Minutes of
39th (Special) Meeting of Academic Council

held on Monday, 7th June 2021

through VLC

Directorate of Academics

Bahria University Islamabad

Reference Designators & Terms used in this Document

These designators/terms are meant to introduce clarity, standardization and ease of reference while consulting or referring to this document.

Item Number	**oonn,** where oo = ordinal sequence of the Academic Council Meeting. nn = serial number of Item in that meeting. Example: Item 2213 means item No 13 taken up by the 22nd ACM
Decision on New Item	**Oonn** Example: Decision 2213 means Decision on Item 2213. Example: Decision 2213.b means Decision 2213, clause 'b'. Example: Decision 2213.b.3 means Decision 2213, clause 'b', sub-clause '3'
Decision on Previous Item	**o_2o_2(oonn)** Example: Decision 22(1930) means Decision taken by the 22nd ACM on the previous/review Item 1930. Example: Decision 22(1930).b means Decision 22(1930), clause 'b'. Example: Decision 22(1930).b.3 means Decision 22(1930), clause 'b', sub-clause '3'.
Action	Authority, Entity, Official, Person, Unit, Dept, Office, etc required to implement the decision
Responsibility	The supra single Authority, Entity, Official, Person, etc required to: a. Coordinate the actions taken by the Authorities, Entities, Officials, Persons, Units, Depts, Offices, etc listed against "Action". b. Report to the Council the progress on the matter, through periodic progress reports and at the meeting of the Council. c. Be responsible to the Competent Authority, and the Council, for the case/issue overall /point/item he or she has been made responsible for.
Statutory Documents affected	Most decisions of the Academic Council imply amendments to the relevant statutory documents. These amendments shall be processed and incorporated into the said documents forthwith and certainly before the next meeting of the Academic Council. The responsibility of processing the amendments and incorporating them into the statutory documents shall be as per the Registrar Notification 23/2015 dated 25th May 2015.
Deadlines	Any time period deadlines shall count from the date of issue of the minutes. Time period in days shall imply working days.

Table of Contents

Acronyms & Abbreviations used in this Document

AACSB	Association to Advanced Collegiate School of Business
BUAR	Bahria University Academic Rules
BUMDC	Bahria University Medical & Dental College
BUCPT	Bahria University College of Physical Therapy
CH	Credit Hour(s)
CCH	Course Codes Handbook
CE	Computer Engineering
CS	Computer Sciences
CSE	Computer & Software Engineering
DIC	Director Islamabad Campus
DIPP	Director IPP
DKC	Director Karachi Campus
DLC	Director Lahore Campus
DNIMA	Director National Institute of Maritime Affairs
DMPRC	Director MPRC (Karachi)
DS	Dental Section BUMDC
EDC	Estimated Date of Completion
EE	Electrical Engineering
EES	Earth & Environmental Sciences
EMBA	Executive Master of Business Administration
EP	Examination Policy
ES	Engineering Sciences
FHB	Faculty Handbook
FYP	Final Year Project
HS	Health Sciences
HSS	Humanities & Social Sciences
iaw	in accordance with
ie	that is
IR	International Relations
MSS	Management & Social Sciences
MS	Management Sciences
NBEAC	National Business Education Accreditation Council
PMDC	Pakistan Medical & Dental Council
PNC	Pakistan Nursing Council
PNNC	Pakistan Navy Nursing College
PNMTS	Pakistan Navy Medical Training School
PFM	Permanent Faculty Member
PEO	Program Educational Objective
PH	Public Health
QAL	Quranic Arabic Language
SE	Software Engineering
SHB	Student Handbook
SCM	Supply Chain Management
T&N	Telecom & Networking
URD	User Requirements Document
VFM	Visiting Faculty Member
wef	with effect from

Attendance

BUHO

Present

1.	Vice Admiral Kaleem Shaukat HI(M) (Retd)	Rector	In Chair
2.	Rear Admiral Nasir Mahmood H(M) (Retd)	Pro-Rector (RIC)	Member
3.	Surg Rear Adm (R) Najm Us Saqib Khan HI(M),T.Bt (Retd)	Pro-Rector (HS)	Member
4.	Rear Admiral Habib Ur Rehman HI(M) (Retd)	Pro-Rector (Acad)	Member
5.	Cdre Shafqat Azad SI (M), S.Bt (Retd)	Registrar	Member
6.	Dr. Atif Raza Jafri	Dean (ES)	Member
7.	Dr. Ali Imtiaz	Dean (MS)	Member
8.	Dr. Adam Saud	Dean (H & SS)	Member
9.	Cdre Asim Raza SI(M) (Retd)	Dir Academics	Member & Secy
10.	Cdre M Masud Akram SI(M), S.Bt	Dir Admissions	Member
11.	Cdre Nasrullah SI(M) (Retd)	Controller of Exams	Member
12.	Brig Asif Ali Asif (Retd)	Dir Health Sciences	Member
13.	Dr. Shehzad Khalid	Dir R&D/ORIC	Member
14.	Dr. Riaz Ahmed	Dir PGP	Member
15.	Mr Fazal Wahab	Dir DQA	Member

In Attendance

16.	Ms. Sundal Mufti	Dir Student Affairs
17.	Mr. Rizwan Aamir	Dir IT
18.	Dr. M Awais Mehmood	Dir IO
19.	Dr. Asim A Awan	Dir Marketing
20.	Captain Azhar Iqbal PN (Retd)	Dy. Registrar (Academics)
21.	Cdr Amer Abdullah PN (Retd)	Dy. Director (Academics)
22.	Cdr Muhammad Iqbal PN (Retd)	Dy. Dir Admissions

BUIC

Present

23.	Rear Admiral Naveed Ahmad Rizvi HI(M) (Retd)	DG BUIC	Member
24.	Dr. Muahmmad Ali Saeed	Principal BBS	Member
25.	Dr. Syed Abdul Siraj	HOD (Media Studies)	Member
26.	Dr. Awais Majeed	HOD (SE)	Member
27.	Dr. Muhammad Muzammal	HOD (CS)	Member
28.	Dr. Said Akbar Khan	HOD (EES)	Member
29.	Dr. Muhammad Umar Hayat	HOD (HSS)	Member
30.	Dr. Shahzad Hassan	HOD (CE)	Member
31.	Dr. Noshi Iram Zaman	HOD (PP)	Member
32.	Dr. Junaid Imtiaz	HOD (EE)	Member
33.	Dr. Syed Muhammad Shahid Tirmazi	HOD (IS)	Member

In Attendance

34.	Dr. Sohaib Mukhtar	PG Coordinator Law Department

BUKC

Present

35.	Vice Adm Khawaja Ghazanfar Hussain HI(M)	DG	Member
36.	Cdre Muzammil Hussain SI(M), SE (Retd)	Director	Member
37.	Dr. Sayma Zia	Principal (BBS)/HOD(BS)	Member
38.	Dr. Sohaib Ahmed	Principal (SEAS)	Member
39.	Dr. Oyoon A Razzaq	Principal BH3S	Member
40.	Dr. Mustaghis-Ur-Rehman	Associate Dean (MS)	Member

41.	Dr. Osama Rehman	HOD (SE)	Member
42.	Dr. Salma Hamza	HOD (E& ES)	Member
43.	Engr. Dr. Najam M Amin	HOD (EE)	Member
44.	Dr Naveed R Khan	HOD (MS)	Member
45.	Engr.Dr Syed Safdar Ali	HOD (CS)	Member
46.	Dr. Shoaib Mughal	HOD (CE)	Member
47.	Dr. Talat Sharafat Rehmani	HOD (H&SS)	Member
48.	Dr. Asif Inam	HOD (Maritime Sciences)	Member
49.	Dr. Abdul Qadir	HOD (IS)	Member
50.	Senior Lecturer Mah-e-Darakhshan	HOD (Media Studies)	Member

In Attendance

51.	Mr. Waqar Uddin	DD (Academics)
52.	Ms. Erum Shafiq	AD (QA)

BULC

Present

53.	Cdre Shahid Azmat Wain SI(M) (Retd)	Director	Member
54.	Dr. Muhammad Ahmed	HOD (MS)	Member
55.	Dr. Khawaja Qasim Maqbool	HOD (CS&IT)	Member
56.	Dr. Urooj Sadiq	HOD (PP)	Member

BUMDC

Present

57.	Vice Admiral Khalid Amin HI(M) (Retd)	DG	Member
58.	Dr. Ambreen Usmani	Dean HS/ Principal	Member
59.	Dr. Wahab Bukh Kadri	Principal (DS)	Member
60.	Dr. Khalid Mustafa	Vice Principal (Med)	Member
61.	Dr. Khalid Aziz	Vice Principal (DPT)	Member
62.	Cdr Saira Nazneen Zaidi PN	Principal PNNC	Member
63.	Dr. Shakeel Ahmed	HOD(Paediatrics)	Member
64.	Dr. Naheed Sultan	HOD (Surgery)	Member
65.	Dr. Nasim Karim	HOD(Pharmacology)	Member
66.	Prof. Khalida Nasreen Abdullah T(M)	HOD (Obst and Gynae)	Member
67.	Dr. Nighat Rukhsana	HOD(Physiology)	Member
68.	Dr. Hasan Ali	HOD (Biochemistry)	Member
69.	Dr. Sameer Shahid Ameen	HOD (Eye)	Member
70.	Dr. Mahreen Lateef	HOD (MDRL)	Member
71.	Dr. Tabasum A Qadeer	HOD (Orphodontics)	Member
72.	Dr. Beenish Fatima	HOD (Oral Biology)	Member

In Attendance

73.	Prof. Iram Sadiqa	Professor of Physiology
74.	Ms. Najam Us Sahar Ilyas	Senior Lecture Islamic Studies

IPP

Present

75.	Dr. Zainab Hussain Bhutto	Dean PP/ Principal	Member

Proceedings

Preliminaries

Commencement of the Meeting, Opening Remarks of the Chair and Meeting Schedule

1. With the quorum complete, the proceedings commenced at 10:00 hrs with recitation from the Holy Quran. The meeting continued till 14:00 on the same day till completion of the agenda.

2. The Chair welcomed the participants and highlighted the purpose of holding the Special ACM to cover the new agenda items that could not be taken up in the last ACM due paucity of time but required consideration by the Academic Council for adoption in next (Fall 2021) Semester. He further expressed satisfaction over the resumption of classes in all CUs after online teaching due Covid-19 related instructions by the Govt, and emphasized upon importance of following the SOPs to avoid closing of the Campuses again.

New Items

Item 3901: Revised Roadmaps – Master of Sciences in Environmental, Geophysics and Geology

Sponsor: HoD (E&ES) BUIC Referral Authority: FBoS-ES

Summary of the Case

3. Revised Roadmaps of three MS Programs of the Department of Earth & Environmental Sciences – *Master of Science in Environmental Sciences*, *Master of Science in Geophysics* and *Master of Science in Geology* – were finalised in 23rd meeting of FBoS (ES) for ACM approval to adopt with effect from Fall 2021 Semester.

Discussion

4. HoD E&ES BUIC presented revised Roadmaps of three MS Programs, comprising of 1 new course in *Environmental Sciences*, 11 new courses in *Geophysics* and 7 new courses in *Geology*. Discussion revolved around placing the compulsory coursed in the 1st semester, to benefit the failures by covering up in more number of subsequent semesters, against HECs proposal to have at least one elective course in the 1st semester. It was agreed that proposed roadmaps did not have any major deviation from HECs guidelines. However, the Chair advised to retain the electives that were already being offered, instead of dropping a few as proposed in revised Roadmap. Further, the CE indicated that some proposed new courses contained the course code or the course title already in use, which needed to be reviewed prior final approval.

Decision 3901

5. The Council approved revised Roadmaps of of *Master of Science in Envernmental Sciences*, *Master of Science in Geophysics*, and *Master of Science in Geology* with amendments and outlines and outcomes/ learning ojvectives of new courses as contained in **Appendage 3901**, for adoption with effect from Fall 2021 Semester, subject to following:

a. Electives already being offered are retained, to keep wide range of options.
b. New compulsory courses will be applicable for new intake only, while new elective courses may be offered to existing intake students as well.

c. Point dropped.

Action Required	Action by	Responsibility of
Implementation of the Decision	Controller of Examinations Director Admissions Director Academics Director IT HoDs (E&ES) BUIC & BUKC	Dean H&SS
Statutory Documents affected:	Updating of CCH, Prospectus, CMS, BU Website.	

Item 3902: Addition of Elective Courses in BEE Roadmap

Sponsor: HoDs (EE) BUIC & BUKC Referral Authority: FBoS-ES

Summary of the Case

6. Following new elective courses were finalized in 23rd meeting of FBoS ES for inclusion in BEE Roadmap to make the academic programme at par with current technology advancements, and forwarded for approval by the Academic Council:

a. Course Code: EET 462, Course Title: Cryptography and Network Security, Credit Hour: 3, Specialization: Telecommunication
b. Course Code: EET 459, Course Title: Introduction to Block chain, Credit Hour: 3, Specialization: Telecommunication
c. Course Code: EEL 470, Course Title: Microelectronics Technology Lab, Credit Hour: 1, Specialization: Electronics wef Fall-2020

7. Following already available courses in BU Course Codes Handbook were also recommended in the FBoS for inclusion in electives of BEE Roadmap, and forwarded for ACM approval:

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

Discussion

8. HoD (EE) BUIC presented the proposals along with outlines and outcomes/ learning objectives of the newly proposed courses. Dean ES supported the proposal on the basis of market demand and availability of relevant resources in CUs.

Decision 3902

9. The Council approved inclusion of proposed Elective Courses as per **Appendage 3902** in the roadmap of BEE Program, along with outlines and outcomes/ learning objectives of the new courses, for adoption with effect from Fall 2021 Semester. Point dropped.

Action Required	Action by	Responsibility of
Implementation of the Decision	Controller of Examinations Director Admissions Director Academics Director IT HoDs (EE) BUIC & BUKC	-
Statutory Documents affected:	Updating of CCH, Prospectus, CMS and BU Website.	

Item 3903: Uniform CBT for Bachelor's Degree in Undergraduate Engineering and Computing Programs

Sponsor: HoDs (EE) BUIC Referral Authority: FBoS-ES

Summary of the Case

10. Entry tests (CBT) for undergraduate Engineering programs and undergraduate Computing programs currently being given to the applicants 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 program (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.

11. FBoS-ES deliberated the proposal to this effect in detail and recommended the uniform CBT scheme for Engineering and Computing Programs as given at **Appendage 3903**, for approval by the Academic Council.

Discussion

12. HoD(EE) BUIC presented the uniform CBT scheme for Engineering and Computing Programs; along with a comparison with current formats and proposed increase/reduction in weightage of sections. Effects of proposed scheme on pre-medical background applicants were deliberated in detail; culminating in the consent for proposed format as supported by Dean ES.

Decision 3903

13. The Council approved adoption of the uniform CBT Scheme for admission in Undergraduate Computing and Engineering Programs as per **Appendage 3903**, with effect from Spring 2022 Semesters admissions. Point dropped.

Action Required	Action by	Responsibility of
Implementation of the Decision	Director Admissions Director IT HoDs (EE) BUIC & BUKC	-
Statutory Documents affected:	Updating of BU Admissions Policy and Prospectus and BU Website.	

Item 3904: Corrections in Prerequisites of Electives Courses for BEE Roadmap and BCE Roadmap

Sponsor: HoDs (EE) & (CE) BUIC Referral Authority: FBoS-ES

Summary of the Case

14. Some inconsistencies have been identified in the pre-requisites of some courses offered in Telecommunication and Electronics specializations in the Roadmap of BEE, which were approved in 32nd ACM (Agenda Item 3223). FBoS-ES has proposed an alignment in the same, as tabulated below, with ACM approval:

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)

15. Similarly, following changes in pre-requisite for BCE Roadmap, approved in 31st ACM (Agenda Item 3104), have been proposed by presented by FBoS-ES for ACM approval:

Course	Current Pre-requisite (Electronics)	Recommended Pre-requisite
Signals and systems (EEN 313)	GSC 220	None

Discussion

16. HoD (EE) BUIC presented the proposal to correct the pre-requisites as described in the summary of the case, for approval by the Academic Council.

Decision 3904

17. The Academic Council approved the following changes in BEE and BCE Roadmaps as proposed by HoD (EE) BUIC during the ACM:

a.

Course	Current Pre-requisite (Telecommunication)	Current Pre-requisite (Electronics)	Recommended Pre-requisite
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)

b.

Course	Current Pre-requisite (Electronics)	Recommended Pre-requisite
Signals and systems (EEN 313)	GSC 220	None

18. Point dropped.

Action Required	Action by	Responsibility of
Implementation of the Decision	Controller of Examinations Director Admissions Director IT HoDs (EE) & (CE) BUIC	-
Statutory Documents affected:	Updating of CCH, Prospectus, CMS and BU Website.	

Item 3905: Addition of Management Science Elective Course in BS(CS) and BS(IT) Programs

Sponsor: HoD (CS) BUKC Referral Authority: FBoS-ES

Summary of the Case

19. 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. 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. 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.

20. After deliberation in 23rd FBoS, it was mutually agreed to add the following course as Management Science elective in BS(CS) and BS(IT) programs; subject to ACM approval:

Course Code	Course Title	Credit Hours
MTM 101	Introduction to Maritime Industry	3+0

Discussion

21. It was deliberated that another elective may be considerd for inclusion in BS(CS) and BS(IT) Roadmaps, related to Maritime Technology or other similar domains for Computing/ ES Programme students.

Decision 3905

22. The course "*Introduction to Maritime Industry*" (MTM 101) with 3 CHs was approved for inclusion in BS (CS) and BS (IT) Roadmaps as Management Sciences elective at BUKC. Another elective related to Maritime Technology may also be included in related ES Roadmaps by respective Departments.

23. Point dropped.

Action Required	Action by	Responsibility of
Implementation of the Decision	Controller of Examinations Director Admissions Director IT HoD (CS) BUKC	-
Statutory Documents affected:	Updating of CCH, Prospectus, CMS and BU Website.	

Item 3906: Addition New Course "Ideologies and International Relations" as Elective PhD Course

Sponsor: HoD (H&SS) BUIC Referral Authority: FBoS-H&SS

Summary of the Case

24. New course *Ideologies and International Relations* was proposed by FBoS-H&SS for addition in PhD elective courses list, with approval of the Academic Council, with course outline as per **Appendage 3906**.

Discussion

25. HoD (H&SS) BUIC presented the case and explained the purpose of inclusion of suggested course for ideological awareness and grooming of PhD scholars. Course outline was discussed in detail by the Council and noted that recommended reference books did not include any non-western writers. Further, the course outline should also include the Muslim/ eastern ideologies influencing history, and view point of Muslim scholars.

Decision 3906

26. The Council directed to review the course outline as well as outcome/ objectives in consultation with Advisor to Rector on Islamic Studies for inclusion of non-western/ Muslim ideologies influencing history and international relations, for approval in next ACM.

