of Computer Science. 6. Develop abilities for effective communication as researchers by presenting research ideas at in-house, National and International forums 7. Be able to convey research contributions, ideas and arguments in a clear and organized form through technical reports and research publications at reputed publication forums. 8. Research and solve problems of common interest in team dynamics. 9. Understand the consequences of and avoid various forms of scientific misconduct including plagiarism, falsification and/or fabrication of results, omissions and misuse of data. 10. Comprehend and respect the ethics concerning authorship and publication issues including criteria for

	authorship, order of authors, guest and ghost authorships, self-citations and duplicate publications/submissions.
6	**Rationale for the Programme:** It's the need of the time
7	**Brief Description of the Programme:**
8	**Duration:** 3 Years, 6 Semesters
9	**Venue(s): On Site/Off Site/Both On & Off Site** *(Tick one; if Off Site, give details)*
10	**Programme Scheduling Format:** **Morning/Evening/Weekend** *(tick one)* **Semester/Annual/** *(tick one)*
11	**Proposed Date of Commencement: Fall 2021**
12	**Mode of Study/Examination: Semester, Full Time, Morning**
13	**Additional Faculty Member(s) Required: As per HEC Requirements**
14	**Additional Skilled-Worker(s) Required:** *(Indicate if there is a requirement for additional Skilled Staff, fulltime/part-time, along with their qualifications/skill sets.)*
15	**Additional Classroom(s) required:** *(The requirement is to include the number of classrooms and their capacities.)*
16	**Additional Requirement for Laboratories:** *(The requirement is to include the number of laboratories, their equipment and their capacities.)*
17	**Additional Requirement for Books, Subscriptions, Memberships to Online Research Sites/ Repositories:**
18	**Minimum Qualification for Admission:** 18 years of education minimum 60% or 3 CGPA in relevant discipline
19	**Admission Eligibility Criteria: (to be aligned with accreditation/regulatory bodies)** GRE/ GAT (Subject with 60%). NTS – GAT / GRE(General)/ University entry test passed with 50% marks.
20	**Additional/Different Examination Requirement** *(Indicate if there will be any examination requirement, additional to or different from the BU Academic Rules or Examination Policy in vogue).* Applicants must provide HEC verification of all academic certificates / degrees.

21	**Number of Admissions Expected for First Intake:**

22	**Number of Admissions Planned/Expected for Subsequent Intakes:**
23	**Referred by:** *(delete which is inapplicable)* **FBOS**: *(Indicate the FBOS meeting reference and Item No)* **Competent Authority**: *(Indicate the File No & date; reproduce the decision)*
24	**Complete Plan of Studies, inclusive of complete Roadmap:** *(Attach as Annex 'B')*
25	**Course Outlines, Descriptions, Pre-Requisites & Readings (Compulsory & Recommended)** *(Attach as Annex 'C')*
	B. FINANCIAL DETAILS
1	**Source of Funding:** • **BU: Fully/Partially:** • **Public Sector (B1): Fully/Partially** *(provide complete details; attach MOU, agreement etc.)* • **NNGO (B1): Fully/Partially** *(provide complete details; attach MOU, agreement etc.)* • **INGO (B1): Fully/Partially** *(provide complete details; attach MOU, agreement etc.)* • **UN/IGO (B1): Fully/Partially** *(provide complete details; attach MOU, agreement etc.)*
2	**Degree Duration:** **Annual or Semester System:** Annual Number of Years Semester: Number of Semester **Total Number of Credit Hours:**
3	**Expected fee to be charged based on Cost & Benefits Analysis:** *(show working)* Per annum fee: or Fee rate per credit hour: 6,065
4	**Expected Number of students for 1st & 2nd Intakes:**
5	**Expected Earning from first two Intakes (B5):** *(Show working)*
6	**Expected Earning for the Next Five Years (B6):** *(show working)*
7	**Total Estimated Salaries of all Additional Human Resources per annum (B7):** *(Show working)*
8	**Cost of Additional Laboratory Equipment/Tools (B8):** *(show working)*
9	**Cost of Additional Classrooms (B9):** *(Include furniture, technical aids etc)*
10	**Cost of Additional Books, Subscription & Memberships to on-line Sites/Repositories (B10):** (*show details)*

11	**Off-Site rental Expenses and Cost of other Fixtures (B11):** *(Show details)*
12	**Miscellaneous Expenses required for Starting the Program (B12):** - Advertisement:
	- Printing & Stationery - Admin Cost - Any other - **Total**
13	**Annual Recurring Expenditures in Subsequent Years (B13):** - Salaries: - Rentals: - Subscriptions/Memberships: - Advertisements: - Printing & Stationery: - Admin Cost - Any other - **Total:**
14	**Total Cost of the Programme (B14): [**Add B(7) to B(12)]
15	**Net Cost of the Programme (B15):** [Subtract B(1) from B(14)]
16	**Net Earnings in First Year (B16:** [Subtract B (15) from B (5)]
17	**Projected Annual Gross Earning in Subsequent Years (B 17): (***show details & working; add 10% towards all expenses in subsequent years.)*
18	**Projected Annual Net Earning in Subsequent Years:** *[Subtract B (13) from B (17)]*