27. Point is to remain on agenda and progress be reported.

Action Required	Action by	Responsibility of
Implementation of the Decision	Advisor (Islamic Studies) HoD (H&SS) BUIC	Dean H&SS
Statutory Documents affected:	-	

Item 3907: Uniform Credits Hours for "Pakistan Studies (Compulsory)" and "Islamic Studies" at BU as per New HEC Policy (Clubbed agenda from HSS and Islamic Studies Department)

Sponsor: HoD (H&SS) BUIC Referral Authority: FBoS-H&SS

Summary of the Case

28. *Pakistan Studies* is being taught at all BS programs at BU as a compulsory subject; offered in 1st, 4th and 7th semesters across BU. Similarly, *Islamic Studies* is being taught at all BS programs at BU as a compulsory subject; offered in 1st, 2nd, 3rd and 5th semesters across BU. Credit hours of these two courses vary from department to department; some offering them as 2-CH course while others offering them as 3xCH course. FBoS-H&SS has recommended that *Pakistan Studies* and *Islamic Studies* may be allocated 3xCH each across BU from Fall 2021, as per HEC Undergraduate Education Policy 2020. It has further recommended that, in order to cater the failures of these courses in Spring 2021 or previous semesters, 2xCH course each can be offered in the upcoming Summer 2021.

Discussion

29. Dean ES stated that since HEC Undergraduate Education Policy 2020 has not been implemented and Pakistan Engineering Council (PEC) has approved the ES Programmes with *Pakistan Studies* and *Islamic Studies* courses of 2xCH each. He proposed that said courses of 3xCH each may not be adopted

for ES programmes. Dean H&SS explained that outline of 2xCH courses are inadequate when considering the importance of these course. He further explained difficulty faced by the faculty members of H&SS FMs in maintaining separate curriculum for various programs. Director Academics emphasised upon the need for standardisation of outlines of courses with the same titles. The Chair advised to further improve the outlines of proposed courses, while Dean ES was asked to adopt the 3xCH courses with revised Roadmaps as required.

Decision 3907

30. The Council approved adoption of *Pakistan Studies* and *Islamic Studies* courses in standardised format with 3xCH each in all Programmes of BU with effect from Fall 2021 Semester intake, while discontinuing the 2xCH courses with these titles, amending the Roadmaps comprising of such courses (2xCH each) through case file followed by ratification in next ACM, and cater the failures of 2xCH courses in Spring 2021 or previous semesters by offering the Repeat course in upcoming Summer 2021 Semester. The Council further directed to improve the course outline of *Pakistan Studies* and *Islamic Studies* with 3xCH each for better outcome and learning objectives.

31. Point is to remain on agenda and progress be reported.

Action Required	Action by	Responsibility of
Implementation of the Decision	All Deans Controller of Examinations Director Admissions Director IT HoD (H&SS) BUIC	Dean H&SS
Statutory Documents affected:	Updating of CCH, Prospectus, CMS and BU Website.	

Item 3908: Launch of New Program – Master of Science in Clinical Psychology at BULC

Sponsor: HoD (PP) BULC Referral Authority: FBoS-PP

Summary of the Case

32. Department of Professional Psychology, BULC has proposed to launch MS Clinical Psychology Programme, already being offered at the IPP Karachi and the Department of Professional Psychology BUIC, which will strengthen the University growth at Lahore aimed at serving the community to maintain its psychological wellbeing. Proposed programme is already being offered in Lahore by the University of the Punjab, Government College University, University of Management and Technology, University of Central Punjab, Riphah International University, Forman Christian College and some other institutes. Meanwhile, the sponsoring Department fulfils the HEC criteria for 2 x PhD PFMs (Clinical Psychology) to launch the MS Clinical Psychology Programme and will follow the approved Roadmap already adopted in IPP and DPP, BUIC.

33. Considering the above factors, the proposal to launch the MS Clinical Psychology Programme at BULC was processed through case file and approved by honorable Rector for taking up in ACM.

Discussion

34. HoD (PP) BULC presented the proposal comprising of the Working Paper, Roadmap and Course Description for approval by the Academic Council. Dean PP indicated that the course namely *Advance Research Methodology* (CPY 651) proposed in Semester-I is in conformance with the Roadmaps adopted at IPP and BUIC; however the same is in variance to Decision 2812 of 28th ACM, whereby the proposed

level 6 Research Methodology course was to be upgraded to level 700 to benefit prospective PhD students. After detailed discussion, it was agreed that proposed Roadmap for MS(Clinical Psychology) at BULC may be amended by replacing *Advance Research Methodology* (CPY 651) with *Research Methods* (PPY 702), along with similar changes in MS(Clinical Psychology) Roadmap for IPP and BUIC.

Decision 3908

35. After due deliberation, the Academic Council decided the following:

a. Launch of *Master of Science in Clinical Psychology* at BULC with effect from Fall 2021 Semester was approved along with Roadmap at **Appendage 3908**; subject to issuance of NOC by the HEC. Accordingly, the Programme is to be advertised for first intake.

b. Roadmap approved for MS (Clinical Psychology) at BULC shall contain the course *Research Methods* (PPY 702), while the Roadmaps for MS (Clinical Psychology) at IPP and BUIC are to be simultaneously amended for conformance of 28th ACM Decision 2812 by amending the Appendage 2812 in MoMs of 28th ACM.

c. Point may be kept on agenda and progress be reported.

Action Required	Action by	Responsibility of
Implementation of the Decision	Dean PP Director BULC Director Academics Controller of Examinations Director Admissions Director QA Director IT	Director BULC
Statutory Documents affected:	Updating of CCH, Prospectus, CMS and BU Website.	

Item 3909: Reduction in Numbers of OSCE/OSPE Stations - BS Nursing

Sponsor: Principal PNNC Referral Authority: FBoS-HS

Summary of the Case

36. Objective Structured Clinical Examination (OSCE)/ Objective Structured Practical Examination (OSPE) of BS Nursing examination comprises of 15 fixed stations, where the Examiners evaluate the students' skills of performing Nursing procedures and award marks accordingly. However, BSN courses/ subjects do not require more than 5-8 stations to evaluate student's skills/ performance. Most of the institutions conducting BSN programme do not evaluate their students' skills/ performance on more than 5-8 stations. FBoS-HS has accordingly proposed to limit the stations for BS Nursing students up to 5 to 8.

Discussion

37. Pro-Rector HS confirmed the requirement of reducing the number of OSCE/ OSPE stations for BSN examinations from 15 to 5-8.

Decision 3909

38. The Council approved the proposal regarding reduction of OSCE/ OSPE stations for BSN examinations from existing fixed 15 to 5-8, as proposed by Principal PNNC. Point dropped.

Action Required	Action by	Responsibility of
Implementation of the Decision	Controller of Examinations Principal PNNC	-
Statutory Documents affected:	Updating of BS Nursing Examination Policy.	

Item 3910: Launch of New Program – Bachelor of Science in Coastal & Marine Sciences at the Department of Maritime Sciences, BUKC

Sponsor: HoD (Maritime Sciences) BUKC Referral Authority: FBoS-MS

Summary of the Case

39. Department of Maritime Sciences at BUKC has proposed to launch 4-years *Bachelor of Science in Coastal & Marine Sciences* Programme with Roadmap and curriculum as attached at **Appendage 3910** wef Fall 2021 Semester. The Programme would comprise of 135 credit hours and follows the HEC Undergraduate Policy 2020. Other major aspects of the Programme would be as under:

a. Eligibility criteria for the program will be Intermediate Science or A-Level with a CGPA of 2.0 or 50% marks in the annual system.
b. The Programme will have mandatory Community Support Program for 40 hours.
c. Proposed curriculum contains a mandatory non-credit, Practical Learning Lab, Internship of 9 weeks and 6 credit hours Project/ Thesis.

40. In light of the above, FBoS-MS has recommended the following for approval of Academic Council:

a. Commencement of 4-years *BS Coastal & Marine Sciences* with proposed Roadmap and curriculum attached as **Appendage 3910** wef Fall 2021 Semester.
b. Intermediate Science/ A-Level with CGPA of 2.0 or 50% marks in the annual system as eligibility criteria for the Program.
c. 4-years *BS Coastal & Marine Sciences* program curriculum.
d. Mandatory BU Community Support Programme of 40 hours.
e. All BU policies of Scholarship, Honors & Awards should apply to these students.

Discussion

41. The proposal was presented by HoD (Maritime Sciences) BUKC. Strong arguments were offered in favor of proposal to launch the program, considering it as an investment into the future. Semester wise courses in proposed Roadmap were deliberated with respect to their relevance and BU focus on maritime/ coastal domains. It was further highlighted by the HoD (Maritime Sciences) that proposed courses outlines were directly linked with Blue Economy.

42. The participants considered the options to formulate a hybrid degree programme, offering a Postgraduate Degree in Maritime/ Coastal Sciences domain (instead of Undergraduate degree as proposed), and/ or conduct diploma/ certificate courses in Maritime domain in lieu of proposed degree programme, for better likely intake as well as post-qualification utility. The discussion switched to the activities related to refinement of BU academic activities in the ambit of School of Maritime

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Sciences(SMS) and Earth & Environmental Sciences (E&ES) domains; being pursued separately by a committee under Pro-Rector (RIC).

43. The Chair desired that proposed Programme may be overlapped with overall development of the School of Maritime Sciences and academic programmes offered there. Government support and affiliation with a foreign institute/ body for academic programmes in Maritime domain were also considered as potential strengths. The Chair advised the Pro-Rector (RIC) to include the proposed Programme in overall plans being formulated by the Committee, which was supported by DG BUKC.

Decision 3910

44. After prolonged deliberations, the Council decided the following:

a. The proposal for 4-years *Bachelor of Science in Coastal and Marine Sciences* Programme may be included in the larger proposal for *School of Martime Sciences* already under deliberation by the Committee headed by Pro-Rector (RIC).

b. The Committee may evaluate improvement of the proposal in form of a hybrid degree programme, efficacy of a Masters degree in proposed domain instead of a Bachelors degree, launching of summer courses in Maritime/ Coastal Sciences, inclusion of elective courses related to Maritime/ Coastal Sciences in other academic programmes and employability of the students of proposed programme.

45. The point is to remain on agenda and progress be reproted.

Action Required	Action by	Responsibility of
Implementation of the Decision	HOD (E&ES) BUKC HOD(Maritime Sciences),	Pro-Rector (RIC)
Statutory Documents affected:	-	

Closing the Meeting

46. The Chair thanked the participants for productive participation during the meeting.

ASIM RAZA SI(M)
Commodore (Retd)
Director Academics
Secy Academic Council

Dated: 5 July 2021

Appendage 3901

Roadmap - Master of Science (MS) Environmental Sciences

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 Credit Hours	30

Compulsory Courses

Course Codes	Course Title	Credit Hours
ENV 531	Environmental Analytical Techniques	3
ENV 572	Climate Change Adaptation and Mitigation	3
ENV 502	Environmental Management	3
ESC 701	Research Methodology	3

Elective Courses

Course Codes	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 508	Environmental Sociology	3

ENV 534	Advanced Environmental Microbiology	3
ENV 535	Freshwater Ecology	3
ENV 536	Advanced Environmental Geology	3
ENV 512	Project Management	3
ENV 516	Wildlife, Forestry and Wetland Management	3
ENV 524	Air and Noise Pollution	3
ENV 584	Advances in Plant Ecology	3
Any other relevant course from Geology and Geophysics disciplines		

COURSE CATALOGUE

Course Code	**ENV 572**
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 584**
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
4. 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. 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. 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
2. Mary Ann Cunningham. (3nd Edition, 2006).
3. "Environmental science" by G.T. Miller Jr (9th edition, 2003)
4. "Living in the Environment" by G.T. Miller Jr . (12th edition, 2002).
5. "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.
3. V. Dessinov. John Wiley and Sons.
4. Introduction to GIS. Campbell. Mc Graw Hill Education.
5. Remote Sensing of the environment: An Earth perspective. Jensen, R. Pearsons Education, Inc.
6. 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
2. Kevin J. Noone' Ussif Rashid SumailaRobert J. Diaz 2013.
3. Marine Pollution and Human Health (Issues in Environmental Science and Technology) R E Hester, R M Harrison RSC Publications 2011
4. Marine Pollution and Its Control (McGraw-Hill series in water resources and environmental engineering) by Paul L. Bishop (1982).
5. 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. 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. 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
2. Mary Ann Cunningham. (8th Edition, 2010).
3. "Living in the Environment" by G.T. Miller Jr . (17th edition, 2012).
4. "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.

Course Code	**ENV 508**
Course Title	**Environmental Sociology**

Course Outline:

Introduction to sociology: individualistic, naturalistic and sociological features. Environmental sociology: history and development, Concepts: "Socio-Environmental Relations"; "Co-evolution"; "Societal metabolism' ; "Human expansionism". Environment and sociology: Relationship between society and nature, Gidden's theory of structuralism and its suitability as a tool for sociological investigation of environmental issues, Co-evolution concept; relationship between society and nature. Interdisciplinary approach to environmental issues, Constructive approaches in environmental sociology, Social commitments. Environment and development: Development, Environmentalism and conservation in developed and developing countries, Sustainable development, Political economy and political ecology. Environmental social movements, Gender and environment: Women and environment, Gender nature of environmental issues, Environmental degradation and women. Eco-feminism. International and national perspectives; e.g. America; Asia; Africa; Europe and Pakistan. Environmental management & Public policy.

Course Aims and Objectives:

Environmental sociology is the sociological study of societal-environmental interactions, although the focus of the field is on relationship between society and environment in general and the social factors that cause environmental problems in particular

Course Outcomes:

After completing this course the students will be able to explore the various forms of interaction between human society and the environment, focusing on the social dimensions of the surrounding natural and human-made environments.

Reference Books/Materials:

1. Gottlieb, Robert. 2015. *Forcing the Spring: The Transformation of the American Environmental Movement*. Washington, D.C.: Island Press.
2. Guha, Ramachandra. 2010. *Environmentalism: A Global History.* New York: Longman.

Course Code	**ENV 534**
Course Title	**Advanced Environmental Microbiology**

Course Outline:

Microbiology & Environment: Biological characteristics of wastes. Microbiological quality of water, food and soil. Effects of disinfectants on water and food borne microorganism. Techniques for the control of microbiological pollution. Environmental hygiene and sanitation. Health problems and issues related to different occupation. Primary health care and practice. Host pathogen interaction. Communicable and non-communicable diseases.

Course Aims and Objectives:

This course deals with the in-depth understanding about the role of microorganisms in the environment.

Course Outcomes:

After completion of this course, students will be able to understand the significance, role and applications of microorganisms in the environment

Reference Books/Materials:

1. *Environmental Microbiology*, Maier, F.M., Pepper, I.L. and Gerba, C.P. 2nd Edition, Academic Press, London, UK, 2009.
2. *Principles and Applications of Soil Microbiology*, Sylvia, D.M., Fuhrmann, J.J., Hartel, P.G. and Zuberer, D.A. Prentice Hall, New Jersey, USA, 2005.
3. *Microbiology*, Prescott, L.M., Harley, J.P. and Klein, D.A. McGraw-Hill Inc., USA, 2007.
4. Microbiology. Pelczar M.J., Chan, E.C. and Krige, N.R. McGraw-Hill, Inc. New York. 1986
5. *Environmental Microbiology: A Laboratory Manual*, peppor,I.L.,Gerba,C.P. and Brendecke,J.W. and Jeffery, W.B. Academic Press, USA, 1995

Course Code	**ENV 535**
Course Title	**Freshwater Ecology**

Course Outline:

Hydrology and Physiography of various types of freshwater systems. Chemistry of various freshwater systems and associated organisms. Physical relationships, Movement of light, heat and chemicals in water, Hydrology and Physiography of groundwater and wetland habitats, Physiography of lakes and reservoirs. Types of aquatic organisms: Cyanobacteria, Eukaryotic Algae, Aquatic fungi, Protozoa, Non-vascular plants and vascular plants. Animals: Porifera, Cnidaria, Platyhelminthes and Nemertea, Gastrotricha, Ŕotifera, Nematoda, Mollusca, Annelida, Bryozoa, Tardigrada, Arthropoda, Fishes, Tetrapods; Biodiversity of freshwaters, Measures of diversity, temporal and spatial factors, short term factors influencing local distribution. Invasious of Nonnative species, extinction. Chemicals in freshwater, Redox potential, potential energy and chemical transformations. Distribution of dissolved oxygen in environment, transformations of carbon, fermentation, methanogenesis, Nitrogen, Sulfur, Phosphorus and other Nutrients. Effects of toxic chemicals and other pollutants on aquatic ecosystems, Fish Ecology, Freshwater Ecosystems: Groundwater Ecosystems, Streams, Lakes and Reservoirs, Wetlands

Course Aims and Objectives:

The objective of this course is to train the students for ecological analysis of freshwater habitats in terms of identification of flora and fauna and the interactions among them.

Course Outcomes:

After completion of this course, the students are expected to acquire the techniques for study of freshwater habitats

Reference Books/Materials:

1. *Lampert, W. and Sommer, U., 2017. Limno-ecology: The Ecology of Lakes and Streams. Oxford University Press, New York.*
2. *Dodds, W.K., 2010. Freshwater Ecology: Concepts and Env. Applications. Academic Press. London.*
3. *Dodds, W.K. and Whiles, M.R., 2012. Freshwater Ecology: Concepts and Environmental Applications of Limnology. 2nd Ed. Academic Press. London.*

Course Code	**ENV 536**
Course Title	**Advance Environmental Geology**

Course Outline:

Introduction: Geologic framework: the home planet, earth systems and cycles, earth structure and materials. hazardous geologic processes: assessing geologic hazards and risks, earthquakes, volcanic activity, tsunamis, landslides, mass wasting, subsidence, floods, and hazards of ocean and weather and meteorite impacts. Using and Caring for Earth Resources: the nature of earth resources, energy from fossil fuels, energy alternatives, mineral resources, soil resources and water resources. Human Impact on the environment: managing waste disposal contaminants in the geologic environment and atmospheric change. Medical Geology: the role of geologic materials in health; trace elements in natural waters, radon and trace elements in soil. Contamination of air and ground water resources by nuclear wastes and nuclear explosions. The effects of radioactivity on human health, and its remedial measures. Environmental Law: History, development and protection of environment.

Course Aims and Objectives:

This course aims to provide knowledge about a wide range of topics in geology, discussing geologic principles to the specific geologic hazards, from an environmental perspective.

Course Outcomes:

After completion of this course, the students are expected to learn geologic hazards from the environmental perspectives.

Reference Books/Materials:

1. Environmental geology: Keller, E.A., 9th edition, Prentice Hall, 2011.
2. Introduction to environmental geology: Keller, E.A., 5th edition, Prentice Hall, 2012.

Course Code	**ENV 512**
Course Title	**Project Management**

Course Outline:

Introduction: What is a Project, Project Life Cycle, Writing Project Proposal, Defining Project objectives. Project Planning: Project Initiation; Need identification, feasibility study, economic evaluation. Logical Framework: Explanation of Vertical Logic; inputs, activities, outputs, specific objectives, development objectives, work breakdown structure. Explanation of Horizontal Logic; indicators, means of verification, assumptions. Stakeholders Analysis and Participation. Participatory project monitoring and evaluation. Reasons for Project success or failure. Planning Commission Performa's, Project Planning and Approval Processes, Resource Mobilization.

Course Aims and Objectives:

This course aims to provide knowledge about a wide range of topics in project management and development.

Course Outcomes:

After completion of this course, the students will be able to know the steps in project Management.