Annex 'B' to Academics Directorate
Letter BU-D-Acad/38th ACM/(1)/2021/87
Dated: 02 March 2021

NEW/REVISED ROADMAPS & COURSE CODES

Campus: Lahore
Department: Computer Sciences
Program Title: PhD Computer Science
Program Level: Postgraduate
Total Duration of Program: 3 years
Total Number of semesters: 6
Total Credit Hours:

Semester-1

Sr.No.	Pre-requisite Course Code	Course Code	Course Title	Credit Hours	Theory	Lab (if any)
1		ESC-702	Research Methods in PhD Studies	3		
2		Elective code	Elective-1	3		
3		Elective code	Elective-2	3		
Total Credit Hours in Semester-1				9		

Semester-2

Sr.No.	Pre-requisite Course Code	Course Code	Course Title	Credit Hours	Theory	Lab (if any)
4		Elective code	Elective-3	3		
5		Elective code	Elective-4	3		
6		Elective code	Elective-5	3		
Total Credit Hours in Semester-2				9		

Semester-3

Sr.No.	Pre-requisite Course Code	Course Code	Course Title	Credit Hours	Theory	Lab (if any)
7		EEN-901	Comprehensive Exam	0		
8		EEN-902	Supervised Research (PhD Thesis) including defense and acceptance of research proposal	9		
Total Credit Hours in Semester-3				9		

Semester-4

Sr.No.	Pre-requisite Course Code	Course Code	Course Title	Credit Hours	Theory	Lab (if any)
9		EEN-902	Supervised Research (PhD Thesis)	9		
Total Credit Hours in Semester-4				9		

Semester-5

Sr.No.	Pre-requisite Course Code	Course Code	Course Title	Credit Hours	Theory	Lab (if any)
10		EEN-902	Supervised Research (PhD Thesis)	9		
Total Credit Hours in Semester-5				9		

Semester-6

Sr.No.	Pre-requisite Course Code	Course Code	Course Title	Credit Hours	Theory	Lab (if any)
11		EEN-902	Supervised Research (PhD Thesis)	9		
Total Credit Hours in Semester-6				9		

List of Elective Courses

Sr.No.	Pre-requisite Course Code	Course Code	Course Title	Credit Hours	Theory	Lab (if any)
1		CSC 711	Advanced Artificial Intelligence	3		
2		CSC-719	Machine Learning	3		
3		CSC-741	Advanced Natural Language Processing	3		
4		CEN-745	Advanced Digital Image Processing	3		
5		CSC 750	Advanced Neural Networks	3		
6		CSC-751	Pattern Recognition	3		
7		CSC-764	Computer Vision	3		
8		CSC 765	Bio Medical Image Analysis	3		
9		CSC-750	Intelligent Tutoring Systems	3		
10		CSC-715	Intelligent Agents	3		

11		CSC 744	Advanced Computer Graphics	3		
12		DSC-701	Big Data Analytics	3		
13		DSC-702	Machine Learning and Data Analysis	3		
14		DSC-703	Data Visualization	3		
15		DSC-704	Distributed Data Engineering	3		
16		DSC-705	Deep Learning and Data Analysis	3		
17		DSC-706	Unstructured Data Processing	3		
18		CSC-746	Advanced Data Mining	3		
19		CSC-747	Text Mining	3		
20		EET-710	Advanced Computer Networks	3		
21		EET-702	Advanced Network Security	3		
22		EET-713	Advanced Network Design	3		
23		EET-716	Advanced Topics in Wireless Networking and	3		
24		EET-718	Network Performance Evaluation	3		
25		EET-761	Network Protocols and Standards	3		
26		EET-705	Broadband Technologies and Components	3		
27		EET 726	Advanced Internet Technologies	3		
28		EET-850	Wireless Sensor Networks	3		
29		EET-851	Mobile and Ad hoc Networks	3		
30		ISC-721	Advanced Cryptography and Cryptanalysis	3		
31		ISC-731	Information Security Management	3		
32		ISC-733	Information Hiding	3		
33		ISC-734	Wireless Network Security	3		
34		ISC-735	Cloud Computing Security	3		
35		ISC-736	Cyber Warfare	3		
36		ISC-737	Computer and Network Forensics	3		
37		ISC-738	Ethical Hacking	3		
38		ISC-739	Cyber Crimes and Laws	3		
39		ISC-740	Quantum Cryptography	3		
40		ISC-741	Algebraic Cryptanalysis	3		

41		ISC-742	Intrusion Detection and Prevention	3		
42		ISC-743	Penetration Testing and Vulnerability Analysis	3		
43		CSC-720	Advanced Operating Systems	3		
44		CSC 758	Parallel Processing	3		
45		CEN 707	Advanced Distributed Systems	3		
46		CSC-752	Advanced DBMS	3		
47		CSC-753	Distributed Databases	3		
48		CSC-754	Object Oriented Databases	3		
49		CSC-755	Web based DBMS	3		
50		CSC-756	Multimedia Databases	3		
51		CSC-760	Advanced Data Warehousing	3		
52		CSC-781	Cloud Computing	3		
53		SEN 761	Semantic Web	3		
54		SEN 764	Ontology Engineering	3		
55		CSC-757	IP Multimedia System	3		
56		SEN 754	Advanced Web Computing System and Application	3		

Annex 'C' to Academics Directorate
Letter BU-D-Acad/38th ACM/(1)/2021/87
Dated: 02 March 2021

Bahria University, Islamabad

Program Title: PhD (CS)

Admission Eligibility Criteria:

18 years of education minimum 60% or 3 CGPA in relevant discipline GRE/ GAT (Subject with 60%). NTS – GAT / GRE(General)/ University entry test passed with 50% marks. Additionally, applicants must provide HEC verification of all academic certificates / degrees

Program Objectives:

The key objectives of the PhD(CS) program include the following.

1. To prepare scholars to have an understanding of the processes of research which will enable them to independently make original, creative and useful research contributions in their respective areas of research.
2. To prepare scholars to effectively convey technical contributions through written and oral communication.
3. To enable scholars to carry out research independently as well as in teams.
4. To acquaint scholars with and enable them to apply professional code of ethics in their research endeavors

Program Learning Outcomes:

Students graduating from the PhD(CS) program are expected to:

1. Demonstrate comprehensive in-depth knowledge of the theory, methods and algorithmic principles in the relevant area of study.
2. Apply the theoretical knowledge and concepts to find answers to research questions.

3. Carry out skilled research, identify, comprehend and synthesize relevant literature, select appropriate techniques and tools to solve the research problem, analyze data produced by experiments and research and, draw meaningful conclusion from the realized results.
4. Critically analyze relevant works and demonstrate creativity and innovation by generating new ideas.
5. Demonstrate their ability to further the frontier of knowledge in at least one sub-area of Computer Science.
6. Develop abilities for effective communication as researchers by presenting research ideas at in-house, National and International forums
7. Be able to convey research contributions, ideas and arguments in a clear and organized form through technical reports and research publications at reputed publication forums.
8. Research and solve problems of common interest in team dynamics.
9. Understand the consequences of and avoid various forms of scientific misconduct including plagiarism, falsification and/or fabrication of results, omissions and misuse of data. 10. Comprehend and respect the ethics concerning authorship and publication issues including criteria for authorship, order of authors, guest and ghost authorships, self-citations and duplicate publications/submissions.

Detail Course Descriptions

(To be prepared for each individual course including elective courses)

Course Title: _ MOS VLSI Circuit Design___
Course Code: __CEN-754_____
Credit Hours: __3_____
Pre-requisite (if any): _____

Course Description

CEN-754 MOS VLSI Circuit Design
This is a graduate level course covering the design and analysis of low power and high-performance digital CMOS integrated circuits. Examples of such circuits that feature large-Digital, small-Analog architectures include microprocessors, FPGAs and DSP and multimedia SoC modules. The course covers the traditional CMOS inverter in depth. Other topics include interconnects, layout, simulation techniques, hierarchical design, timing issues, EDA tools, complex macro architectures, arithmetic building blocks and memory structures. Intensive project work is included using Mentor Graphic IC design tools. Fabrication of modern CMOS circuits is covered along with a survey of the industry at the beginning of the course.

Course Objectives

1.
2.
3.
4.
5.

Course Learning Outcomes

1.
2.
3.
4.
5.

Course Contents:

1.
2.
3.
4.

5.
6.

Recommended Textbooks/Reference Books (latest edition)

1.
2.
3.
4.

Web Resources/Other Course Materials

1.
2.
3.
4.

Prepared by: _____

EEN-728 Real Time DSP Design and Applications

This course introduces real time application and design to the students. Furthermore, topics like discrete time signal processing, peripheral Components, Real Time Implementation issues, DSP architecture, efficient Computation of the Discrete Fourier transform and implementation of the DFT using Convolution synchronization is covered. Towards the latter half of the course designing and implementation of the Hilbert transform, filters Hardware Accelerators and design approach on DSK TMSc6713 System-on-chip is also discussed.

EET-711 Advanced Digital Communications

This course introduces advanced topics in digital communication. Topics such as Random and Deterministic Signals, Bandpass Modulation and Demodulation, Digital Modulation, Waveform and vector AWGN channels, Synchronization and multichannel and multicarrier systems form the core of this course.

ESC-702 Research Methods in PhD Studies

This course covers all aspects which will enable students to learn what and how is research carried out in their doctoral studies. It will look in depth about what a research process is,
i.e. Essential first steps (Phase 1), data collection (Phase 2) & Analysis and Interpretation (Phase 3). It will also cover how a research thesis is written and all the aspects related to it.

EEP-770 Power Management in Wired and Wireless Systems

This course is basically related to the various issues and challenges relating to energy conservation for both wired and wireless systems. Low power system designing techniques are also the integral part of this course which describes the System Level Approach for Energy Conservation. Power management in mobile based systems such as Wireless sensor networks and RFID, where power management is of great interest, will also be covered in this course.