Reference Books/Materials:

1. A Guide to Project Management; Body of Knowledge PMBOK Guide, Project Management Institute,2000.
2. Project Management: A Managerial Approach, Meredith J. R., Mantel s. J., John Wiley and Sons, Inc. 1997

Course Code	**ENV 516**
Course Title	**Wildlife and Forestry Management**

Course Outline:

Introduction to wildlife and their relationship with human population. Concepts of wildlife conservation: sustainable development and ecosystem. Effects of Industrial and Agricultural development and urbanization on wildlife. Endangered species: causes and measures for the conservation. National Parks: Wildlife sanctuaries and game reserves of Pakistan. their management and environmental problems. Modern techniques for control of environmental pollution in wildlife areas. International Conventions.

Course Aims and Objectives:

This course will make the students familiar with the concepts of wildlife and forest management practices.

Course Outcomes:

After completion of this course, students will be able to learn the factors that lead towards loss of wildlife and forest resources and its consequences on ecosystems.

Reference Books/Materials:

1. Bailey, J. A. 1998. Principals of Wildlife Management. John-Wiley and Sons, New York, USA.
2. Hosetti, B.B. 2015. Concepts in Wildlife management. Daya Publishing House, New Delhi, India.
3. Sinclair, A. R. E., J. M. Fryxell and G. Caughley. 2016. Wildlife Ecology, Conservation and Management. 2nd Ed. Blackwell Publishing, New York, USA..

Course Code	**ENV 524**
Course Title	**Air and Noise Pollution**

Course Outline:

Air Pollution Essentials; The Risks of Air Pollution; Measurement and Monitoring of Air Pollution; The methodology of Air Pollution; The Regulatory Control of Air Pollution; The Engineering Control of Air Pollution; Introduction to Noise Pollution; Basic concepts of sound and noise; Noise and its effects; approaches to noise problems; Planning to control noise pollution; Noise reduction; Characteristics and impact of surface transportation noise; Traffic noise reduction; Aircraft noise reduction; Preventing airport noise; Control of noise pollution from diesel generator sets; Noise pollution in oil exploring and its control; noise pollution and its control in mining and product industries Sound control technologies and instrumentation. Electromagnetic waves generated by cellular tower and its potential impact on humans and the environment.

Course Aims and Objectives:

The course aims to introduce types of air, noise and electromagnetic waves. Causes and sources of air pollution, particulate matter, techniques of measurement of air pollutants and particulate matters, greenhouse gases, global warming, causes sources and effects, ozone depletion, acid rain.

Course Outcomes:

After completion of this course, students will be able to learn air pollution prevention and control, strategies/methodology compliance of NEQS standards for air pollutants and impact of noise pollution on health.

Reference Books/Materials:

1. Electromagnetic Surface Waves: A Modern Perspective (Elsevier Insights) by John Polo 2012.
2. Fundamentals of Air Pollution. Daniel Vallero. 4thEdition. ISBN10: 0-12- 373615-3 (2007).
3. Textbook of Noise Pollution and its Control. S.C. Bhatia. Atlantic Publishers and Distributors, (2007).

Roadmap - Master of Science (MS) Geology

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

Compulsory Courses

Course Codes	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 Codes	Course Title	Credit Hours
GEO 597	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 598	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 532	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 502	Geophysical Exploration Methods	3
GEO 519	Coal Geology	3
ENV 572	Climate Change Adaption and Mitigation	3
ENV 522	Disaster Management	3
ENV 504	Environmental Impact Assessment	3
GEO 516	Applied Environmental Geophysics	3
GEO 603	Engineering Geophysics	3
GEO 604	Machine Learning for Geosciences	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 Geophysics/Environmental Sciences		

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)**

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 Outline:

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

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	**ESC 701**
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:

1. At the end of semester, the students should be able to:
2. Understand research methods
3. Literature review of their research projects
4. Develop their research plan
5. Prepare their thesis proposals
6. Prepare presentations
7. Prepare publications
8. 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 597**
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, hills hades and calculating views hed; Map Algebra, working with No Data 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.
2. Allen, 2000; SEPM Concepts in Sedimentology and Paleontology Series 7, Society for Sedimentary Geology, 204 pages.
3. Seismic and Sequence Stratigraphy and Integrated Stratigraphy: New Insights and contributions by Gemma Aiello edition I.2017
4. The Sedimentary Record of Sea-Level Change by Angela L.Coe, cmabridge uni press 2nd edition,2003
5. Sequence Stratigraphy and Facies Associations (Special Publication 18 of the IAS) Henry W. Posamentier,haq and Allen,
6. Seismic Stratigraphy and Depositional Facies Models by P.C.H Veeken, 1st edition
7. 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 598**
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
2. Advective Transport, 381 pages, Academic Press; 1st edition (1991) ISBN-10: 0120594854, ISBN-
3. 13: 978-0120594856
4. Freeze, R .A. and J.A. Cherry (1979): Groundwater.- Prentice-Hall, Englewood Cliffs
5. Fetter,C.W.(2001): Applied Hydrogeology.-Prentice Hall, Englewood Cliffs
6. 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
3. Hawkes (Author), John Stuart Webb (Author), Carey Croneis (Editor) (2012), Literary Licensing, LC publisher
4. Geochemical Exploration, Volume 17 by G.R. Parslow (1984), Elsevier Science publisher
5. 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 527**
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; Intra-continental 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
3. Mineral Deposit Evaluation- A Practical Approach by Alwyn E. Annels (1991), Chapman & Hall Publisher.
4. An introduction to economic geology and its environmental impact by Anthony M. Evans (1997), Wiley-Blackwell publisher

5. Gems and Gemology in Pakistan by Tahseenullah Khan and Allah Bakhsh Kausar (2010), Geological Survey of Pakistan
6. Journal of Economic Geology
7. 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 for Geosciences (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
3. Reservoir Engineering Analysis ISBN: 978-1-119-42032-3 American Geophysical Union

Course Code	**GEO 608**
Course Title	**Practical Applications of Geosciences Softwares**

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.

Course Code	**GEO 519**
Course Title	**Coal Geology**

Course Outline:

Definition, composition, classification and origin of coal. Litho types and coal macerals. Chemical and petrographical analysis. Application of coal petrography. Depositional environments of coal and coal bearing strata, coalification process, types of coal basin sand their tectonic setting, concepts of cyclic deposition in coal basin, origin of split sand partings in coal seams. Comparison between modern and ancient coal forming environments, structural problems relevant to exploration & mining. Coal utilization and resource evaluation. Methods of coal exploration; geological, geophysical and drilling. Coal bearing sequences of Pakistan. Coal mining and its environmental issues.

Lab: Petrography of coal and associated rocks. Preparation a coal pellets. Petrographic methods of coal analysis. Specified assignments/projects.

Course Aims and Objectives:

The course begins with a review of the global coal and coal seam gas industry, and the likely future directions based on the current project pipeline and demand scenarios. The details of coal geology, how it's formed, stratigraphy, the chemistry of coal, understanding reservoirs, groundwater and the different types of coal beds around world. How to assess a coal basin play and then evaluate one and the difference between mining and gas plays. Variability in the subsurface and the relationships between groundwater, Finally, underground coal gasification, sequestration and storage, along with issues with overlapping tenures and other techniques.

Course Outcomes:

The expected outcomes of course are to explain how coal is formed, to explain how coal is found and extracted by either surface or underground mines, to discuss how geological problems and environmental issues surrounding extraction affect mining and to explain the reasons for the decline in the coal industry.

Reference Books/Materials:

1. Hydrocarbons from Coal (AAPG Studies in Geology)" by B E Law
2. "Coal and Coal-bearing Strata: Recent Advances" by Scott A C
3. "Coal Geology" by Thomas and Larry
4. "Coal Geology" by WARD

Course Code	**ENV 572**
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 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 504**
Course Title	**Environmental Impact Assessment**

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. Environmental Impact Assessment in Practice, Harrop, D.O. & Nixon, .A., National Book Foundation, Islamabad, 2000.

Roadmap - Master of Science (MS) Geophysics

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 Credit Hours	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 598	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 597	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 502	Geophysical Exploration Methods	3
GEO 512	Mineral Prospecting and Exploration	3
GEO 519	Coal Geology	3
GEO 524	Clastic Sedimentology	3
GEO 525	Carbonate Sedimentology	3
ENV 572	Climate Change Adaption and Mitigation	3
ENV 504	Environmental Impact Assessment	3
GEO 516	Applied Environmental Geophysics	3
GEO 604	Machine Learning for Geosciences	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 Geology and 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
3. Logging Principles for Geophysicists: Society of Exploration Geophysicists.
4. Sayers, Colin M. (2010). Geophysics under stress: Geomechanical applications of seismic and
5. 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:

1. 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.

Course Code	**GEO 502**
Course Title	**Geophysical Exploration Methods**

Course Outline:

An introduction to the physics of the earth. Theory and application of basic geophysical field techniques including, gravity, magnetic, electrical, electromagnetic, GPS, seismic studies, and satellite remote sensing. The present internal structure and dynamics of the earth and constraints from the gravitational and magnetic fields, seismology, mineral phases and wave propagation in earth materials. The earthquake source in terms of seismic and geodetic signals. Contributions of heat-flow, gravity, paleomagnetic, and earthquake mechanism data to plate tectonics, the driving mechanism of plate tectonics, and the energy sources of mantle convection.
Application of the basic principles of physics to the earth sciences, including mechanics of rotating bodies, the two-body problem, tidal theory, oscillations and normal modes, diffusion and heat transfer, wave propagation, electro- and magneto-statics.

Course Aims and Objectives:

This course will introduce a series of geological and geophysical techniques that can be applied to determine the physical characteristics of the Earth's lithosphere, with direct application to the detection and mapping of mineral and energy resources in three dimensions. 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). Theoretical basis of each technique will be studied, the methods of data collection, presentation and analysis, and appropriate, geologically constrained, interpretation of the data. Students will explore an industry style data base and softwares with the aim of developing an exploration and targeting model for hydrocarbon resources.

Course Outcomes:

The anticipated knowledge, skills and/or attitude to be developed by the student are: Demonstrated proficiency in common practical skills in resource exploration, The scientific basis of mineral, energy and natural resource exploration, he generic characteristics of economic mineral and energy resources – geological, geophysical and geochemical anomalism, The geophysical techniques (seismic, gravity, magnetic, electrical and electro-magnetics), The geochemical techniques (sampling media, sampling strategies, analytical techniques), Field based data collection – sampling strategies, Demonstrated understanding of the importance of data quality – collection, analysis, processes techniques

Reference Books/Materials:

1. Geophysical Exploration Technology by Ming li
2. Developments in Geophysical Exploration Methods by Fitch
3. An Introduction to Geophysical Exploration by Robert H. Tatham

Course Code	**GEO 516**
Course Title	**Applied Environmental Geophysics**

Course Outline:

Introduction to geophysical methods for environmental applications. Fixed and mobile hazards. Applications in contaminant plumes, conduits, fractures, voids, aquifers. buried containers, waste pits, ordnance, landfill delineation. Use of seismic methods, ground penetration radar, electromagnetic methods, tomography and other geophysical methods to environmental problems.

Course Aims and Objectives:

Geophysical exploration methods are fundamental tools in the search for mineral resources but are also used widely in engineering, archaeology and in earth and environmental sciences to explore and image the shallow subsurface (< 200 m depth). A wide range of geophysical methods are now used routinely in the search for buried archaeological sites, characterization of groundwater resources, geological imaging of subsurface structures and stratigraphic studies.

Course Outcomes:

Introduces geophysical exploration methods with emphasis on techniques used to investigate the near-surface (< 200 m depth). These methods include seismic reflection/refraction, ground-penetrating radar, electromagnetic, resistivity, gravity and magnetic methods. For each method, we will examine the underlying physical principles, the practical aspects of field data acquisition and signal processing and interpretation.

Reference Books/Materials:

1. Mussett, A.E. and Khan, M.A., Looking into the Earth: An Introduction to Geological Geophysics, Cambridge University Press, 2000.
2. Kearey, P., Brooks, M., Hill I., An Introduction to Geophysical Exploration, Blackwell, 2002.
3. Reynolds, J.M., An Introduction to Applied and Environmental Geophysics, Wiley, 2011.
4. Lay, T. and Wallance, T.C., Modern Global Seismology, Academic Press, 1995.
5. Sheriff R., and Geldart L., Exploration Seismology, Cambridge University Press, 1995.
6. Sheehan, H.R., Jones, A.F., and Burger C.H., Introduction to Applied Geophysics: Exploring the Shallow Subsurface, W. W. Norton & Company, 2006.

Appendage 3902

ADDITION OF ELECTIVE COURSES IN BEE ROADMAP

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 generations and implementations of Blockchain Technology.	PLO 2	C2	3
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 3903

Existing Scheme of CBT

	CS /IT (TEST NO. 01)					BEE (TEST NO.02)				
	Subject name	Subject topic	Difficulty Level	Questions	Total	Total	Questions	Difficulty Level	Subject topic	Subject name
	English	English Comprehension	Easy	8			6	Easy	English Comprehension	English
			Moderate	4			2	Moderate		
			Difficult	3	15	10	2	Difficult		
	English	English Grammar	Easy	8			6	Easy	English Grammar	English
			Moderate	4			2	Moderate		
			Difficult	3	15	10	2	Difficult		
	Maths	Algebra	Easy	10			6	Easy	Algebra	Maths
			Moderate	5			5	Moderate		
			Difficult	5	20	15	4	Difficult		
	Maths	General Maths	Easy	15			15	Easy	General Maths	Maths
			Moderate	10			5	Moderate		
			Difficult	5	30	25	5	Difficult		
	Analytical		Easy	10			10	Easy		Analytical
			Moderate	5			5	Moderate		
			Difficult	5	20	20	5	Difficult		
				100	100	80	80			
							10	Easy		Physics
							5	Moderate		
						20	5	Difficult		

Uniform Scheme of CBT

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 3906

IDEOLOGIES AND INTERNATIONAL RELATIONS

COURSE OUTLINE

Ideologies and International Politics:

The purpose of this course is to explore the meaning and utility of the concept ideology. Ideology serves to interpret the world and actor's position within it. It is important for the scholars of International Relations (IR) to have ideological analysis of world politics. The emergence of paradigms based on religious, historical, philosophical, political, economic and critical ideologies have influenced international relations. This course will focus on reviewing these distinct ideologies and their impact on world level and will also emphasize on the engagement between these divergent ideologies in order to completely understand the complexities of international relations.

Course Contents:

1. Ideology: A Conceptual and Theoretical Toolkit
2. Is Ideology a Useful Analytical Concept?
3. Comparative Historical and Sociological Perspective of Ideology
4. Ideologies from the Age of Empire to World War I
5. Ideologies from World War I to World War II
6. Ideologies in Cold War
7. Post-Cold War Ideologies
8. Ideologies and Non State Actors
9. Ideology and International Security
10. The Role of Ideology in Mass Political Violence
11. Ideologies and Transitions in World Order
12. Environmental Ideologies in Global Politics

Learning Outcomes:

1. Students will be able to understand different ideologies and their history
2. Students will understand the role of ideologies in international politics
3. Students will be able to use ideologies as analytical tools
4. Students can analyze the lasting impact of ideologies in domestic social context.

Key Books.

Giesen ,Klaus Gerd. *Ideologies in World Politics* (Springer Fachmedien Wiesbaden;Springer, 2020)

Goldwag, Arthur, *'Isms & 'Ologies: All the Movements, Ideologies and Doctrines That Have Shaped Our World.* (Vintage Books USA, 2007)

Pomper, Philip Richard H. Elphick, Richard T. Vann, World History: Ideologies, Structures, and Identities (Wiley-Blackwell, 1998).

Pagden, Anthony, *Lords of all the World: Ideologies of Empire in Spain, Britain and France c.1500-c.1800* (Yale University Press, 1998).

Rupert, Mark. *Ideologies of Globalization Contending visions of a New World Order* (Routledge: New York 2000)

Appendage 3908

NEW PROGRAMME PROPOSAL - MASTER OF SCIENCE IN CLINICAL PSYCHOLOGY

	A. ACADEMIC DETAILS
1	**Faculty/Department:** Professional Psychology
2	**Name/Title of the Programme (as to be written on transcript and degree):** Master of Science in Clinical Psychology
3	**Mission of the Programme:** The program is designed to provide opportunities for the development of necessary knowledge and skills needed in practice of and the research practices in psychology. The candidates are trained in diagnostic testing, psychotherapy, rehabilitation, educational, vocational counseling, and research under supervision.
4	**Objectives of the Programme:** 1. To develop important diagnostic, therapeutic, and consultative skills through immersion in intensive coursework, internship and field placement. 2. To enable effective application of counseling and therapeutic practice. 3. Be able to conduct research and practice according to internationally approved standards.
5	**Outcomes of the Programme:** After completion of the Program, candidates will be able 1. To teach in educational institutions. 2. To work as professional psychologists in institutionalized practice. 3. Serve as an asset to diagnosis and treatment of patients. 4. To conduct personnel selection, appraisal and assessments in an organizational setting.
6	**Rationale for the Programme:** MS Clinical Psychology program is designed to train students in academic, research and clinical skills. It is a specialized course that could help in reducing the gap between academia and professional services. The aim is to offer training in psychological assessment and intervention to deal with the growing psychological problems, thus enhancing individual and societal development and productivity.
7	**Brief Description of the Programme:** MS Clinical Psychology is a 2-year program. It is comprised of 4 semesters with 39 Credit Hours Coursework = 25 Credit Hours Internship = 08 Credit Hours Dissertation = 06 Credit Hours Total = 39 Credit Hours
8	**Duration:** 2 years
9	**Venue(s): On Site/Off Site/Both On & Off Site** 1st Semester: On site; 2nd – 4th Semester: Both on and off site (Students will visit hospital settings, mental health facilities and special education schools for internships in Semester 2, 3 and 4)

<table>
<tr><td>10</td><td>Program Scheduling Format: Evening</td></tr>
<tr><td>11</td><td>Proposed Date of Commencement: Fall 2021</td></tr>
<tr><td>12</td><td>Mode of Study/Examination: As per existing examination criteria and BU policy</td></tr>
<tr><td>13</td><td>Additional Faculty Member(s) Required:
Two PhDs (Clinical Psychology) as per HEC requirement to commence MS Clinical Psychology Program are already present
One permanent lecturer is required (1st year)</td></tr>
<tr><td>14</td><td>Additional Skilled-Worker(s) Required: Nil</td></tr>
<tr><td>15</td><td>Additional Classroom(s) required:
1 class room with the capacity of 10-15 students</td></tr>
<tr><td>16</td><td>Additional Requirement for Laboratories: Psychology lab is already established</td></tr>
<tr><td>17</td><td>Additional Requirement for Books, Subscriptions, Memberships to Online Research Sites/ Repositories: Nil</td></tr>
<tr><td>18</td><td>Minimum Entry Level/Eligibility criteria:
• Minimum 16 years of education in the relevant field of Psychology with a minimum of 50% marks (in annual system) or CGPA 2.5/4.0 (in semester system).
• BU Admission Test or GAT (General) with minimum 50% marks required at the time of admission</td></tr>
<tr><td>19</td><td>Admission Criteria:
• Minimum 16 years of education in the relevant field of Psychology with a minimum of 50% marks (in annual system) or CGPA 2.5/4.0 (in semester system).
• BU Admission Test or GAT (General) with minimum 50% marks required at the time of admission</td></tr>
<tr><td>20</td><td>Additional/Different Examination Requirement Nil</td></tr>
<tr><td>21</td><td>Number of Admissions Expected for First Intake: 10</td></tr>
<tr><td>22</td><td>Number of Admissions Planned/Expected for Subsequent Intakes:
<table>
<tr><th>Semester</th><th>Expected Intake</th></tr>
<tr><td>Fall 2021</td><td>10</td></tr>
<tr><td>Spring 2022</td><td>10</td></tr>
<tr><td>Fall 2022</td><td>10</td></tr>
<tr><td>Spring 2023</td><td>10</td></tr>
<tr><td>Fall 2023</td><td>10</td></tr>
<tr><td>Spring 2024</td><td>10</td></tr>
<tr><td>Fall 2024</td><td>10</td></tr>
<tr><td>Spring 2025</td><td>10</td></tr>
<tr><td>Fall 2025</td><td>10</td></tr>
<tr><td>Spring 2026</td><td>10</td></tr>
</table></td></tr>
<tr><td>23</td><td>Referred by: HOD DPP (BULC)</td></tr>
<tr><td>24</td><td>Complete Plan of Studies, inclusive of complete Roadmap: Attached as Annex ‘B’</td></tr>
<tr><td>25</td><td>Course Outlines, Descriptions, Pre-Requisites & Readings (Compulsory & Recommended) Attached as Annex ‘C’</td></tr>
</table>