EEP-771 Low Power System Design

This course deals with the low power consuming system design where Nano-meter transistor and their models will be discussed. This course has its practical relevance with transceivers designing used in Wireless sensor networks. Ultra-low power operated circuits their designing and simulators on which these can be developed constitute a major portion of this course.

CEN-708 Advanced System Modeling and Simulation

This course has two major portions: system modeling and simulation. In the first portion, mathematical models of the communication system are discussed. Here we further extend this modeling to random processes,

queuing theories and Markov chaining. In the second part, various simulation tools and their significance is discussed.

EN-707 Advanced Distributed Systems
This course deals with the theoretical foundations on distributed system, protocol design for inter-process communication systems and database systems. Real time systems and distributed multimedia systems are also an integral part of this course. This course will help the students to develop their research direction in the areas of distributed systems and cloud computing.

EEP-772 Power Awareness in Distributed Systems
This course describes the advanced concepts of distributed systems in terms of energy efficiency. Modern power system operations with distributed generation by renewable energy sources are also discussed. Power management points in power aware real time systems, power quality disturbances, fault protection and transmission with distributed generation make this course versatile in the area of the distributed computing with power efficiency.

EEP-773 Power System Stability and Dynamics
This course is basically the advanced course of power system analysis; it describes the concept of power system dynamics and stability. Effect of excitation system on generator power limit, transformation model of excitation system, and machine representation by classical model are the major parts of this course. This course also provides the students with the research directions in different areas of power stability.

EEP-774 Power System Transients
This course deals with the concepts of simple switching transient in electric power systems switching of RL, LC, RLC circuits and Transient analysis for 3-phase Power System-Sequence network. Basic ideas about protection, Surge diverters, Surge absorbers, Ground fault neutralizers, Protection of lines and stations by shielding are also discussed in this course.

EE-775 HVDC and Flexible AC Transmission
This course describes the concepts of the High Voltage DC Transmission with the Application of FACTS Controllers. Thyristor Controlled Series Compensators and Transient Stability Improvement explore the power electronics integration with Power system. Simulation of HVDC link (EMTDC) and SVC and TCSC application in power system (PSS/E) is essential for practical understanding of its various parameters.

EEP-776 Rural Electrification and Distributed Generation
This course deals with the Economic and Financial Analysis of Stand-alone Electrification Projects. Renewable energy sources, fuel cells and gas turbine based powered distributed generators are an integral part of this course.

EEP-777 Artificial Intelligence Techniques in Power systems
This course starts with the Fuzzy logic concepts and Robust Artificial Neural Network. Furthermore, ANN approach to the Diagnosis of Transformer Faults, Real-Time Frequency and Harmonic Evaluation using ANN are discussed. This course also includes some object-oriented analysis, design and implementation of EP. Application of EP to Transmission Network Planning is also integrated in this course.

EEP-778 Power System Deregulation
This course deals with the Power sector economics and performance of indices of power utility. Demand side management (DSM) & Integrated resource planning (IRP) are also included. For practical significance and research point of view, power sector issues and challenges of Pakistan, Structural models (single buyer model,

wholesale competition, retail competition) Ownership models (public sector, state owned and municipal utilities, joint sector, cooperatives and private sector) have also been included in this course.

CEN-720 Advanced Computer Architecture
This course covers the advanced concepts in computer architecture including computer organization instruction set design principles and MIPS architecture, pipelining, instruction level parallelism, compilers, code optimization, caches, main and virtual memory. Students will also be introduced to parallel computers.

CEN-740 Advanced Embedded Systems
This advanced course on embedded systems covers topics like Processor technologies, IC technology, Programmable Logic Devices, FPGA Programming Models, HDL, EDK Structure, EDK Programming, Instruction Set Architecture Design, Real Time Task Scheduling, Resource Sharing in RT Tasks, RTOS, processes, threads, context switching, process synchronization, interrupts, Real time Communications, Routing and Rate Control, Real time data bases, Embedded System Architecture, I/O interface / Memory interface, Memory and Caches, etc., Embedded Computing Platforms, Program Design, Dataflow Graphs, Simulation, Hardware Accelerators and Device Drivers.

EEN-725 Advanced Digital Signal Processing
This course on Digital Signal Processing will discuss topics including Discrete-time Signals, Input-Output Relationships, Discrete-Time Networks, Sampling of Signals, Discrete Fourier Transform & FFT Algorithms, IIR, FIR Filters, Design of signal-processing system, Advanced digital filter design, Multi-rate DSP, FFT and DSP applications.

CEN-742 Advanced Digital System Design
This course is dedicated to advanced topics in digital system design including Application-Specific Integrated Circuits, System on Chip (SoC), Validation and Verification, Simulation, Hardware acceleration, VHDL language, from specification to model, Application-specific instruction-set processor (ASIP) design, Field-programmable gate array (FPGA), Hardware Design Methodologies, EDA (GPL Electronic Design Automation), Programmable logic devices: PLA, PAL, GAL, CPLD and FPGA

CEN-741 ASIC Design Methodology
The course introduces the design and analysis of Application Specific Integrated Circuits (ASICs). The main focus would be on, logic and physical synthesis, verification and testing. Describe the different phases of the design flow for digital ASICs, how non-functional design constraints affect the design process, categorize different types of ASICs and explain their technology, apply techniques to analyze the timing of the final implementation.

SEN-753 Power Aware Computing
This course basically describes the Flip Flops and Applications of Data Gating in dynamic Flip Flops for High Speed. Low Power Sandwich/Spin Tunneling Memory Devices and Micro Architecture Design and Control Speculation for Energy Reduction are also discussed. From application point of view a Compiler Targeting ASICs and FPGAs with Power and Performance.

CSC-711 Advanced Artificial Intelligence
This course in Artificial Intelligence (AI)deals with the coverage of search, knowledge representation and reasoning, machine learning (paradigms, models, and algorithms), use of knowledge in learning, and AI applications. The emphasis of the course is on recent developments in AI (i.e., beyond monkeys and bananas), especially contributions that forged novel connections among diverse areas, or addressed problems of significant impact. The goal is to emphasize certain thematic issues that recur in AI systems and applications.

SEN-810 Advanced Neural Networks & Fuzzy Logic

The goal of this course is to familiarize students with a powerful class of model, the Neural Network. In fact, this is a broad term which includes many diverse models and approaches. We will first motivate networks by analogy to the brain. The analogy is loose but serves to introduce the idea of
Parallel and distributed computation. We then introduce one kind of network in detail: the feed-forward network trained by back propagation of error. The course then discusses model architectures, training methods and data representation issues. The course aims to cover everything a student needs to know to get back-propagation working. A range of applications and extensions to the basic model will be presented in the final section of the module.

SEN-811 Data Warehousing and Mining

The course in data warehousing (DW) and data mining (DM) presents the paradigms of DW and DM (methodology, tools, techniques, systems and terminology) to students by putting these concepts into context and comparing expert views in these areas through seminars, discussions, and hands-on-work in computer labs. The prerequisite for the course is a graduate course in Database Systems. The main purpose of the course is to develop and gain an understanding of the principles, concepts, functions and uses of data warehouses, data modeling and data mining in business. A DW and DM project is usually business-driven and will work to improve the direction of the company by aligning the data warehouse technology with business strategy. It will also enable students to understand and implement classical algorithms in data mining and data warehousing. Students will learn how to analyze the data, identify the problems, and choose the relevant algorithms to apply. Then, they will be able to assess the strengths and weaknesses of the algorithms and analyze their behavior on real datasets.

CSC-719 Machine Learning

Machine learning is a scientific discipline concerned with the design and development of algorithms that allow computers to evolve behaviors based on empirical data, such as from sensor data or databases. A learner can take advantage of examples (data) to capture characteristics of interest of their unknown underlying probability distribution. Data can be seen as examples that illustrate relations between observed variables. A major focus of machine learning research is to automatically learn to recognize complex patterns and make intelligent decisions based on data; the difficulty lies in the fact that the set of all possible behaviors given all possible inputs is too large to be covered by the set of observed examples (training data).

SEN-723 Formal Methods and Specifications

As more complex computational systems are used within critical applications, it is becoming essential that these systems are formally specified. Such specifications are used to give a precise and unambiguous description of the required system. While this is clearly important in critical systems such as industrial process management and air/space craft control, it is also becoming essential when applications involving E-commerce and mobile code are developed. In addition, as computational systems become more complex in general, formal specification can allow us to define the key characteristics of systems in a clear way and so help the development process. Formal specifications provide the basis for verification of properties of systems.

SEN-751 Human Aspects in Software Engineering

Extensive human involvement in software development has made humans an important stakeholder in software process. Furthermore, due to emerging paradigm of end user development where end users also take up the role of software enhancement, need for understanding human aspects has become more critical. The goal of this course is to provide an introduction to the fundamental human aspects in software development process. Students will also be introduced to end user software engineering paradigm and underlying issues.

GSC-700 Advanced Engineering Mathematics

There are three main objectives of this course. First, presenting the concepts of partial differential equations and complex variables and some basic techniques for analyzing these problems. Second, by studying the application of PDE's to physics, engineering, and biology, the student will begin to acquire intuition and expertise about how to use these equations to model scientific processes. Finally, by utilizing numerous

numerical techniques, the student will begin to visualize, hence better understand, what a PDE is and how it can be used to study the Natural Sciences.