B. FINANCIAL DETAILS

1 **Source of Funding**: BU: Fully

2 **Degree Duration:** 2 years **Annual or Semester System:** 4 Semesters

3 **Expected fee to be charged based on Cost & Benefits Analysis:** Rs.2,66,190

	Duration	1 (Semester)	2 (Semester)	3 (Semester)	4 (Semester)	Total
Fall 2021	**C.Hrs**	**12**	**9**	**12**	**6**	**39**
	02 Years	100520	51890	67520	46260	**266190**

4 **Expected Number of students for 1st& 2nd Intakes:** 20 (10 students per intake)

5 **Expected Earning from first two Intakes (B5):** Rs. 2,529,300

6 **Expected Earnings for the Next Five Years (B6):**

Semester Wise Revenue

Per semester	No. of Students	Income
Fall 2021	10	1,005,200
Spring 2022	20	1,524,100
Fall 2022	30	2,285,100
Spring 2023	40	2,763,300
Fall 2023	40	2,870,550
Spring 2024	40	5,741,100
Fall 2024	40	6,515,200
Spring 2025	40	6,811,550
Fall 2025	40	7,481,850
Spring 2026	40	7,746,250
G. Total		**44,744,200**

7 **Total Estimated Salaries of all Additional Human Resources per annum (B7):**
1st and 2nd intake:

- One permanent lecturer: 60,000 *12 = Rs. 7,20,000
  Placement Supervisor: 250Rs. per student *56 days* 10 students = Rs. 1,40,000

Total expense for 1 year: 720,000+ 1,40,000 = Rs. 8,60,000

8 **Cost of Additional Laboratory Equipment/Tools (B8): Nil**

9 **Cost of Additional Classrooms (B9): Nil**

10 **Cost of Additional Books, Subscription & Memberships to on-line Sites/Repositories (B10): Nil**

11 **Off-Site rental Expenses and Cost of other Fixtures (B11): Nil**

12 **Miscellaneous Expenses required for Starting the Programme (B12):**

- Advertisement: Rs. 1,50,000
- Printing & Stationery: Rs. 1,50,000
- Admin Cost: Rs. 1,50,000
- Any other: Nil

- Total: Rs.4,50,000

13 **Annual Recurring Expenditures in Subsequent Years (B13):**

	First Year		
Year	**Expenses (with 10 % add)**		**Gross Earning (Fee)**
Fall 21 – Spring 22	Salaries	8,60,000	**2,529,300**
	Advertisement	1,50,000	
	Printing & Stationary	1,50,000	
	Admin Cost	1,50,000	
Total	**Total**	**1,310,000**	

	Second Year		
Year	**Expenses (with 10 % add)**		**Gross Earning (Fee)**
Fall 22 – Spring 23	Salaries	2,186,800	**5,048,400**
	Advertisement	1,65,000	
	Printing & Stationary	1,65,000	
	Admin Cost	1,65,000	
	Thesis Supervision	2,30,000	
Total	**Total**	**2,911,800**	

	Third Year		
Year	**Expenses (with 10 % add)**		**Gross Earning (Fee)**
Fall 23 – Spring 24	Salaries	3,197,480	**5,741,100**
	Advertisement	1,81,500	
	Printing & Stationary	1,81,500	
	Admin Cost	1,81,500	
	Thesis Supervision	4,60,000	
Total	**Total**	**4,201,980**	

	Fourth Year		
Year	**Expenses (with 10 % add)**		**Gross Earning (Fee)**
Fall 24 – Spring 25	Salaries	3,517,228	
	Advertisement	1,99,650	**5,963,400**

		Printing & Stationary	1,99,650	
		Admin Cost	1,99,650	
		Thesis Supervision	4,60,000	
	Total	**Total**	**4,576,178**	
		Fifth Year		
	Year	**Expenses (with 10 % add)**		**Gross Earning (Fee)**
	Fall 25 – Spring 26	Salaries	3,868,951	**6,197,200**
		Advertisement	2,19,615	
		Printing & Stationary	2,19,615	
		Admin Cost	2,19,615	
		Thesis Supervision	4,60,000	
	Total	**Total**	**4,987,796**	

14	**Total Cost of the Programme (B14):** [Add B(7) to B(12)] = **Rs. 1,310,000**
15	**Net Cost of the Programme (B15):** [Subtract B(1) from B(14)] = **Rs. 1,310,000**
16	**Net Earnings in First Year (B16):** [Subtract B(15) from B(5)] = **Rs. 1,219,300** (Program will be more profitable in the next financial year)
17	**Projected Annual Gross Earning in Subsequent Years (B 17):**

Per Year	**No. of Students**	**Income**	**Gross Earning Per Year**
Fall 2021	10	1,005,200	**2,529,300**
Spring 2022	20	1,524,100	
Fall 2022	30	2,285,100	**5,048,400**
Spring 2023	40	2,763,300	
Fall 2023	40	2,870,550	**5,741,100**
Spring 2024	40	5,741,100	
Fall 2024	40	6,515,200	**5,963,400**
Spring 2025	40	6,811,550	
Fall 2025	40	7,481,850	**6,197,200**
Spring 2026	40	7,746,250	
G. Total		**44,744,200**	

18 **Projected Annual Net Earning in Subsequent Years:** *[Subtract B(13) from B(17)]*

	First Year		
	Expenses	**Gross Earning (Fee)**	**Net Earning**
Total	1,310,000	2,529,300	1,219,300

	Second Year		
	Expenses	**Gross Earning (Fee)**	**Net Earning**
Total	2,911,800	5,048,400	2,136,600
	Third Year		
	Expenses	**Gross Earning (Fee)**	**Net Earning**
Total	4201980	5,741,100	1,539,120
	Fourth Year		
	Expenses	**Gross Earning (Fee)**	**Net Earning**
Total	4,576,178	5,963,400	1,387,222
	Fifth Year		
	Expenses	**Gross Earning (Fee)**	**Net Earning**
Total	4987796	6,197,200	1,209,404

Annex "B"

ROAD MAP - MASTER OF SCIENCE IN CLINICAL PSYCHOLOGY

SEMESTER I					
Sr. No.	**Course Code**	**Course Title**	**Theory**	**Lab**	**Total**
1	CPY 643	Humanistic & Existential Therapies	1	1	2
2	CPY 644	Applied Behavioral Analysis	1	1	2
3	CPY 645	Psychodiagnosis & Intellectual & Neuropsychological Assessment	1	2	3
4	CPY 651	Advance Research Methodology	2	1	3
5	CPY 647	Neurological Basis of Behaviour	2	-	2
Total Credit Hours			**12**		
SEMESTER II					
Sr. No.	**Course Code**	**Course Title**	**Theory**	**Lab**	**Total**
1	CPY 652	Cognitive Behavioral Therapy	1	1	2
2	CPY 648	Personality Assessment	-	3	3
3	CPY 653	Pharmacology	2	-	2
4	CPY 654	Internship-I	-	2	2
Total Credit Hours			**9**		
SEMESTER III					
Sr. No.	**Course Code**	**Course Title**	**Theory**	**Lab**	**Total**
1	CPY 649	Psychodynamic Therapies	2	1	3
2	CPY 650	Psychopathology & Psychotherapies of Children/Adolescents	2	1	3
3	CPY 613	Internship II	-	3	3
4	CPY 753	Dissertation I	3	-	3
Total Credit Hours			**12**		
SEMESTER IV					
Sr. No.	**Course Code**	**Course Title**	**Theory**	**Lab**	**Total**
1	CPY 745	Internship III	-	3	3
2	CPY 744	Dissertation II	3	-	3
Total Credit Hours			**6**		
Total Credit Hours OF Program			**39**		

Coursework = 25 Credit Hours
Internship = 08 Credit Hours
Dissertation = 06 Credit Hours
Total = 39 Credit Hour

COURSE DESCRIPTION

CPY 643

Humanistic & Existential Therapies

This course includes humanistic approach to psychology; provide an appropriate philosophical context for the understanding of human behavior, experience and therapeutic change; personality, growth and development from a humanistic-phenomenological perspective and transpersonal approaches to the study of the human experience.

Recommended Books:

- Deurzen, E. V. (2020) The Wiley World Handbook of Existential Therapy. Wiley-Blackwell
- Hoffman, L, Cleare-Hoffman, H., Granger, N. Jr., and St. John, D. (2019). Humanistic Approaches to Multiculturalism and Diversity: Perspectives on Existence and Difference. Routledge
- Krug, O.T. and Piwowarski, T. (2019) Ethical Issues in Existential-Humanistic Psychotherapy. Oxford
- Schneider, K.J. and Krug, O. T. (2017) Existential-Humanistic Therapy (Theories of Psychotherapy).American Psychological Association
- Reiter, M., Chenail, R. J. (2017). Behavioral, Humanistic-Existential, and Psychodynamic Approaches to Couples. Routledge

CPY 644

Applied Behavioral Analysis

The course provides an introduction to the concepts and principles of Behavior Analysis and their usage in behavioral change. Identifying and using appropriate observational methods based on individual cases, assessing individuals using functional assessment procedures and methods, displaying and interpreting behavioral data, and designing behavior support plans.

Recommended Books:

- Martin, G. and Pear, J. J. (2019). Behavior Modification What It Is and How To Do It. Routledge
- Cooper, J., Heron, T., Heward, W. (2020). Applied Behavior Analysis 3rd Edition. Thomson Wadsworth Publishers
- Cooper, J., Heron, T., and Heward, W. (2020). Applied Behavior Analysis. Florida Tech.
- Powell, ,R. A., Honey P. L., and Symbaluk, D. G. (2016). Introduction to Learning and Behavior. Cengage Learning
- Kearney, A. J. & Kingsley, J. (2008). Understanding Applied Behavior Analysis: An Introduction to ABA for Parents, Teachers and other Professionals. Jessica Kingsley.

CPY 647

Neurological Basis of Behavior

This course provides an overview of the relationship between the brain and behavior. This including neuroanatomy, neurochemistry, vision, and hearing, sleep and circadian rhythms, reproductive and ingestive behavior, and learning and memory in humans. Human neurological and mental disorders across the lifespan including: Agnosia, Apraxia, Amnestic Syndromes, and Aphasic Syndromes.

Recommended Books:

- Gaskin, S. (2019). Behavioral Neuroscience: Essentials and Beyond, Sage Publishing Julien. B, François. B, Makoto, I (2019). History of neuropsychology. Karger
- Kalat, J. (2019). Biological psychology. Cengage
- Anderson, V. (2018).Developmental Neuropsychology: A Clinical Approach (Brain, Behaviour and Cognition)
- Joel E. Morgan, J. E., and Ricker, J. H (2018). Textbook of Clinical Neuropsychology. Routledge.
- Parsons, M. W., and Hammeke, T. A. (2014) Clinical Neuropsychology: A Pocket Handbook for Assessment, American Psychiatric Association.

CPY 645

Psychodiagnosis & Intellectual & Neuropsychological Assessment

The course lays the foundation of the concepts to understand the nature of intelligence, Intellectual disabilities, the importance of Intellectual and Neuropsychological Assessments along with Diagnosis. The student will be able to understand the theory, administration, practice, scoring, and analysis, interpretation of different intellectual and neuropsychological tests in order to assess the intellectual and neuropsychological functioning and learn to write psycho-diagnostic reports. Furthermore, the course develops an insight into the various Psychological disorders and their etiology.

Recommended Books:

- Diagnostic Statistical Manual of Mental Disorders (2013). American Psychiatric Association.
- Gregory, R. J. (2015). Psychological Testing: history, principles and applications, (4rth ed.). Pearson Education, Inc.
- Groth-Marnat, G. (2016). Handbook of psychological assessment. USA: John Wiley & Sons.
- Cohen, R. J., Swerdlik, M. (2017). Psychological Testing and Assessment 9th Edition. McGraw-Hill Education.
- Franzen, M. D. (2013). Reliability and Validity in Neuropsychological Assessment. Springer Science & Business Media, LLC.

CPY 651

Research Methods

The course prepares the student to undertake a research effort as required for the completion of research dissertation for higher degree (MS). The primary intent is to understand the different research paradigms, their underlying epistemological assumptions as well as their associated research traditions and techniques. This course will facilitate the process of developing specific skills that will enable the students to effectively carry out independent research. Their conceptual and analytical skills will be developed, with written and oral presentation skills and will be formally assessed.

Recommended Books:

- Hennink, M., Hutter, I. and Bailey, A (2020). Qualitative Research Method. Sage Publications.
- Hair, J. F. Jr., Page, M., and Brunsveld, N. (2020). Essentials of Business Research Methods. Routledge.
- Creswell, J. D., & Creswell, J.W. (2018). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches(5thed). USA: Sage Publications.
- Coolican, H. (2017). Research Methods and Statistics in Psychology. (6th ed.). USA: Psychology Press.

- Goodwin, K.A., & Goodwin, C.J. (2017). Research in Psychology: Methods and Design. (8th ed.). USA: John Wiley & Sons.

CPY 652

Cognitive Behavioral Therapy

This course includes the history, nature, scope and theories of cognitive behavioral psychology. This course will help the student to understand essential concepts, key contributors, current controversies in cognitive-behavior therapy. Moreover, it will build an understanding of specific cognitive and behavioral assessment methods, Cognitive-behavioral intervention techniques and their applications, contextual considerations, including human diversity, other sociocultural factors and developmental factors, which will help in conceptualizing cases and their treatment plans.

Recommended Books:

- Beck & Beck (2020) Cognitive Behavior Therapy, Basics and Beyond. Third edition. Guilford Publications, Inc.
- Leslie Sokol &, Marci Fox (2019) The Comprehensive Clinician's Guide to Cognitive Behavioral Therapy. PESI Publishing & Media
- Seth J. Gillihan (2018) Cognitive Behavioral Therapy Made Simple: 10 Strategies for Managing Anxiety, Depression, Anger, Panic, And Worry. Althea Press
- Leahy, R. L. (2017). Cognitive Therapy Techniques: A Practitioner's Guide. (2nd Ed.).: New York, NY: Guilford Press
- Dryden, W., & Branch, R. (2012). The CBT handbook. SAGE Publications Inc.

CPY 648

Personality Assessment

This course aims to understand the scientific and theoretical knowledge base of psychology that is necessary for successful entry into the practice of clinical profession of psychology. It will help students to understand the theory, practice, analysis and interpretation of different scales, checklist and psychological tests that includes achievement, objective, semi projective and projective tests in order to assess personality and behavior and learn to write professional psycho-diagnostic reports.

Recommended Books:

- Irving B. Weiner, Roger L. Greene (2017) Handbook of Personality Assessment (2nd ed.). Wiley Online Books.
- Updesh Kumar (2016). The Wiley Handbook of Personality Assessment. Wiley Online Books.
- Schultz & Schultz (2016). Theories of Personality. Cengage Learning
- Steven R. Smith (2014) Personality Assessment (2nd ed.). Routledge.
- Gregory, R. J. (2014). Psychological Testing: history, principles and applications, (4rth ed.). Pearson Education, Inc.

CPY 653

Pharmacology

This course will ensure the student's ability to gain basic knowledge of pharmacology and its related concepts. This course will build an understanding of common psychotropic drugs used for the treatment, mechanism of action, adverse effects, and interactions amongst various psychotropic drugs used in neurological and psychological disorders.

Recommended Books:

- Nassir Ghaemi (2019) Clinical Psychopharmacology: Principles and Practice. Oxford University Press
- R. H. Ettinger (2017) Psychopharmacology. Routledge: NY
- Ian M. Anderson & .(2015(Ian C. ReidFundamentals of Clinical Psychopharmacology. Routledge & CRC Press
- Michael I. Levi (2007)Basic Notes in Psychopharmacology. Routledge & CRC Press
- Muse, M. & Moore, B. A. (2012). Handbook of Clinical Psychopharmacology. Wiley & Sons, Inc.

CPY 649

Psychodynamic Therapies

This course lays the foundation of the advanced concepts of psychodynamic theories, object relation, and psychotherapy. In order to provide practical explanation, this course focuses on the various aspects of Freudian, Jungian, and Adlerian approaches, including the techniques of transference, counter-transference, resistance, and catharsis.

Recommended Books:

- Gertrude Pollitt (2020) Psychodynamic Treatment of Children with Severe Emotional Disturbances. Rowman & Littlefield Publishers
- Tasca, Hewitt, and Mikail. (2020) Group Psychodynamic-interpersonal Psychotherapy. American Psychological Association
- Jacobs, M. (2017) Psychodynamic Counselling in Action. London: SAGE Publisher
- Laurence Spurling (2017) An Introduction to Psychodynamic Counselling. Palgrave Macmillan
- Deborah L. Cabaniss (2016) Psychodynamic Psychotherapy: A Clinical Manual. Wiley

CPY 650

Psychopathology & Psychotherapies of Children/ Adolescents

This course includes knowledge of developmental theories and related psychotherapies of children and adolescents. It will help students in understanding the application of therapeutic techniques primarily designed for children and adolescents.

Recommended Books:

- Graham Davey (2021) Psychopathology: Research, Assessment and Treatment in Clinical Psychology. John Wiley & Sons, Limited
- James E. Maddux, Psychopathology)2019(Barbara A. Winstead: Foundations for a Contemporary Understanding. Taylor & Francis
- June Gruber (2019) The Oxford Handbook of Positive Emotion and Psychopathology. Oxford University Press
- Giovanni Stanghellini, ,Matthew Broome (2019(Andrea RaballoThe Oxford Handbook of Phenomenological Psychopathology. Oxford University Press
- Butcher, J.N., Hooley, J.M., & Kendall, P.C. (2018). APA Handbook of Psychopathology. USA: American Psychological Association.

CPY 654, CPY 613, CPY 745

Internship I, II, III

The aim of the internship is to train the student to work in the field and acquire knowledge necessary for practice of Professional Psychology. All the psychotherapy sessions are supervised by highly qualified professionals. Candidates are required to complete a 250 psychotherapy sessions and 25 psychological assessment batteries while being supervised for internship.

CPY 753 & CPY 744
Dissertation I & II
For their mandatory dissertation, students are assigned with a research supervisor, who provide the candidate with guidance and advices them throughout their period, entailing synopsis approval, data collection, analysis and write-up. Students meet regularly with their supervisors to monitor their progress until completion.

Course Work = 25 Credit Hours
Internship = 08 Credit Hours
Dissertation = 06 Credit Hours
Total = 39 Credit Hours

Appendage 3910

NEW PROGRAMME PROPOSAL – BACHELOR OF SCIENCE IN COASTAL & MARINE SCIENCES

(FEASIBILITY REPROT)

A: ACADEMIC DETAILS	
1	**Faculty/Department:** DEPARTMENT OF MARITIME SCIENCES
2	**Name or the program:** Bachelor of Science in Coastal & Marine Sciences (4 Years)
3	**Mission or the Program:** The department has planned to expand horizontally by launching programs in the discipline of Applied Marine and Coastal Sciences to develop required human resources for Pakistan Maritime Science and Technology Park (PMSTP) in the discipline of marine sciences. This human resource is likely to cater to the foreseeable challenges of climate change and coastal zone management. The proposed course is being taught all over the world but at present, the universities in the public or private sector in Pakistan are not offering this course.
4	**Objectives of the Program:** The BS (Coastal and Marine Sciences) would provide students with the knowledge and practical skills to plan and manage activities for conserving the marine and coastal areas from anthropogenic and climate-induced effects. Fields of study will include Climate Change, Sea Level Rise, marine biology, Geographic Information Systems (GIS), geomorphology, and the physical environment of the coastal zone.
5	**Outcomes of the Programme:** A graduate of the BS (Coastal and Marine Sciences) would be able a. To apply principles and practices of coastal and marine sciences to the planning and sustainable management of coastal zones. b. He/She would be able to apply problem-solving and decision-making skills to develop innovative and sustainable solutions to the challenges being faced by Pakistan's coastal zones due to climate change. c. Would be qualified enough to locate, extract and interpret relevant evidence and scientific literature for decision making; critically assess the value of information and available data for the creation of a scientifically-based argument; d. Demonstrate written, oral, and interpersonal communication skills appropriate to the conduct of a science professional; argue the merits and limitations of current and developing technologies in marine and coastal research and management; use research and learning skills to maintain the currency of knowledge of the science related to the management of coastal and marine areas; evaluate and actively engage in their continued learning and development as environmental scientists; e. Recognize the national and global imperatives driving coastal changes to biological, chemical, and physical systems; integrate international case studies and experiences in the application of knowledge to coastal decision-making; incorporate indigenous and other community perspectives in the development of solutions to issues relating to the coastal zone, and demonstrate professional and ethical practice in keeping with community and industry standards, and relevant to marine science.
6	**The rationale for the program:** Pakistan has been grouped by the UNEP's Oceans and Coastal Areas Program Activity Centre among the countries which are most vulnerable to the effects of sea-level rise. The coastal areas are vulnerable for two reasons: rise in sea level and increased frequency and intensity of tropical cyclones. The threats associated with

	Climate change have already started exerting pressure not only on the coastal ecosystem but also causing a serious problem of coastal erosion and associated land loss. Most of the vital infrastructure along the Sindh and Makran coast would have to be protected and new structures would require non-conventional approaches. The proposed BS Coastal & Marine Science is going to cater to the requirement of trained and skilled manpower to undertake the challenging task of protecting the coastal infrastructure as well as for habitants.
7	**Brief Description of the Programme:** The BS (Coastal and Marine Sciences) would provide students with the knowledge and practical skills to plan and manage activities for conserving the marine and coastal areas from anthropogenic and climate-induced effects. Fields of study will include Climate Change, Sea Level Rise, marine biology, Geographic Information Systems (GIS), geomorphology, and the physical environment of the coastal zone. A graduate of the BS (Coastal and Marine Sciences) would be able to apply principles and practices of coastal and marine science to the planning and sustainable management of coastal zones by developing innovative and sustainable solutions to the challenges faced by Pakistan's coastal zones due to climate change.
8	**Duration:** 4 years
9	**Venue(s): On-Site/Off-Site/Both On & Off-Site (Tick one; if Off-Site, give details):** Department of Maritime Sciences, Bahria University Karachi Campus
10	**Programme Scheduling Format; Morning/Evening/Weekend (tick one); Bi-Semester/Trimester/Semester+Summer Session/Annual/Bi-Annual (tick one):** Bi Semester er
11	**Proposed Date of Commencement:** Fall 2021
12	**Mode of Study/Examination:** As per BU Examination Rules
13	**Additional Faculty Member(s) Required: (Indicate if there is a requirement for additional faculty members, full-time/visiting, along with qualifications):** No immediate requirement is envisaged.
14	**Additional Skilled-worker(s) Required:** *(Indicate if there is a requirement for additional Skilled Staff, full-time/part-time, along with their qualifications/skill sets.)*: One Lab/Field Technician
15	**Additional Classroom(s) required: (The requirement is to include the number of classrooms and their capacities.)** First Semester: 1 Additional one classroom with the start of every semester till the 8th semester.
16	**Additional Requirement for Laboratories: (The requirement is to include the number of laboratories, their equipment, and their capacities).** One general lab would be required in the first year and one lab would be shared with the Department of Earth & Environmental Sciences BUKC.
17	**Additional Requirement for Books, Subscriptions, Memberships to Online Research Sites/ Repositories:** Some books are already available in the library, besides NIO has offered access to its Research Library to the faculty of the Department of Maritime Sciences.
18	**Minimum Entry Level:** F. Sc/A Level With 2 CGPA or 50 % marks.
19	**Admission Criteria:** As per BU Rules
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).*** Nil
21	**Number of Admissions Expected for First Intake:** 20
22	**Number of Admissions Planned/Expected for subsequent Intakes:** 20
23	**Referred by:** DBOS/FBOS
24	**Complete Plan of Studies, inclusive of complete Roadmap:** Attached as Annex-A
25	**Course Outlines, Descriptions, Pre-Requisites & Readings (Compulsory & Recommended)** (Attached as Annex "B")

B. FINANCIAL DETAILS	
1	**Source of Funding:** • **BU: Fully/Partially: Fully**
2	**Degree Duration:** **Annual or Semester System;** Annual Number of Years **Semester Number of Semester: 8 Semester** **Total Number of Credit Hours:** 135
3	**The expected fee to be charged based on Cost & Benefits Analysis: (show working)** Per annum fee: or Fee rate per credit hour: Rs. 4138 Fee Rate / Credit Hour: Rs 3860 Tuition Fee/Semester/Student: Rs 3860 x 18 + 5000 = Rs 74,480
4	**Expected Number of students for 1st & 2nd Intakes: 20 & 20**
5	**Expected Earning from first two Intakes (B5): (Show working):** Tuition Fee/Semester/Student: Rs 74,480 Admission Fee and other Charges/Student (One Time): Rs. 21000+10000 = 31000 Earning from First Two Intakes: 2,109,600+1,489,600= 3,599,200
6	**Expected Earnings for the Next Five Years (B6): (show working)** Attached as Annex C
7	**Total Estimated Salaries of all Additional Human Resources per annum (B7): (Show working)** 1(Technician)xRs 20833.33/monthx12 months = 2,50,000.0
8	**Cost of Additional Laboratory Equipment/Tools (B8): (show working) :** NIL One general lab facility shall be required. Alternatively, the lab of Earth & Environment Science would be used
9	**Cost of Additional Classrooms (B9): include furniture, technical aids, etc):** NIL Existing classrooms facilities shall be used
10	**Cost of Additional Books, Subscription & Memberships to on-line Sites/Repositories (B10): (show details)** Cost of one Book: 12000 Approximately on Average Cost of 100 Books: 250, 000
11	**Off-Site rental Expenses and Cost of Other Fixtures (B11): (Show details)** Nil
12	**Miscellaneous Expenses required for starting the Programme (B12) –** - Advertisement: 100,000 - Printing & Stationery: 10,000 - Admin Cost: 5000 - Any other: 5000 - **Total:** 1,20,000
13	**Annual Recurring Expenditures in Subsequent Years (B13):** - Salaries (five years): - Nil - Rentals: - Nil - Subscriptions/Memberships: - Nil - Advertisements: 500,000 per year - Printing & Stationery: 2,00,000

<table>
<tr><td></td><td>- Admin Cost: 5,00,000
- Any other: 1,00,000
- Total: 13,00,000</td></tr>
<tr><td>14</td><td>Total Cost of the Programme (B14): [Add B(7) to B(12)

2,50,000+1,20,000= Rs. 370,000</td></tr>
<tr><td>15</td><td>Net Cost of the Programme (B15): [Subtract B(1) from B(14)]
Rs 370,000</td></tr>
<tr><td>16</td><td>Net Earnings in First Year (B16: [Subtract B(15) from B(5)]
For First Two Intake: 4,746,600-370,000= 4,376,600
Including Summer Semester: 6,534,900 -370,000=6,164,900</td></tr>
<tr><td>17</td><td>Projected Annual Gross Earning in Subsequent Years (B17): (show details & working; add 10% towards all expenses in subsequent years)
<table>
<tr><th>Year</th><th>Total Revenue (5 Year)</th><th>Total Expenses (5 Years) 10% increment/year</th><th>Net Earning</th></tr>
<tr><td>Year1</td><td>5,708,800</td><td>370,000</td><td>5,338,800</td></tr>
<tr><td>Year2</td><td>11,667,200</td><td>407,000</td><td>11,260,200</td></tr>
<tr><td>Year3</td><td>17,394,000</td><td>447,700</td><td>16,946,300</td></tr>
<tr><td>Year4</td><td>33,010,000</td><td>492,470</td><td>32,517,530</td></tr>
<tr><td>Year5</td><td>34,036,400</td><td>541,717</td><td>33,494,683</td></tr>
<tr><td></td><td>101,816,400</td><td>2,258,887</td><td>99,557,513</td></tr>
</table></td></tr>
<tr><td>18</td><td>Projected Annual Net Earning in Subsequent Years: [Subtract B(13) from B(17) 98,257,513</td></tr>
</table>

Mapping of Roadmap in Specified Categories as per HEC UG Policy 2020

Program: BS (COASTAL AND MARINE SCIENCES) ***Faculty: School of Business Studies***

a. General Education Requirement

Sub-Category	*Total Credit Hours*	*Course Code*	*Course Title*	*Credit Hours*	*Remarks (Existing or new course, CHs added, etc.)*
Breadth Courses (6) Art & Humanities (2) Natural Sciences (2) Social Sciences (2)	18	ENG 132	Oral Communication	3	Existing
		ENV 425	Occupational safety, health& environment	3	Existing
		CMS 508	Marine Biology	3(2+1)	New
		GEO 311	Marine Geochemistry	3(2+1)	Existing
		HSS 202	Introduction to Sociology	3	Existing
		CMS 614	Socio-Ecological Fundamentals of Coastal Zones	3	New
Civilizational Courses Pakistan Studies (1) Islamic or Religious Studies (1)	6	PAK 101	Pakistan Studies	3	Existing
		ISL 101	Islamic Studies/ Ethics	3	Existing
Foundational Skills Courses (5) Expository Writing (3) Quantitative Reasoning (2)	15	ENG 105	Functional English	3	Existing
		MRM 302	Research Project Writing Method	3	Existing
		CMS 604	Environmental Impact Assessment	3	New
		IT 101	Information Technology	3	Existing
		BSS 307	Biostatistics	2+1	New

b***. Disciplinary Requirement***

Sub-Category	***Course Code***	***Course Title***	***Credit Hours***	***Remarks (Existing or new course, CHs added, etc.)***
Discipline Courses (Major)	CMS 301	Introduction to Marine Science	3	New
	MTM 120	Introduction to Meteorology & Oceanography	3	Existing
	CMS 403	Marine Biotechnology	3(2+1)	New
	CMS 304	Basic Principles and Scope of ICZM	3	New
	CMS 401	Marine Resources	3	New
	MTM 222	Introduction to Coastal Zone Management	3	Existing
	MTM 224	Marine Pollution and Control	3	Existing
	CMS 402	Marine Microbiology	3(2+1)	New
	ENV 236	Introduction to Climate Change	3	Existing
	CMS 406	Oceanographic Instruments and Methods	3(2+1)	New
	CMS 505	Marine Biodiversity	3(2+1)	New
	GEO 320	Marine Geology	3(2+1)	Existing
	CMS 502	Coastal ecosystem and Climate Change	3	New
	CMS 605	Marine Geophysics	3	New
	GEO 414	Physical Oceanography & Surveying	3	New
	MTM 401	Coastal Ecotourism Development and Management	3	Existing
	MTM 605	Sea Level Changes and Coastal Zones	3	Existing
Distribution Courses	CMS 303	Marine Ecology and Ecosystems	3(2+1)	New
	CHM 105	Chemistry	2+1	Existing
	MTM 402	Hydrographic Data & Services Management/Hydrography & Navigation	3	Existing
		Elective I	3	
		Elective II	3	
		Elective III	3	
Minor	ECO 101	Fundamental of Economics	3	Existing
	ENV 100	Fundamental of Biology	2+1	Existing
	MAT 105	Mathematics	3	Existing
	GEO 105	Physical & General Geology	2+1	Existing
	MAT	Statistics	3	Existing

	205			Quantitative Reasoning
	GEO 437	GIS & Remote Sensing	3(2+1)	New
	PHY 101	Physics	3	Existing
Lab/Fieldwork/ Thesis	SDW 499	Project/ Thesis	6	Existing

c. *Practical Learning Requirements*

Category			***Weeks/Hours***		
Practical Learning Requirements	***Internship (9 weeks)***		*9/360*		
	Practical Learning Lab* (4 contact hrs per week)				
		Entrepreneurship	Activities are planned to be undertaken as per the new HEC policy		
		Youth Club	Activities are planned to be undertaken regularly		
		Sports	Activities are planned to be undertaken regularly		

* weekly PLL activities are planned for all the semesters

Program Summary

Roadmap	*Total Courses*	*Total CHs*	*Internship*	*PLL*	*Remarks*
New Program	44	135	9 weeks	Activities are planned to be undertaken regularly	Internship time extended.

Semester-Wise Roadmap following HEC UG Policy 2020

Program: *BS (COASTAL AND MARINE SCIENCES)* **Faculty: Bahria Business School**

Semester 1:

Sr. #	*Pre-Req*	*Course Code*	*Course Title*	*Credit Hours*		*Category as per HEC Policy*	*Remarks (Existing or New Course, CHs added, etc.)*
				Theory	Lab		
1		ENG 105	Functional English	3	-	Expository Writing (1)	Existing
2		IT 101	Information Technology	3		Quantitative Reasoning (1)	Existing
3		ECO 101	Fundamental of Economics	3		Minor (1)	Existing
4		CMS 301	Introduction to Marine Science	3	-	Major (1)	New
5		ENV 100	Fundamentals of Biology	2	1	Minor (2)	Existing
6		MAT 105	Mathematics	3	-	Minor (3)	Existing
	Total Credit Hours			**18**			
		Practical Learning Lab (4 contact hours per week)					

Semester 2:

Sr. #	*Pre-Req*	*Course Code*	*Course Title*	*Credit Hours*		*Category as per HEC Policy*	*Remarks (Existing or New Course, CHs added, etc.)*
				Theory	Lab		
1		ISL 101	Islamic Studies/ Ethics	3	-	Islamiat (1)	Existing
2		ENV 425	Occupational safety, health& environment	3	-	Art & Humanities (2)	Existing
3		CMS 303	Marine Ecology and Ecosystems	2	1	Distribution (1)	New
4		MTM 120	Introduction to Meteorology & Oceanography	3		Major (2)	Existing

5		HSS 202	Introduction to Sociology	3		Social Sciences (1)	Existing
6		CMS 403	Marine Biotechnology	2	1	Major (3)	New
	Total Credit Hours			**18**			
		Practical Learning Lab (4 contact hours per week)					

Semester 3:

Sr. #	***Pre-Req***	***Course Code***	***Course Title***	***Credit Hours***		***Category as per HEC Policy***	***Remarks (Existing or New Course, CHs added, etc.)***
				Theory	*Lab*		
1		ENG 132	Oral Communication	3		Art & Humanities (1)	Existing
2		PAK 101	Pakistan Studies	3		Pakistan Studies (1)	Existing
3		CMS 304	Basic Principles and Scope of ICZM	3		Major (4)	New
4		CMS 401	Marine Resources	3		Major (5)	New
5		CHM 105	Chemistry	2	1	Distribution (2)	Existing
6		GEO 105	Physical & General Geology	2	1	Minor (4)	Existing
	Total Credit Hours			**18**			
		Practical Learning Lab (4 contact hours per week)					

Semester 4:

Sr. #	***Pre-Req***	***Course Code***	***Course Title***	***Credit Hours***		***Category as per HEC Policy***	***Remarks (Existing or new Course, CHs added, etc.)***
				Theory	Lab		
1		MTM 222	Introduction to Coastal Zone Management	3	-	Major (6)	Existing
2		MTM 224	Marine Pollution and Control	3	-	Major (7)	Existing
3		MAT 205	Statistics	3		Minor (5)	Existing
4		CMS 614	Socio-Ecological Fundamentals of Coastal Zones	3	-	Social Sciences (2)	New
5		CMS 402	Marine Microbiology	2	1	Major (8)	New
6		ENV 236	Introduction to Climate Change	3		Major (9)	Existing

		Total Credit Hours	**18**	
		Practical Learning Lab (4 contact hours per week)		

Semester 5:

Sr. #	***Pre-Req***	***Course Code***	***Course Title***	***Credit Hours***		***Category as per HEC Policy***	***Remarks (Existing or New Course, CHs added, etc.)***
				Theory	Lab		
1		GEO 437	GIS & Remote Sensing	2	1	Minor (6)	Existing
2		CMS 406	Oceanographic Instruments and Methods	3		Major (10)	New
3		CMS 505	Marine Biodiversity	2	1	Major (11)	New
4		PHY 101	Physics	3		Minor (7)	Existing
5		BSS 307	Biostatistics	2	1	Quantitative Reasoning (2)	New
6		GEO 320	Marine Geology	2	1	Major (12)	Existing
	Total			**18**			
	Practical Learning Lab (4 contact hours per week)						

Semester 6:

Sr. #	***Pre-Req***	***Course Code***	***Course Title***	***Credit Hours***		***Category as per HEC Policy***	***Remarks (Existing or new course, CHs added, etc.)***
				Theory	*Lab*		
1		CMS 502	Coastal ecosystem and Climate Change	3		Major (13)	New
2		MTM 402	Hydrographic Data & Services Management/Hydrography & Navigation	3	-	Distribution (3)	Existing
3		GEO 414	Physical Oceanography & Surveying	3	-	Major (14)	New

4		CMS 508	Marine Biology	2	1	Natural Sciences (1)	New
5		GEO 311	Marine Geochemistry	2	1	Natural Sciences (2)	Existing
6		MRM 302	Research Project Writing Method	3	-	Expository Writing (2)	Existing
Total				**18**			
	Practical Learning Lab (4 contact hours per week)						

Semester 7:

Sr. #	***Pre-Req***	***Course Code***	***Course Title***	***Credit Hours***		***Category as per HEC Policy***	***Remarks (Existing or new course, CHs added, etc.)***
				Theory	*Lab*		
1		CMS 604	Environmental Impact Assessment	3	-	Expository Writing (3)	New
2		CMS 605	Marine Geophysics	3		Major (15)	New
3		MTM 401	Coastal Ecotourism Development and Management	3	-	Major (16)	Existing
4		-	ELECTIVE I	3		Distribution (4)	-
5		-	ELECTIVE II	3		Distribution (5)	-
Total				**15**			
	Practical Learning Lab (4 contact hours per week)						

Semester 8:

Sr. #	*Pre-Req*	*Course Code*	*Course Title*	*Credit Hours*		*Category as per HEC Policy*	*Remarks (Existing or new course, CHs added, etc.)*
				Theory	*Lab*		
1		-	ELECTIVE III	3		Distribution (6)	-
2		MTM 605	Sea Level Changes and Coastal Zones	3	-	Major (17)	Existing
3		SDW 499	Project/ Thesis	6		Major (18)	Existing
Total				**12**			
		Practical Learning Lab (4 contact hours per week)					

Program Summary:

Total Courses	**Total Credit Hours**
44	135

ELECTIVES

Sr. #	*Pre-Req*	*Course Code*	*Course Title*	*Credit Hours*		*Category as per HEC Policy*	*Remarks (Existing or new course, CHs added, etc.)*
				Theory	*Lab*		
1		MTM 603	Natural Hazards and Management	3	-	Major	Existing
2		MTM 604	Coastal and Marine Sedimentology	3	-	Major	Existing
3		CMS 608	Coastal Resilience and Disaster Risk Reduction	3	-	Major	New
4		CMS 408	Introduction to Aquaculture	3		Major	New
5		MTM 607	Coastal Land Reclamation	3	-	Major	Existing

6		MTM 608	Mangrove Coastal Forest Management	3	-	Major	Existing
7		CMS 613	Marine Protected Areas Management	3	-	Major	New
8		MTM 610	Ocean Waves, Tides, and Currents	3	-	Major	Existing
9		CMS 507	Coastal Processes	3	-	Major	New

COURSES DESCRIPTIONS: *BS (COASTAL AND MARINE SCIENCES)*

FUNCTIONAL ENGLISH (ENG 105)

Course Description

The purpose of this course is to develop the English-language proficiency of students and to help them become confident in reading, writing, speaking, and listening to the English language. Instead of teaching grammar in isolation and only at the sentence level, this course is based on developing the language abilities of students through an integrated approach that provides opportunities to develop their listening, speaking, reading, and writing skills.