Appendage 2309

ALIGNMENT OF EE DEPARTMENT VISION & PROGRAM MISSION WITH BU VISION AND MISSION

Vision & Mission	**Department's Vision** **"**Commitment to prepare students for professional and research activities with an ability to learn independently, within a diverse multi-cultural environment, and enabling them to become the global leaders in their respective fields."	**Program's Mission** **"**To produce ethically sound and technically competent electrical engineers who can serve in the diverse fields of research, design and development, teaching, system installation, support and maintenance. "
University Vision **"**To become a knowledge and creativity driven international university that contributes towards development of society. "	✓	✓
University Mission **"**To ensure academic excellence through deliverance of quality education and applied research in a collegiate environment having strong linkages with industry and international community to meet the societal challenges."	✓	✓

ALIGNMENT OF PEOs

Vision & Mission	Program Educational Objectives (PEOs)			
	PEO 1	**PEO 2**	**PEO3**	**PEO4**
University Vision To become a knowledge and creativity driven international university that contributes towards development of society.	Find solutions of Complex Engineering problems	Skillful employable graduates	Professional growth	Leadership & responsive to societal issues
University Mission To ensure academic excellence through deliverance of quality education and applied research in a collegiate environment having strong linkages with industry and international community to meet the societal challenges.	Compete with technical challenges	Explore opportunities for entrepeuership in industry	Develop proficiency in the usage of new tools	Multi-cultural environment & communities
Department's Vision Commitment to prepare students for professional and research activities with an ability to learn independently, within a diverse multi-cultural environment, and enabling them to become the global leaders in their respective fields.	To exhibit expertise	Expertise in domain of design, development, operation and maintenance	Professional Growth in the related fields	Multi-cultural environment & Providing Leadership
Program's Mission To produce ethically sound and technically competent electrical engineers who can serve in the diverse fields of research, design and development, teaching, system installation, support and maintenance.	To compete with technological challenges	Skillful graduates in different domains	Ascertain Technologies	Responsive to ethical, moral and societal issues

Appendage 2310

Vision Statement for the Department of E&ES

To become one of the leading interdisciplinary academic and research institutions in the region through excellence in teaching, research, and sustaining the societal needs.

Mission Statement for the Department of E&ES

To remain committed for the achievement of highest standards in professional teaching, learning, pure and applied research in the fields of Geology, Geophysics and Environmental Sciences at par with the international standards to produce high quality professionals.

Appendage 2311

ALIGNMENT OF SE DEPARTMENT VISION & PROGRAM MISSION WITH BU VISION AND MISSION

Vision & Mission		**Program Educational Objectives (PEOs)**		
	Department Vision	**PEO 1**	**PEO 2**	**PEO3**
University Vision To become a **knowledge** and **creativity** driven **international university** that contributes towards **development of society**.	To be recognized as a **leading national** and **international institution** in **Software Engineering education** & **research** contributing towards **development of individuals and society**.	Graduates should demonstrate **competence in applying Software Engineering principles** & practices in various phases of software/system development life cycle in their respective **professional career**.	Graduates should demonstrate effective team member or leadership skills with strong managerial skills and a sound sense of **social responsibility for the sustainable development of society**.	Graduates should demonstrate **sustained career development** and progression through ethical engineering practices, effective communication skills and continuous learning.
University Mission To ensure **academic excellence** through deliverance of **quality education** and **applied research** in a collegiate environment having **strong linkages with industry** and **international community** to meet the **societal challenges**.	**Program Mission** To prepare **technically strong Software Engineers** who can contribute effectively towards **industry, society** and the **world at large** through effective **application of engineering knowledge**, **problem solving skills**, **leadership** and **healthy lifelong learning attitude**.	Graduates should demonstrate competence in **applying Software Engineering principles** & practices in various phases of software/system development life cycle in their respective professional career.	Graduates should demonstrate **effective team member or leadership skills** with strong managerial skills and a sound sense of social responsibility for the sustainable development of society.	Graduates should demonstrate **sustained career development** and progression through ethical engineering practices, effective communication skills **and continuous learning**.

Appendage 2312

Consistency of the vision and mission of the Computer Engineering Department with the updated vision and mission of Bahria University

Vision & Mission	University	Department/Program
Vision	To become a knowledge and creativity driven international university that contributes towards the development of society.	The Computer Engineering Department is committed to prepare students for professional and research activities with an ability to learn independently, within a diverse multi-cultural environment, and enabling them to become global leaders in their respective fields.
Mission	To ensure academic excellence through the deliverance of quality education and applied research in a collegiate environment having strong linkages with industry and the international community to meet the societal challenges.	The mission of the Bachelor of Computer Engineering program is to produce ethically sound and technically competent graduates who can fulfill the evolving needs of academia, industry, and society.

Consistency of PEOs with Vision and Mission

VISION & MISSION	PEOS			
	PEO 1	**PEO 2**	**PEO 3**	**PEO 4**
UNIVRSITY VISION To become a knowledge and creativity driven international university that contributes towards development of society.	Attain an ability to identify and solve challenging problems in their professions by applying theory, principles and modern tools learnt during degree program.	Demonstrate effective communication as an individual or team player with strong managerial and entrepreneurial skills.	Maintain highest ethical and professional standards in pursuing their careers.	Engage in life- long learning to continually polish their professional capabilities for their personal growth and the betterment of society.

UNIVERSITY MISSION To ensure academic excellence through deliverance of quality education and applied research in a collegiate environment having strong linkages with industry and international community to meet the societal challenges.	Attain an ability to identify and solve challenging problems in their professions by applying theory, principles and modern tools learnt during degree program	Demonstrate effective communication as an individual or team player with strong managerial and entrepreneurial skills.	Maintain highest ethical and professional standards in pursuing their careers.	Engage in life- long learning to continually polish their professional capabilities for their personal growth and the betterment of society.
DEPARTMENT'S VISION The Computer Engineering Department is committed to prepare students for professional and research activities with an ability to learn independently, within a diverse multi-cultural environment, and enabling them to become global leaders in their respective fields.	Attain an ability to identify and solve challenging problems in their professions by applying theory, principles and modern tools learnt during degree program	Demonstrate effective communication as an individual or team player with strong managerial and entrepreneurial skills.	Maintain highest ethical and professional standards in pursuing their careers.	Engage in life- long learning to continually polish their professional capabilities for their personal growth and the betterment of society.

PROGRAM'S MISSION The mission of Bachelor of Computer Engineering program is to produce ethically sound and technically competent graduates who can fulfill the evolving needs of academia, industry and society.	Attain an ability to identify and solve challenging problems in their professions by applying theory, principles and modern tools learnt during degree program	Demonstrate effective communication as an individual or team player with strong managerial and entrepreneurial skills.	Maintain highest ethical and professional standards in pursuing their careers.	Engage in life- long learning to continually polish their professional capabilities for their personal growth and the betterment of society.

- **University Vision (revised):** To become a **knowledge** and **creativity** driven **international university** that contributes towards **development of society**.
- ***Departmental Vision (previous):*** *Department of Software Engineering aims to be recognized as a premier institution in Software Engineering education and research by producing graduates who can contribute to the society and profession through the application or creation of relevant knowledge, independent learning and leadership.*
- **Departmental Vision (proposed):** To be recognized as a **premier international institution** in **Software Engineering education** and **research** capable of producing graduates who can **contribute sustainably** and **progressively** to the **profession** and the **society**.

- **University Mission (revised):** To ensure **academic excellence** through deliverance of **quality education** and **applied research** in a collegiate environment having **strong linkages with industry** and **international community** to meet the **societal challenges**.
- ***Program Mission (previous):*** *The mission of Bachelor of Software Engineering program is to prepare technically strong Software Engineers who can contribute effectively towards the nation, society and the world at large through effective problem solving skills, application of engineering knowledge, leadership and healthy lifelong learning attitude.*

  Program Mission (proposed): To prepare technically strong Software Engineers having **effective problem solving skills**, **applied engineering knowledge**, **leadership qualities** and **healthy lifelong learning attitude** to contribute effectively towards **industry, society** and the **world at large**.

FINAL YEAR PROJECT POLICY
BAHRIA UNIVERSITY

PREFACE

The primary objective of this document is to provide guideline to students who are enrolled or are going to select Final Year Project (FYP) as a partial degree requirement. This policy will also assist the FYP supervisors to better track and evaluate the FYP procedures/activities as per the university requirements and to monitor the students under their supervision accordingly.

BACKGROUND

- The final year project is the culmination of any undergraduate academic degree where continuous effort, dedication and integrity are the key elements to succeed.
- This is a six-credit hour course (03 credit hours/semester) and shall be graded as other modules in the semester. Every FYP group must register Project-I in 7th and Project – II in their 8th semesters respectively.
- After project approval by the evaluation committee, an FYP group must meet with their respective supervisor (at least bi-monthly) and a Log Book (Annex-A) must be maintained to record minutes of the meeting. 24 log entries are required to be maintained for the complete FYP process.
- Student not showing his/her project progress to the supervisor for two consecutive weeks, his/her absence shall be reported to the concerned head of department for further actions. Student not showing his/her project progress to the supervisor for five weeks, his/her registration for the project shall stand cancelled and he/she will be required to re-register with payment of full fee.
- If the project is not completed in the time specified. The individuals and each member (in a case of group) have to re-register their project for the next academic year and pay the full fee of modules Project-I and Project-II.
- Student should inform to the FYP coordinator about continuous non-availability of the supervisor.

FYP WORKFLOW

The applicable workflow of the FYP activities and assessment constitute the following steps:

Step-0:

The students are to first identify problem/research gap and then define the aims and objectives of the FYP by taking advice/recommendations either from faculty members or industry personnel.

1. This step is recommended to be completed during 12th-13th week of 6th semester.

Step-1: Proposal Defense Presentations

The scope of this step will be to assess the identified problem/research gap and the corresponding solution being proposed by the FYP group.

1. This step is recommended to be completed during 2nd week of 7th semester.
2. The proposal document with presentation has to be prepared by each FYP group under the guidance of their respective supervisors, as per the template provided by the FYP Coordinator.
3. The proposal document and the presentation of each group have to be thoroughly reviewed by the respective supervisor before submission to the FYP Coordinator.
4. FYP Coordinator has to formulate the proposal defense panels comprising minimum of 2-3 permanent faculty members (PFM)* in consultation with HoD.
5. The proposal defense has to be conducted through presentation followed by a Q&A session and should be defended in front of proposal defense panel. The deliverables with their marks distributions is recommended as follows:

Proposal Defense Deliverables	Marks
Proposal Document	Non Graded
Presentation	Non Graded

*For Panel Presentations constituting 03 Permanent FMs (Presence of Subject Specialist/Cluster Head/Research Group Head is mandatory)

6. The deferred proposal defense has to be conducted during the 4th week of 7th semester.

Step-2: Initial Defense Presentations/ Project-I

The scope of this step will be to assess the study of related work and initial conceptual design being developed by FYP group.