Course Content

- Grammar
- Construction of Sentence
- Reading skills
- Writing skills

Reading Material

- T. K. Carver and S. Fortinos-Riggs, Conversation Book II – English in Everyday Life (New York: Pearson Education Limited, 2006).
- J. Eastwood, Oxford Practice Grammar (Karachi: Oxford University Press, 2005).
- J. Swan, Practical English Usage, 3rd ed. (New York: Oxford University Press, 2005).
- J. Thomson and A. V. Martinet, A Practical English Grammar (Intermediate)
  - (New York: Oxford University Press, 1986)

FUNDAMENTALS OF BIOLOGY (ENV 100)

Course Description

The course provides a wide range of coverage to principles of life. Particular emphasis is on the chemical basis of life and polymerization in carbohydrates, lipids, proteins and nucleic acids. The course will impart knowledge about enzymes and the phenomenon of hereditary transformation in living organisms.

Course Content

Origin of life: Definition and concept of life, the chemical basis of life, chemical evolution, the origin of metabolism, protobionts, prokaryotic and eukaryotic cells; Functional diversity: Structure and the basis of function, chemical diversity, functional groups; Molecules of life: Polymerization, carbohydrates, lipids, proteins, phospholipids in membrane systems, polypeptides in protein diversity, enzymes as molecular tools in chemical transformations. Nucleic acids, the molecule of genetic information and replication; Cell biology: Overview of structure and function of cell organelles. Cell division. Genetics, Evolution and ecology.

Lab. Work:

Identification of the chemical nature of different animal and plant materials. Phytography and zoography. Cytochemical demonstration of DNA and RNA in Avian blood and Protozoa. Biochemical tests for carbohydrates and proteins, lipids. Plasmolysis and de-plasmolysis in blood cells. Protein digestion benzyl me pepsin. Gram staining of bacteria and study of fungus. Study of mitosis in the onion root tip.

Reading Material

- Campbell, N.A., 2008. *Biology.* 8th Ed., The Benjamin/ Cummings Publishing Company Inc. New York. The USA.
- Fowler et al., 2016. Concept of Biology (http://rms.rsccd.edu/faculty/ kimomorris/bio109/online/openstax/concepts_of_biology-oer-nonmajors.pdf)
- Lewis, B., Cassimeris,L.,Lingappa,V.R.andPlopper,G.,2007.*Cells.*
- Jones and Bartlett Publishers, Canada.
- Shier, D., Butler, J. and Lewis, R., 2007. *Holes Human Anatomy and Physiology.* McGraw- Hill International Edition. The USA.
- Starr, C., 2003. *Biology:human emphasis.*5thEd.,WadsworthGroup, USA.

CHEMISTRY (CHM 105)
Course Description

The main objective of this course is to provide basic knowledge and understanding of chemistry and the principles of chemical reactions. The course not only provides excellent practice in basic chemistry but also allows the rigorous development of experimental schemes and analysis methods, relying on physical chemistry and analytical reasoning.

Course Content:

Chemical Bonding, Periodic tables. Ionic, covalent, coordinate covalent bond. Radioactivity and its environmental hazards. General chemistry of functional groups of organic compounds (alcohols, carbonyls, esters, carboxylic acids, amines). Aromatic compounds, ions, radicals. Photochemical reactions. Chemistry solution. Surface chemistry. Colloids chemistry. Thermodynamics and chemical kinetics.

Lab. Work:

Preparation of molar, molal, normal solutions/buffers. Osmosis and Dialysis. Paper Chromatography (one and two dimensional), thin layer chromatography, Column chromatography. Measurement of pH, EC and TDS. Use of titrimetric and gravimetric analysis. Use of spectrophotometric techniques.

Reading Material

- Andrews, J.E., Brimblecombe, P., Jickells, T.D., Liss, P.S. and Reid, B.J., 2004. *An Introduction to Environmental Chemistry*. 2nd Edition. Blackwell Science, UK.
- Freeman, W.H., 2003. Qualitative Chemical Analysis, Harris, D.C., 6th Edition. and Company, USA.
- Girard, J.E.,2005. Principles of Environmental Chemistry, 1st Ed. Jones and Barlett, USA.
- Hill, M. K., 2004. Understanding Environmental Pollution, 2nd Edition. Cambridge University Press, UK.
- Skoog, D.A., West, D.M. and Holler, F.J., 2004. *Fundamentals of Analytical Chemistry.* 8th Edition. Thomson and Brooks, Canada.

THEMATICS (MAT 105)
Course Description

It will cover Number System: Real Numbers; Properties of Real Numbers; Complex Numbers and related laws of addition, multiplication and division; Functions Domain & Range; Inverse of a Function; Quadratic equations and their solutions; Matrices and Determinants; Partial Fractions; Sequences and Series; Permutations and Combination; Mathematical Induction and Binomial Theorem; Basics of Vector Analysis; Basic Coordinate Geometry; Limits and Continuity of Functions; Differentiation and Integration of Functions.

Course Content

- Natural numbers, complex numbers, p-adics
- Real division Algebras
- Infinitesimals, games and Sets

Reading Material

- Hermes, Hiebruch, Koecher, Mainzer, Neukirc, Prestell & Remmert, Numbers, English Ed, Springer-Verlag New York, 1991.
- Fulton/Harns, Representation Theory: A First Course, 1st Ed, Springer-Verlag New York, 2004.
- Remmert, Theory of Complex Functions, 2nd Ed, Springer-Verlag New York, 1990.

INTRODUCTION TO MARINE SCIENCE (CMS 301)
Course Description

To understand the basics of Marine Science, its biological, geological, chemical and physical characteristics and interrelationship.

Course Content

History of Marine Science, the basic structure of the earth, plate tectonics and ocean basins, Basics of Ocean Chemistry, Basics of Ocean Physics, Climate System, Waves, Tides and Ocean currents, Life in the Oceans, Marine Ecology, Plankton, benthos, Nekton, Food chains and food webs. Oceanic Resources, Marine Pollution, Maritime Activities.

Reading Material

- Anonymous, Compendium on UN Law of the Sea.
- Anonymous, Guidelines for Offshore Marine Operations.
- Gross, G., Oceanography: A view of the Earth.
- Pinet, P.R., 1992. Oceanography, An Introduction to the Planet Oceanus.
- P. S. Meadows, J. I. Campbell, 2012. An Introduction to Marine Science.
- Tom, S., Oceanography: An Invitation to Marine Science, 9th Edition, Garrison Orange Coast College, ISBN-10: 1305105168| ISBN-13: 9781305105164, 640pp.
- Weyl, P.K., Oceanography, An introduction to the Marine Environment.
- John Morrissey, Introduction to the Biology of Marine Life .2012 ,James Sumich

INTRODUCTION TO COASTAL ZONE MANAGEMENT (MTM 222)

Course Description

This course will examine major trends and issues that are impacting the world's coastal and ocean resources. Scientific, economic, social and political aspects of each issue will be discussed and case studies will be used to illustrate the challenge of linking good scientific data with regulatory and management decisions. Topics include offshore renewable energy facilities, marine aquaculture, coastal development, climate change and coastal hazards, coastal pollution impacts. This course will give students an understanding of water resources management and protection.

Course Content

Characterization of the coasts and oceans, State of the world's Oceans: Trends and Issue, Marine Protected Areas (MPA), Coastal pollution: role of science and technology, Coastal hazards and urban ports, Global fisheries and aquaculture, Coastal Zone Management Issues: Land-Sea Linkages, Offshore Energy: fossil fuels or renewable sources, international Coastal Zone Management / Coastal Megacities, Coastal Tourism: benefits and impacts, Marine Mammals: Conservation and Protection, Climate Change Impacts on Coasts and Oceans,

Reading Material

- Crossland Ch., Coastal Fluxes in the Anthropocene, ISBN-10 3-540-25450-1 Springer Berlin Heidelberg New York, 2005 (e-book)
- Nick Harvey, Global Change and Integrated Coastal Management, ISBN-10 14020-3628-0 (e-book)
- UNESCO (2006): A handbook of measuring the progress and outcomes of Integrated Coastal and Ocean Management.
- Gordon, Jr.D.C., Boudreau, P.R., Mann, K.H., Ong, J.-E., Silvert, W.L., Smith, S.V., Wattayakorn, G., Wulff, F., Yanagi, T., 1996. LOICZ Biogeochemical Modelling Guidelines. LOICZ Reports & Studies, No.5, LOICZ, Texel, The Netherlands.
- Christopher J. Crossland · Hartwig H. Kremer · Han J. Lindeboom Janet I. Marshall Crossland · Martin D.A. Le Tissier (2005): Coastal Fluxes in the Anthropocene, ISBN-10 3-540-25450-1 Springer Berlin, Heidelberg New York.

ISLAMIC STUDIES/ETHICS (ISI 101)

Course Description

Islamic ethics is the study of the methods practised by Muslims to discover the best way they should engage with other individuals and the rest of the world. Islamic reasoning is a holistic approach to behaviour, reuniting the principles and tools of Islamic laws with the exemplary conduct of the prophet Muhammad (S.A.W.), in a manner that is appropriate to an actual ethical case. The students will examine principled reasoning in classical Islamic jurisprudence, the theological status of reason in Islam, the principles and priorities of traditional ethical reasoning, the arguments for a goal-oriented approach to ethics, the contemporary emphasis on the context of the ethicist and the construction of religious authority, and the importance of individual moral formation. This course will enhance the skill of the students for understanding issues related to faith and religious life.

Course Content

Introduction to Quranic Studies, Study of Selected Text of Holly Quran, Seerat of Holy Prophet (S.A.W), Introduction To Sunnah, Introduction To Islamic Law & Jurisprudence, Islamic Culture & Civilization, Islam & Science, Islamic Economic System, Political System of Islam, Islamic History, Social System of Islam.

Reading Material

- Hameedullah Muhammad, "Emergence of Islam", IRI, Islamabad
- Hameedullah Muhammad, "Muslim Conduct of State"
- Hameedullah Muhammad, 'Introduction to Islam
- Mulana Muhammad YousafIslahi," Hussain Hamid Hassan, "An Introduction to the Study of Islamic Law" leaf Publication Islamabad, Pakistan.
- Ahmad Hasan, "Principles of Islamic Jurisprudence" Islamic Research Institute, International Islamic University, Islamabad (1993)
- Mir Waliullah, "Muslim Jurisprudence and the Quranic Law of Crimes" Islamic Book Service (1982)
- H.S. Bhatia, "Studies in Islamic Law, Religion and Society" Deep & Deep Publications New Delhi (1989)
- Dr Muhammad Zia-ul-Haq, "Introduction to Al-Sharia Al Islamia" Allama Iqbal Open University, Islamabad (2001)

PHYSICAL & GENERAL GEOLOGY (GEO 105)
Course Description

This course is designed to acquire knowledge about the basic concepts of Geology. This will help the students to get knowledge about various types of rocks and minerals and the processes of their formation.

Course Content

Fundamental processes of dynamic earth, exploring their nature and quantitative interactions; Fundamentals composition and structure of the planet earth; geologic events using numerical age dating techniques; formation of mountain ranges, rocks and basins; Earth resources such as Surface and groundwater; minerals; energy resources hydrocarbons & geothermal; Geological Eras, Weathering and erosion; Sedimentation; Glaciations, Fossils, volcanism & Environments; theory of plate tectonics; Laboratory exercises in the identification of common minerals and rocks; and interpretation of topographic maps; Field trips to nearby geological localities.

Lab. Work:

Study of relief features with the help of models and topographic maps. Identification of rocks and minerals.

Reading Material

- Bennison, G.M., 1997. An Introduction of Geological Structures and maps. Edward Arnold.
- Holmes, A., 1978. *Principles of Physical Geology.* Nelson.
- Jones, Norris. W., Johnes, Charles E., 2005. Lab. Manual for Physical Geology, McGraw-Hill.
- McClay, K.R., 1987. The Mapping of Geological Structures. Open University Press.
- Park, R.G., 1983. Foundation of Structural Geology. Blackie.
- Platt, J.I., 1961. Elementary Exercises upon Geological Maps. Thomas Murby & Co.
- Plummer, McGeary & Carlson, 2005, Physical Geology.
- Smith, G. and Pun, A., 2006. How Does Earth Work: Physical Geology and Process of Science, Prentice-Hall.

PHYSICS (PHY 101)
Course Description

This course is designed to enable students to acquire a basic understanding of the physical world, its origin and structure to help the potential application of the unexplored and unidentified organisms in the industry.

Course Content
Newton's gravitation law; Kepler laws; Electro statistics; Magnetism; Amperes1aw; Magnetic flux density B; Reflection and refraction Interference and diffraction; Natural and artificial radioactivity; Heat and Conductivity; Pressure and Density; Thermodynamic Principles; Electricity and Magnetism; Semi-Conductor; Transistors; Satellite Communication; Introduction to Meteorology.

Lab. Work:

Specific experiments.

Reading Material
- Boas, M.L., Mathematical Methods in Physical Sciences. John Willey& Sons.
- Subrahmanyam N. and BrijLal, Waves and Oscillations. Vikas Publishing House Pvt. Ltd., NewDelhi.
- Tewari, K.K., Electricity and Magnetism, S. Chand & Co., Ltd.

STATISTICS (MAT 205)
Course Description
The course is designed to provide students of business and economics with the basic concepts of data analysis and statistical computing. Topics covered include basic descriptive measures, measures of association, probability theory, confidence intervals, and hypothesis testing, sampling distributions, normal theory estimation, regression and correlation, exploratory data analysis. This course provides students with pragmatic tools for assessing statistical claims and conducting their statistical analyses.

Course Content
Histograms, The average, The standard deviation, The normal curve, Correlation. Statistical reasoning, The theory of probability. Chance Models, Expected value, Standard error, Probability histograms, Convergence to the normal curve. Statistical inference, Estimation, Measurement Error, Tests of statistical significance.

Reading Material
- Freedman, David, Robert Pisani, & Roger Pervis (2007). Statistics. New York:
- W. W. Norton.
- James, Gareth, Daniela Witten, Trevor Hastie, & Robert Tibshirani (2013). An Introduction to Statistical Learning: With Applications in R. New York: Springer. •Kabacoff, Robert (2015). R In Action: Data Analysis and Graphics with R.
- Shelter Island, NY: Manning Publications Co.
- David M. Dietz, Christopher D. Barr, and Mine Cetinkaya-Rundel (2015). OpenIntro Statistics, American Institute for Mathematics.

MARINE ECOLOGY AND ECOSYSTEMS (CMS 303)
Pre-Requisite: CMS 301
Course Description
To understand the basic functional definition of ecology and ecosystem.

Course Content
Abiotic and biotic components of an ecosystem, Habitat and zonation. Primary Production, factor affecting primary productivity. The consumer in the marine environment: Dynamics of populations, competition, Feeding and response, Food selection, Processing of conserved energy. Structure and dynamics: Marine communities, Trophic structure, Taxonomic structure, social structure, colonization and succession. The function of the marine ecosystem: Nutrient cycling, Seasonal changes, Long-term and large scale changes.

Lab. Work:
Field trips and reports, case studies of coastal ecosystems.

Reading Material

- Barnes, R.S.K., Stephen, R., Barnes, K. and Hughes, R.N., 1999. An Introduction to Marine Ecology. Wiley-Blackwell.
- Connell, S.D. and Gillanders, B.M., 2007. Marine ecology. Oxford University Press.
- Raffaelli, D.G. and Hawkins, S.J., 1999. Intertidal Ecology. Springer Verlag.
- Speight, M.R. and Henderson, P.A., 2010. Marine Ecology: Concepts and Applications, Willey and Blackwell.
- Stephen, R., Barnes, K. and Mann, K.H., 1991. Fundamentals of Aquatic Ecology. Willey and Blackwell.
- Tait, R.V., Butterworth, F.D. and Heinemann, 1998. Elements of Marine Ecology.
- Valiela, I., 1995. Marine Ecological Processes. Springer.

BASIC PRINCIPLES AND SCOPE OF ICZM (CMS 304)
Pre-Requisite: MTM 222
Course Description
To define ICM and the common terminology involved in discussing ICM principles and approaches; To explain the scope and functions of ICM and the typical actions relating to each function. To understand the principles of good governance, sustainable development.

Course Content
Introduction to the need for ICM and the link between social-ecological systems and single sector development approaches. Terms and definitions: ICM and ICZM as defined by different organizations and experts, key terms in ICM including integrates, sustainable development, process versus project. Overview of the eleven principles that reflect the character and uniqueness of oceans and coasts under the three headings used by Cicin-Sains and Knecht (1998), plus additional information regarding more recent developments in ICM. Internationally accepted definitions for coastal zone and coastal waters: Internal waters, Territorial waters, Exclusive Economic Zone (EEZ), Continental shelf.

Lab. Work:

Identify and describe the objectives and functions of at least three important regional intergovernmental or non-governmental organisations/programs, or other regional cooperation initiatives, involved with

coastal and marine area and/ or resources management. Group based discussion guided by a set of questions uncovering "Why is ICM needed?"

Reading Material

- Cicin-Sain, B. and Knecht, R.W., 1998. Integrated Coastal and Ocean Management: Concepts and Practices. Island Press, USA. 517pp.
- Clark, J.R., 1992. Integrated Management of Coastal Zones. FAO Fisheries Technical Paper No. 327. Food and Agricultural Organization of the United Nations, Rome, Italy. 167pp.
- Haines-Young, R. and Potschin, M. 2011. Integrated Coastal Zone Management and the Ecosystem Approach. CEM Working Paper No 7, University of Nottingham, England. 17pp.
- Moore, P., Zhang, X. and Triraganon, R., 2011. Natural Resource Governance Trainers' Manual. IUCN, RECOFT, SNV, Bangkok, Thailand.

ORAL COMMUNICATION (ENG 132)
Pre-Requisite: ENG 105
Course Description
This course provides instruction and experience in the preparation and delivery of speeches within a public setting and group discussion. Emphasis is on research, preparation, delivery, and evaluation of informative, persuasive, and special occasion public speaking. Upon completion, students should be able to prepare and deliver well-organized speeches and participate in a group discussion with appropriate audiovisual support. Students should also demonstrate the speaking, listening, and interpersonal skills necessary to be effective communicators in academic settings, in the workplace, and the community.

Course Content
Paragraph writing, Essay writing, CV and job application, Study Skills, Academic Skills, Presentation skills

Reading Material

- Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 2.
  - Third edition. Oxford University Press 1986. ISBN 0 19 431350 6.
- Writing. Intermediate by Marie-Chrisitine Boutin, Suzanne Brinand and Francoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 019 435405 7
- Writing. Upper-Intermediate by Rob Nolasco. Oxford Supplementary Skills. Fourth Impression 1992. ISBN 0 19 435406 5
- Reading. Advanced. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1991. ISBN 0 19 453403 0.

BIOSTATISTICS (BSS 307)
Pre-Requisite: MAT 205
Course Description

To familiarize students with the statistical parameters necessary for the scientific presentation and drawing inferences of biological problems**.**

Course Content
Descriptive Statistics. Organizing and displaying data. Measures of Central Tendency. Measures of

Dispersion and Variability. Curve Fitting. Probability. Simple and Multiple Regression. Simple and Multiple Correlation. Test of Hypothesis and Significance. Student"t", "F" and Chii- Square Distributions. Analysis of Variance.

Lab. Work:

Exercises may be given**.**

Reading Material

- Chaudhry, S. A. and Kamal, S. 1996. *Introduction to Statistical Theory*. Part- I and Part-II, Ilmi Kitab Khana, Urdu Bazar, Lahore.
- Daniel, W. W. 1983. *Bio-Statistics.* Foundation for Analysis in Health Science. 3rdEd.
- Harvey, M. 1995. *Intuitive Biostatistics.* Oxford University Press. NY.
- Kuzma, J.W. and Bohnenblust, S.E. 2001. *Basic Statistics for the Health Sciences.* McGraw-Hill International Education.
- Nilton, J. S. and Tsokos, J. D. 1983. *Statistical Methods in Biological and Health Sciences*. McGrew-Hill.
- Onton, P., Adams, S. and Voelkar, D.H. 2001.*Cliff notes for Statistics.* Blackwell Scientific publishers.
- Pacano, M. and Gauvreau, K. 2000. *Principles of Biostatistics.*
- Quinn, G.2002.*Experimental Design and Data Analysis for Biologists.* Cambridge University Press.
- Rosner, B. 2005. *Fundamentals of Biostatistics.* John Wiley &Sons.
- Samuels, M. 1991. *Statistics for the life sciences*. Dellen Pub Co SF, USA.
- Samuels, M. L. and Witmar, J. A. 2003. *Statistics for Life Sciences.* 3rd Edition. Cambridge University Press.
- Walpole, R. E. 1982. *Introduction to Statistics*. Macmillan Pub Co, NY.
- Zar, J. H. 1984 Biostatistical Analysis. 2nd Ed Prentice Hall USA.

INFORMATION TECHNOLOGY (IT 101)

Course Description

Introduction to Computers and Applications will introduce the students to basic computer hardware and processing concepts using Windows-based applications. The course will include basic computer literacy and Windows unit, a unit on the Internet using Internet browser, a word processing unit using Microsoft Word latest edition, a spreadsheet unit using Microsoft Excel latest edition, a database unit using Microsoft Access latest edition, and a presentation software unit using PowerPoint latest edition.

Course Content

- Computers, Devices, and the Web
- Programs and Apps
- Connecting and Communicating Online
- Digital Security, Ethics, and Privacy
- Management of Windows and Office (latest edition)

Reading Material

- Steinberg, G., Introduction to Computer Information System, 1st Ed. 2018.
- Kendal/Hunt. Fundamentals of Computing, 3 rd edition. ISBN: 978-0-8556-2 Customized e-book, available at book and from publisher's website – http://www.khwebcom.com/fundofcomputing.

INTRODUCTION TO SOCIOLOGY (HSS 202)

Course Description

The course offers an introduction to the basic nature of society and the relationship between society and the individual. This course focuses on how society functions and is organized, and how society impacts and influences individual motivation, understanding, action, and well-being. Basic sociological ideas regarding social relations, social interaction, social structure, and social change are examined. Students are introduced to key issues addressed by contemporary sociologists; class, race, gender, sexuality, religion, globalization, education, health care, crime, the media, and the environment. The knowledge gained in this course will aid students in future studies within a variety of fields and careers and encourage the development of critical thinking about important issues.

Course Content

Introduction to sociology and the sociological imagination, Methods to the madness & Culture and Media, Socialization and Reality & Groups and Networks, Social Control and Deviance, Stratification, Gender & Race, Poverty & Health and Society, Capitalism and the Economy, Authority and the State & Religion, Science, the Environment, and Society, Collective Action, Social Movements, and Social Change.

Reading Material

- Conley, Dalton. 20011. You May Ask Yourself: An Introduction to Thinking Like a Sociologist. 2 nd Edition. New York: W. W. Norton & Company. ISBN: 0393935175 or 978-0393935172

MARINE RESOURCES (CMS 401)

Pre-Requisite: CMS 301

Course Description

Broadening the scope of harvesting marine resources. Technological advancement in developing conventional and non-conventional marine products. Sustainable utilization and development of marine resources.

Course Content

Identification of living and non-living resources on the coast, seabed and offshore areas. Aggregates, sea salt. Gas hydrates, commercially important seabed minerals. Renewable energy from waves, tides, currents. Sustainable development of coastal and offshore resources. Living resources i.e. sponges, crustacean, molluscan, echinoderms, fish, turtles, mammals, seaweeds and Mangroves. Plankton fisheries and pearl fisheries, exploration of local potential commercial species concerning regional fisheries.

Lab. Work:

Identify coastal resources along the Pakistan Coast. Introduction of GIS techniques to develop and highlight coastal resources.

Reading Material

- Falque, M., De Alessi, M. and Lamotte, H. 2002. *Marine Resources: Property Rights, Economics and Environment.*
- Iversen, E.S., 1996. Living Marine Resources: Their Utilization and Management.

- Sherman, K., Okemwa, E. and Ntiba, M.J., 1998. *Large Marine Ecosystems of the Indian Ocean: Assessment, Sustainability and Management.*

MARINE BIOTECHNOLOGY (CMS 403)
Pre-Requisite: ENV 100

Course Description
To acquaint students with recent advancements in the field of marine biotechnology and how molecular techniques may be applied for studying marine organisms and to provide basic concepts and significance of biotechnology as it is being used in the industry.

Course Content
Definition and history; foundations of biotechnology and interdisciplinary pursuit; introduction to marine microorganisms commonly used in industry and marine biotechnology; branches and/ or applications of biotechnology in medicine, agriculture (algae, fungi, food, livestock and fisheries, *etc.*); primary and secondary metabolites (*e.g.*, antibiotics, organic acids, toxins, *etc.*); aquaculture techniques; marine microbes and phytoplankton/ flora of biotechnological importance; the role of marine microbes in global carbon cycling; recent progress in the discovery of drugs and enzymes from marine sources; the significance of microorganisms in food production, fermentation, pharmaceutical and other industries; protection of biotechnological products; media and nutritional requirements of industrial organisms; safety in biotechnology; public perception of biotechnology; biotechnology and ethics; biotechnology and the developing world.

Lab. Work:

Isolation and screening of potential microbes from different environmental sources; lab-scale production of bacterial enzymes; lab-scale production of alcohol by yeast; the use of microbes in bioleaching; use of microbes in microbial enhanced oil recovery.

Reading Material

- Daugherty, E., 2012. Biotechnology: Science for the New Millennium. 1stEdition, Revised; Paradigm Publication.
- Gal, Y.L., 2010. New Developments in Marine Biotechnology. Springer.
- Gal, Y.L., 2010. Marine Biotechnology I (Advances in Biochemical Engineering Biotechnology). Springer.
- Gal, Y.L., 2010. Marine Biotechnology II (Advances in Biochemical Engineering Biotechnology). Springer.
- Johansen, M.N., 2011. Microalgae: Biotechnology, Microbiology and Energy. Nova Science Pub Inc.
- Okafor, N., 2007. Modern Industrial Microbiology and Biotechnology. 1stEdition; Science Publishers, USA.
- Ratlegde, C. and Kristiansen, B., 2006. Basic Biotechnology. 2nd Edition; Cambridge University Press, UK.
- Smith, J.E.,2009. Biotechnology.5thEdition; Cambridge Univ. Press.
- Thomas, J.A. and Fuchs, R.L., 2002.Biotechnology and Safety Assessment. 3rd Edition; Academic Press, UK.

PAKISTAN STUDIES (101)

Course Description

The course provides a vision of historical perspective, government, politics, contemporary Pakistan, Factors leading to Muslim separatism, People and land, Muslim advent, Location and Geophysical features, the ideological background of Pakistan with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid e Azam Muhammad Ali Jinnah. Students will study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan. They will also Global issues of War and Peace, Economic and political integration, Poverty and the Status of human rights in Pakistan.

Course Content

Historical Perspective, Government and Politics in Pakistan, Contemporary Pakistan.

Reading Material

Burki, Shahid Javed. *State & Society in Pakistan,* The Macmillan Press Ltd 1980.
Akbar, S. Zaidi. *The issue in Pakistan's Economy.* Karachi: Oxford University Press, 2000.
Ziring, Lawrence. *Enigma of Political Development.* Kent England: WmDawson& sons Ltd, 1980.
Zahid, Ansar. *History & Culture of Sindh.* Karachi: Royal Book Company, 1980.
Afzal, M. Rafique. *Political Parties in Pakistan,* Vol. I, II & III. Islamabad:
National Institute of Historical and Cultural Research, 1998.
Sayeed, Khalid Bin. *The Political System of Pakistan.* Boston: Houghton Mifflin, 1967.
Haq, Noor ul. *Making of Pakistan: The Military Perspective.* Islamabad:
National Commission on Historical and Cultural Research, 1993.

FUNDAMENTALS OF ECONOMICS (ECO 101)

Course Description

The course will cover fundamental concepts of both macro-and microeconomics at the introductory level. Microeconomic aspects of the course include supply and demand; elasticity; market efficiency; the cost of production; and profit maximization in competitive and monopolistic markets. Macroeconomics aspects include national income accounting; unemployment; inflation; Long-run and short-run aggregate demand and supply curves; economic growth and international trade.

Course Content

- Elementary microeconomics.
- The economic problem.
- Supply and demand.
- Elasticity.
- Marginal analysis of consumers' and firms' behaviour.
- The theory of profit maximization.
- Analysis of markets.
- Pricing in competitive and non-competitive markets

Reading Material

- Mankiw, Principles of Economics, 7th Ed, 2008, Southwest Publishers.
- Pindyck and Rubinfeld, Microeconomics, 9th Ed, 2018, Pearson.
- Basu, K. Analytical Development Economics: The Less Developed Economy Revisited. 1st Ed, 2003, Cambridge, MIT Press.

MARINE MICROBIOLOGY (CMS 402)
Pre-Requisite: CMS 301

Course Description
Students will learn about the microbial world in seas and oceans, their role in the environment, importance in the marine food web.

Course Content
Introduction to marine microbiology: microbial environment, biological organization and evolution, the importance of microbes and their sizes, chemical & physical factors influencing microbial distribution and processes, marine microbial habitat; Methods in microbiology, cell structure and function, physiological processes; Eukaryotic microbes (nanoplanktonic flagellates, dinoflagellates, ciliates, diatom, coccolithophorids, radiolarians, foraminifera, fungi), Prokaryotic microbes (virus, bacteria and cyanobacteria, marine Archaea), Role of microbes in oceanic processes (primary productivity, carbon and nitrogen cycling), marine microbial loop, Eutrophication, Symbiotic Association, Harmful microbes (pathogens and toxin-producing) to human and marine organisms (fish and invertebrates), Marine microbes and human society.

Reading Material

- Marine microbiology: ecology and applications, Colin B. Munn – 2004.
- Marine microbiology John H. Paul – 2001.
- Marine microbiology Brian Austin – 1988.
- Marine microbiology Carol D. Litchfield – 1976.
- Alien ocean: anthropological voyages in microbial seas. Stefan
- Helmreich – 2009.
- Marine microbiology Abhijit, Mitra, Kakoli Banerjee – 2004.
- The living ocean: marine microbiology. E. J. Ferguson Wood – 1975.

INTRODUCTION TO METEOROLOGY & OCEANOGRAPHY (MTM 120)
Course Description
This course is a foundation earth science course on meteorology and oceanography. Its objective is to provide students with a basic knowledge of atmospheric and ocean processes. Earth's energy budget, atmosphere moisture and cloud development. Global wind systems, thunderstorms and tornadoes. Seawater properties, atmosphere-ocean interaction, ocean currents, tides and waves. On completion of the course, the students will be able to understand the dynamics of the ocean and the atmosphere.

Course Content
Introduction and the earth and its atmosphere, Energy, Energy balance. Temperature distribution, Atmospheric moisture, Condensation, Atmospheric stability, Cloud development, Atmosphere in Motion, Global wind systems, Thunderstorms and Tornadoes, Introduction to Oceanography, History of voyaging, Properties of seawater, The Atmosphere and the Oceans, Circulation pattern and ocean current, Tides and waves.

Reading Material

- Ahrens, C. D., Meteorology Today: an introduction to weather climate and the environment, 7th edition, Thomson Learning Inc, 2002.
- Garrison, T., Essentials of Oceanography, 3rd edition, Thomson Learning Inc, 2004
- Sverdrup, K.A., Duxbury, A.B. and Duxbury, A.C., Fundamentals of
- Oceanography, 5th edition, McGraw-Hill Companies Inc, 2006

INTRODUCTION TO CLIMATE CHANGE (ENV 236)

Course Description:

Global mean surface air temperatures over land and oceans have increased over the last 100 years. Temperature measurements in the oceans show a continuing increase in the heat content of the oceans. Analyses based on measurements of the Earth's radiative budget suggest a small positive energy imbalance that serves to increase the global heat content of the Earth system. Observations from satellites and in situ measurements show a trend of significant reductions in the mass balance of most land ice masses and Arctic sea ice. The oceans' uptake of CO2 is having a significant effect on the chemistry of seawater. Paleoclimatic reconstructions have helped place ongoing climate change in the perspective of natural climate variability. This introductory course presents the Earth's climate system and explores the science and related issues of global climate change.

Course Content

Principle of climate change, Earth's energy budget. Climate change trends, Earth's surface temperature, Earth's atmosphere, Carbon dioxide and other Greenhouse gases, Carbon cycle, Earth's albedo, Radiative forcing and climate change, Atmospheric circulation and climate, World ocean, Ocean heat content and rising sea level, Glaciers and latest ice age, Permafrost and methane, continents and mountain ranges, climate classifications, climates of recent past, Projections of future climates

Reading Material:

Eggleton, T. 2012: A Short Introduction to Climate Change. DOI: https://doi.org/10.1017/CBO9781139524353.

Letcher, T., 2015. Climate Change, 2nd Edition. eBook ISBN: 9780444635358. Paperback ISBN: 9780444635242. Elsevier. Pp 632.

Barry, Atmosphere, Weather and Climate.

Flannery, T., The Weather Makers: Our Changing Climate and What it Means for Life on Earth.

INTRODUCTION TO AQUACULTURE (CMS 408)

Course Description

To develop basic learning and practical knowledge in the field of aquaculture.

Course Content

Carrying capacity modules, Finfish, shellfish culture systems (hatchery to grow-out), Pond, cage, raft and line culture system, Seaweed and microalgae culture, Water quality, Feed and feeding efficiency, fish health issues in aquaculture.

Lab. Outline:

Water quality assessment and management Techniques of broodstock conditioning and spawning Formulation and preparation of balanced aqua feed Procurement and culture of live feeds Feeding trials on fish, shrimp and bivalves Estimation of feed conversion efficiency Estimation of specific growth rate from data obtained.

Reading Material

- Aquatic Engineering (Mike Walker).27
- Sustainable Aquaculture by J.E Bardach. 1997
- Intensive Fish Farming by Jonathan Shepherd and Niall Bromage 1992.
- Fish Hatchery Management by G Wedemeyer 2001.
- Cage Aquaculture by M. Beveridge. 2004
- FAO Manual on Hatchery Production of Seabass and Gilthead Seabream by Alessandro Moretti and Mario Pedini Fernandez-Criado 2005
- Responsible Marine Aquaculture. Edited by Stickney and JP McVey, 2002.
- Aquaculture: Principles and Practices. T.V.R. Pillay and M. N. Kutty, 2005.

GIS & REMOTE SENSING (GEO 437)

Course Description

This course is designed to introduce principles, concepts and applications of Geographic Information Systems (GIS) and Remote Sensing (RS): a decision support tool for planners and managers of spatial information and to obtain information on the earth from the decimeter level to km level locally and globally.

Course Contents:

Introduction to Geographical Information System, Data Types (spatial/non-spatial), Data Models and Structures (Raster / Vector), GIS Data Sources and Satellite Image Capturing Techniques Displaying and Manipulating spatial information, Vector Data Models such as rivers, coastal features, water bodies, etc. Preparation (Digitization and Spatial Data Editing), GPS Survey, Introduction to the concept of RS, Electromagnetic Spectrum, Atmospheric Interaction, Technology of Remote Sensing (Orbits, Satellites, Sensors and Platforms), Applications of Remote Sensing, Satellite Image Processing Cycle, Image Enhancement, Data Fusion and Mosaicking Information Extraction (Classification and Vectorization). Photogrammetry, Satellite Imageries, Image Processing, Interpretation, Preparation of thematic maps, Image Data analysis and output.

Lab. Outline

Introduction to ArcGIS, Exploring GIS Dataset in Arc Catalog, Working on vector data in ArcGIS (Scanning, Digitization and Editing), Integrating GPS data in GIS Environment, Applications of GIS, ERDAS Imagine - Environment, Noise Corrections, Geometric Corrections, Radiometric Corrections.26

Reading Material

- Matt Duckham, Michael F. Goodchild, Michael F. Worboys, (2003) Foundations of Geographic Information Science, Tylor & Francis, NewYork, USA.