1. Students must produce initial draft of their thesis encompassing Introduction, Literature Review and Conceptual Design.

2. FYP Coordinator has to formulate the initial defense panels, comprising minimum of 2-3 permanent faculty members (PFM)* in consultation with the HoD.
3. Initial defense evaluation has to be carried out in 12^{th} – 14^{th} week of 7^{th} semester. The deliverables and associated marks according to rubrics are as under:

Initial Defense Deliverables	**Marks**
1. FYP Thesis First Draft	Non Graded
2. Initial Defense Panel Presentation/Demonstration (including hardware/software modules as per approved timeline & scope)	15
3. Record of 12 meetings on Log Book (Showing students-supervisor meetings)	Non Graded

* For panel presentations comprising of 03 permanent faculty members, the presence of subject specialist/cluster head / research group head is mandatory

Step-3: Midterm Defense Presentations

The scope of this step will be to assess the detailed design/implementation plan established by FYP group as well as the incorporated suggestions/recommendations of the Initial defense presentations.

1. Students must submit their second thesis draft encompassing Introduction, Literature Review, Conceptual Design and Implementation.
2. FYP Coordinator has to formulate the midterm defense panels comprising a minimum of 2-3 permanent faculty members (PFM)* in consultation with the HoD.
3. Midterm evaluations are to be carried out between 3^{rd} – 4^{th} week of the 8^{th} semester. The deliverables and associated marks according to rubrics are as under:

Midterm Defense Deliverables	**Marks**
1. FYP Thesis Report	Non Graded
2. Midterm Defense Panel Presentation/Demonstration (including hardware/software modules as per approved timeline & scope)	15
3. Record of 18 Log Book entries (Showing students-supervisor meetings)	Non Graded

* For panel presentations comprising of 03 permanent faculty members, the presence of subject specialist/cluster head / research group head is mandatory

Step-4: Final Defense Presentations/ Project-II

The scope of this step will be to assess the fully functional FYP as per the approved criteria. Following steps are proposed to ensure the quality of a final year project:

1. Students must submit their final thesis report encompassing Introduction, Literature Review, Conceptual Design, Implementation, Testing and Conclusion/Future work according to the approved scope and previous recommendations/suggestions.
2. FYP Coordinator has to formulate the final defense panels comprising of one internal permanent faculty member and one external examiner.
3. Final evaluation is to be carried out between 12^{th} - 13^{th} week of the 8^{th} Semester. The relevant marks distribution according to rubrics and compulsory deliverables are as under:

Final Year Evaluation Deliverables	**Marks**
1. Final Project Defense Presentation / Demonstration	
• Internal Examiner Evaluation	15
• External Examiner Evaluation	15
2. FYP Supervisor Evaluation	30
3. FYP Coordinator Evaluation	10
4. Complete FYP Report+ Plagiarism Report	Non Graded
5. 24 Log Book Entries (Showing students-supervisor meetings)	Non Graded
6. Hardware / Software (Code + Data) Submission	Non Graded
7. Ethics (Following timeline/deadlines)	Non Graded
8. CVs of all FYP Members	Non Graded
9. Brochure and Panaflex of FYP (According to the given Template)	Non Graded

Recommended Semester-wise Schedule for FYP Procedure

Semester	Week No.	Activity/Deliverables	
6th	12	FYP Idea Formulation	**12 Log Book Entries**
	13		
	14 - 18		
7th	1		
	2	Proposal Defense Presentations	
	3		
	4	Proposal Re-Defense (deferred projects only)	
	5		
	6		
	7		
	8		
	10		
	11		
	12	Initial Defense Presentations/ Thesis First Draft / Demo / Logbook	
	13		
	14		
	15		
	16		
	17		
	18	**End of 7th Semester**	
8th	1		**12 Log Book Entries**
	2		
	3	Midterm Defense Presentations/ Thesis 2nd Draft / Demo / Logbook	
	4		
	5		
	6		
	7		
	8		
	9		
	10		
	11		
	12	Final Defense Presentations/ Thesis Final Draft / Demo / Logbook/ CVs of all FYP Members / Brochure and Panaflex of FYP	
	13		
	14		
	15		
	16		
	17		
	18	**End of 8th Semester**	

Annex –A

Log Book Entry Template

SEMESTER: ……

Date:…..…/…..…/…… **Meeting:** 1 / 2 / 3 / 4 / 5 / 6 / 7 / 8 / 9 / 10/ 11/ 12

Student (Meeting Minute/ Achievements/ Activities) : ……..
……
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Supervisor (Suggestion& Comments) : ……..
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Next Meeting Plan : ……
……
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……
……

Supervisor's Signature

…… Date: ……