- Michael N. Demers (2002) Fundamentals of Geographic Information System, John Wiley & Sons, Inc., Singapore.
- Basanta Shrestha & Birendra Bajracharya (2000), GIS for Beginners, By ICIMOD, Kathmandu, Nepal.
- Kang-tsung Chang (2002) Introduction to Geographic Information Systems, McGraw- Hill Company, New York, U.S.A.
- W. G. Rees (2001) Physical Principles of Remote Sensing Cambridge University Press, United Kingdom. ISBN: 0521669480.
- Robert A. Schowengerdt (January 15, 1997) Remote Sensing 2nd edition, Academic Press ISBN: 0126289816.
- Thomas M. Lillesand& Ralph W. Kiefer (the Year 2000) Remote Sensing and Image Interpretation John Wiley & Sons, Inc.
- James B. Campbell (1996) Introduction to Remote Sensing, The Guilford Press, New York, USA.

HYDROGRAPHIC DATA & SERVICES MANAGEMENT/HYDROGRAPHY & NAVIGATION (MTM 402)

Course Description

The purpose of the course is to give the students comprehension of hydrography along with fundamentals of hydrographic surveying methods and measurement principles with a practical demonstration to enable students to participate effectively in various hydrographic surveying tasks.

Course Content

Definition of Hydrography; Importance of hydrographic surveying; Contributions of hydrography to Maritime Activities including support for Port Management, coastal engineering and offshore construction; Economic benefits of hydrography; Principles of Hydrographic Surveying; Geodesy (Ellipsoid, Geoid, Projections, Datum transformation, vertical datums and reference planes); Surveying equipment and their calibrations; Positioning (Basic knowledge, GPS, DGPS, RTK, Underwater positioning); Bathymetry (General, Single-beam, Multi-beam); Data acquisition and Processing using Single and Multi-beam echo-sounding systems and other sensors such as Side Scan Sonar, Sub-bottom Profilers, Sound velocity meter and Land Surveyor's equipment with its accuracies; DGPS Accuracy, Error detection, Statistics; Tides (Theory, Observations, Predictions and uses of Tidal information); Quality assurance; Project Management; Hydrographic Data management; Nautical Charting; National/ Port Hydrographic organizations with roles & responsibilities and National Hydrographic Service obligations under the SOLAS Convention.

Lab.

OJT's on hydrographic equipment; Practical demonstrations and a visit to National/ Port Hydrographic setups.

Reading Material

- Anonymous, 2005. Manual on Hydrography. International Hydrographic Bureau, Monaco.
- Anonymous, 2010, Manual on Hydrography. International Hydrographic Organisation (IHO), Publication C-13.
- Anonymous, Geodesy: Introduction and Overview of Geodetic Datums available on the University of Colorado.
- Anonymous, Guidelines of Good Practice for Hydrographic Surveys in New Zealand Ports and Harbours.

- Anonymous, Hydrographic Survey Standards. IHO Special Publication.
- Caspers, H., 1964. Hela, Ilmo, and TaivoLaevastu: Fisheries Hydrography. How
- Oceanography and Meteorology can and do serve fisheries. With 67 figs. London: Fishing News (Books) Ltd., 137 pp.
- De Jong, C.D., Lachapelle, G., Skone, S. and Elema I.A., 2003. Hydrography. 2nd Ed., Delft University Press, NL., 353 pp.
- Ingham, A.E. and Abbott, V.J., 1993. Hydrography for the Surveyor and Engineer. 3rd Ed., Wiley-Blackwell, 144 pp.
- Lekkerkerk, H-J, 2011, Handbook of Offshore Surveying-Three Volumes Set, Skilltrade, The Netherlands.

MARINE BIODIVERSITY (CMS 505)

Course Description

To understand the structure and function of marine biodiversity components from genes to habitats and develop skills to carry out impact assessment and conservation.

Course Content

The structure and functioning of Marine Biodiversity (from genes to habitats) and with Impact studies and its relationship with the basic oceanographic processes. Toolbox for investigating marine biodiversity for attempting data analysis: experimental design, modelling, taxonomy, Evolution, Invasive species, data and Information Management, Field observations and interpretation and Molecular methods; Molecular bar-coding of biodiversity, Conservation, Laws for conservation, Marine protected areas. Conservation and Restoration of marine 25 biodiversities and application of the above-mentioned theories and methods to develop sustainable use of the marine environment.

Lab. Outline:

Laboratory work on major biological taxa, field trips on biodiversity in situ, computer labs for informatics tools. Design and present a specific marine conservation project report writing and discussions covering marine conservation issues, including informal student presentations on political, economic, historical, educational, and natural science issues related to conservation and analysis of marine biodiversity.

Reading Material

- Marine Biodiversity: Patterns and Processes, Rupert F. G. Ormond, John D. Gage, Martin V. Angel - 2005 - 472 pages
- The Living Oceans, B. Thorne Miller, Island Press, USA
- Marine Conservation Biology: a science of maintaining the Sea's Biodiversity, E. Norse and L. Crowder. 1999. Island Press, USA
- Marine biodiversity: patterns and processes, assessment, threats, management and conservation. Henrique Queiroga. 2006 Springer.

COASTAL PROCESSES (CMS 507)

Course Description

Study the effects of seawater movement on the coastal sediments, the role of beach sediments in the protection of coasts, anthropogenic activities that alter the beach profile.

Course Content

Waves, tides, coastal currents. Distribution of sediment on the beach. Beach drift, Factors responsible for coastal erosion, coastal accretion, classification of sediments, sediment budget, coastal sediment transport, shoreline protection. Protection of chronically eroding beaches, types of hard stabilization for protection of coastal areas, Natural beach nourishment. Anthropogenic activities, beach management. Set back limits. Shifting of beach dunes. Sediments pathways in the Deep sea sedimentation, Minerals in the sediments. Formation of deltas. Barrier island formation, Options for Management of Coastal areas.

Lab. Outline:

Microscopic examination of beach sediments, identification of Biogenic oozes. Placer minerals, Sediment grain size analysis using a standard sieve shaker. Monitoring beach changes. Measuring beach slope. Case study of erosional beaches, creeks, islands etc.

Reading Material

- Brebbia, C.A., Benassai, G. and Rodriguez, G.R., Coastal Processes: Volume 126.
- Coastal Processes: Concepts in Coastal Engineering and their Application to multifarious environment by TomoyaShibayama.
- Kjerfve, B., Coastal LagoonProcesses.
- Kosian, R.D., Pykhov, N.V. and Edge, B.L., Coastal Processes in Tideless Seas.
- McAnally, W.H. and Mehta, A.J., Coastal and Estuarine Fine Sediment Processes.

OCCUPATIONAL SAFETY, HEALTH& ENVIRONMENT (ENV 425)

OBJECTIVES:

The course will provide information on occupational health and safety as well as it will review various types of workplace hazards, their exposure and effects on the body. The focus will be on hazardous chemicals, carcinogens, effects of chemicals acute and chronic health problems related to work and safe use of chemicals at work. Awareness will also be created about the health and safety laws and enforcement, the role of health and safety committees at work etc.

COURSE OUTLINE:

Introduction to occupational health and safety: Accidents, Disease, Normal working, Health and safety problems worldwide, Importance of management and training in occupational health and safety, with emphasis on maritime safety and practices. Common workplace associated hazards; biological, chemical, mechanical, physical and psychological hazards and their effects on health and safety, local effects, systemic effects, acute and chronic effects. Chemicals in the workplace, Noise at work, Manual handling, Controlling hazards: Methods of control, Elimination, Substitution, Engineering Controls, Administrative controls, Personal protective equipment (PPE), Cumulative trauma disorder (CTD), Evaluation of job risk factors, Controlling vibration hazards. Labour code of Pakistan. Occupational health safety management system. Legislation related to health and safety at work, Checklist, Role of the health and safety representatives and labour union at work; meetings, reports, training education, negotiation, Role of government, Health and safety committee.

RECOMMENDED BOOKS:

1. Occupational Health Hazards and Remedies. (2002). Mohapatra, R. Jaypee Brothers Medical Publishers Pvt. Ltd. India.
2. Biosafety Management: Principles and Applications. (2000). Aynor, P. L. Virginia Polytechnic Institute Publications. The USA.
3. Hazardous Chemicals Handbook. (2002). 2nded. Carson, P. and Mumford, C. Butterworth Heinemann. Oxford, UK.
4. Basic Environmental Health. (2001). 1sted. Yassi, A., Kjellstrom, T., deKok, T. and Guidotti, T. L. Oxford University Press. NY, USA.
5. Risk assessment of chemicals: An Introduction. 2007. Leeuwen, C.J.V. Springer, USA.

MARINE GEOLOGY (GEO 320)

Course Description

To give a detailed overview of the structure, evolution and geological processes of the ocean basin and continental margin. This course will enable the students to fully understand the marine environment, what dynamic processes shape the surface of the earth under the ocean surface, sedimentation processes, and sediment distribution on the seafloor.

Pre-Requisite: GEO 105

Course Contents:

Coastal environment & Biodiversity, Coastal features, Development of marine geology, contribution of deep-sea drilling project and ocean drilling program. Hypsometry, topographic features of the ocean. Plate tectonics and seafloor spreading, major ocean basins, gulfs and seas. Geology of continental margins, estuaries, deltas, barrier islands and coral reefs. Sediment types and distributions, shelf sedimentation, oxygen and strontium—Isotope, deep-sea sedimentation. Methods and instrumentation in marine geology. Worldwide sea-level changes through time.

Lab:

According to the marine and coastal environment and its resources using modern technologies.

Reading Material:

1. Grotzinger, J., Jordan, T. H., & Press, F. (2010). Understanding earth. Macmillan.
2. Erickson, J., & Kusky, T. M. (2009). Marine geology: exploring the new frontiers of the ocean. Infobase Publishing.
3. Keen, Michael John. An introduction to marine geology. Elsevier, 2017.

COASTAL ECOSYSTEM AND CLIMATE CHANGE (CMS 502)

Course Description

To explore how the predicted changes in climate during the present century may affect coastal ecosystems and to examine the likely impacts of climate change on mangroves and corals. To understand the basic concepts of climate change and resilience. To identify various ecosystems based tools for climate change adaptation.

Course Content

Terms and definitions: IPCC and UNFCCC, Climate Change, Weather and Climate. Overview on a component of climate change covering principal components of global climate change that most affect coastal ecosystems: Carbon Dioxide, Acidification of the Oceans, Temperature, Sea Level Rise, Extreme Weather Events and Changes in Precipitation. Introduction to Disaster Risk Reduction for coastal communities. Why do disasters matter to sustainable development? Disaster trends. Explain the definitions of disaster, disaster risk, and disaster risk reduction making the linkages to climate change. Case study analysis to understand disaster risk. Explore why ecosystems matter to reducing disasters, including a comparison of Eco-DRR and Ecosystems Based Approach.

Lab. Work:

Comparative analysis of ecosystem-based adaptation and engineering options. Other case studies also available for lab exploration.

Reading Material

- IPCC., 2012. IPCC Special Report on Extreme Events, Summary for Policymakers.29.Geneva: Intergovernmental Panel on Climate Change First Joint Session of Working Groups I and II.
- McLeod, E. and Salm, R.V., 2006. Managing Mangroves for Resilience to Climate Change. IUCN, Gland, Switzerland. 64pp.
- Renaud, K. F., Sudmeier-Rieux and Estrella, M., 2015. The Role of Ecosystems in Disaster Risk Reduction, eds. Bonn: United Nations University. UN/ ISDR. Global Assessment Report. Geneva: UN/ISDR.
- Souter, D.W. and Linden, O., 2000. The health and future of coral reef systems. Ocean and Coastal Management 43:657-688.

OCEANOGRAPHIC INSTRUMENTS AND METHODS (CMS 406)

Course Description

To understand the principles and function of the instruments used in oceanography.

Course Content

Introduction to the principles of the instruments, Brief account of the following: time and position measurements (clocks, time signals, ground- and satellite-based navigation, attitude sensors), data logging (analogue and digital recorders, telemetry, memory and recording, water properties measurements (temperature, conductivity, oxygen, optical properties, tracers and dyes), seabed sampling (grabs, corers, ROVs, underwater cameras), current measurements (mechanical, acoustic, electromagnetic, optical, radar, drifters), pressure and sea-level measurements, mechanical technology (cables, winches, buoys, anchors).

Lab Outline:

Short field deployment of available instrument, and analyzing the resulting data.

Reading Material

- Handbook of the ocean and underwater engineering, McGraw-Hill Book Co., New York (1969).
- Baker, D.J., 'Ocean instruments and experiment design,'' in Evolution of physical oceanography, ed.

- B.A. Warren and C. Wunsch, pp. 396-433, The MIT Press, Boston (1981).
- Berteaux, H.O., Buoy engineering, pp. 1-319, John Wiley & Sons, New York (1975).
- Bowditch, N., American practical navigator, U.S. Defence Mapping Agency (1984).
- Dobson, F., L. Hasse, and R. Davis, Air-sea interactions: instruments and methods, pp. 1-801, PlenumPress, New York (1980).
- Ulrick, R.J., Principles of underwater sounds, pp. 1-384, McGraw-Hill Book Co., New York (1975).
- Laboratory Exercises in Oceanography 2nd Edition by Popkin, B.W, Gorsline, D.S and Hammond, D.E., 1987, W.H. Freeman and Company. New York.

PHYSICAL OCEANOGRAPHY & SURVEYING (GEO 462)
Pre-requisite: CMS 406

Course Description

This course is designed to introduce students to the important physical processes in the oceans in such a way that they will understand both the conceptual physical principles and at a larger scale how these fit into the earth as a system.

Course Content:

Representation of annual wave period percentage frequency of the given region in the form of bar-diagram/histogram and its study. Representation of wave direction data in the form of a rose diagram and their study. Interpretation of wave climate for the given data. T-S diagrams.CSS diagram and study of waves. Wave forecasting and Wave refraction study. Observation and study of different wave breaker types. Study of waves during rough and fair weather seasons. Preparation and study of tidal curves (mean tidal range, spring and neap tidal range - for different months). Calculation of velocity of sound using Nomograph. Study of major surface current patterns of the Indian Ocean. Study of major surface current patterns of the Atlantic Ocean. Study of major surface current patterns of the Pacific Ocean. Deep ocean circulation in the Atlantic Ocean. Littoral drift study in the field & lab using dye & tracer techniques.
Laboratory work: According to Geography & Location.

Reading Material

- Anonymous, Compendium on UN Law of the sea.
- Gross, G., Oceanography: A view of the earth.
- Pickard, G.L. and Emery, W.J., Descriptive PhysicalOceanography.
- Pinet, P.R., 1992. Oceanography: An Introduction to the Planet Oceanus.
- Sverdrup, Johnson and Fleming, The Ocean.
- Weyl, P.K., Oceanography, An introduction to the Marine Environment.

MARINE BIOLOGY (CMS 508)
Pre-Requisite: CMS 301

Course Description
To introduce basic concepts of oceanography, biodiversity, ecology and evolution as they pertain to marine coastal environments. To learn through theoretical and practical exercises how environmental and

biological factors interact to sustain near-shore ecosystems. To acquire field skills to study marine near-shore environments. To improve discussion, analytical, presentation and writing skills.

Course Content
Biodiversity of different shore types such as rocky, sandy, muddy, rocky- sandy, rocky-muddy and sandy-muddy shores *etc*. Seaweeds and Mangroves. Interaction of biological factors to sustain near-shore ecosystems. Coral reef systems, physiological and behavioural adaptations that enable organisms to live in a particular environment. Basic ecological principles, marine conservation, metapopulations- dynamics, adaptation to climate change, and conservation genetics.

Lab. Work:
Field trips of different shore types.

Reading Material
- Bertness, Gaines and Hay, Marine Community Ecology. Sinauer Associates, Inc. ISBN 0-87893-057-4.
- Human, The Reef Set: Reef Fish, Reef Creature and Reef Coral (3 Volumes). New World Publications, Inc. ISBN 1-878348-32-9.
- Kaplan, Coral Reefs. Peterson Field Guide. Houghton Mifflin Company. ISBN 0-618-00211-1.
- Kaplan, Southeastern and Caribbean Seashores. Peterson Field Guide. Houghton Mifflin Company. ISBN-13 978-0-395-97516-9.
- Morrissey and Sumich, Biology of Marine Life. 9th edition. Jones and Bartlett Publishers.
- Trujillo and Thurman, Essentials of Oceanography, 10 eds. Prentice-Hall. ISBN-13: 9780321668127.
- Wisehart, A Photographic Atlas of Marine Biology. Morton Publishing Company. ISBN: 9780895827852.

MARINE GEOCHEMISTRY (GEO 311)
Pre-Requisite: CHM 105

Course Description
The course has been designed to provide background for and exposure to current research in marine geochemistry to understand the role of physical, chemical, biological processes in controlling chemical distribution in the marine environment.

Course Content
The geochemical cycle and the composition of ocean water; the transport of material to ocean, nutrients, organic carbon and carbon cycle in seawater; trace elements in the ocean, residence time and reactivity of elements; the 107

Composition of oceanic suspended matter; the geochemistry of marine sediments, sediment interstitial waters and digenesis; organic matter production, accumulation and preservation; marine carbonates; isotopes in marine geochemistry; chemical characteristics of hydrothermal vent

Fluids; geochemistry of ferromanganese deposits in the ocean; geochemical proxies and global environmental history; pollution in the sea; geochemical models.

Labs:

Exercises dealing with the determination of salinity, residence time and reactivity of major elements, calculation of chemical fluxes, pale productivity, interpretation of geochemical proxies; geochemical analysis of marine sediments.

Reading Material

- Ocean Biogeochemical Dynamics by Sarmiento, J. L. and N. Gruber, 2006, Princeton University Press
- Marine Geochemistry by Schulz, H. D., and Zabel, M. (eds), 2002, Springer.
- Coastal upwelling: Its sedimentary record, Part B: Sedimentary records of ancient coastal upwelling by Thiede, J and Suess, E (eds), 1983, Plenum Press. New York
- Modern and ancient continental shelf anoxia by Tyson, R.V and Pearson, T.H. (eds); 1991, Geol. Soc. Spec. Publ; 58, Blackwell, Oxford.
- Organic matter: Productivity, accumulation and preservation in recent and ancient sediments by Whelan, J.k and Farrington, J.W. (eds), 1992, Columbia University Press. New York.

RESEARCH & PROJECT WRITING METHODS (MRM 302)

Course Description

This course will provide students with a strong foundation in the conceptualization and operationalization of research, how to design a research project and 'hands-on' skills in the utilization of different research methods. Students will be exposed to a wide range of research methods and will learn the key principles of research design. Topics to be covered in detail include sampling, surveying, interviewing, case study analysis, focus groups, analyzing and presenting data. Intellectual and methodological debates will be discussed to assist students to develop informed opinions and a critical appreciation for other's research. The imperative for ethical research practice will be presented. Students will be equipped with the knowledge and ability to undertake methodologically sound, original research projects and will develop a set of transferable workplace skills.

Course Content

Meaning of research, Literature reviews and database searches, Writing workshop Online activity this week Formative Writing task, Research Ethics and Engaging Cultures Writing an ethics application, Theoretical Approaches, Qualitative Methods, Quantitative Methods, Research Analysis, Journal work, writing a research project, Verbal Presentations on research proposals.

Reading Material

- Booth W., Colomb G. and Williams J., The Craft of Research, Second edition. Chicago: Chicago UP, 2003.
- Ranjit Kumar, Research Methodology A Step-by-Step Guide for Beginners, 5th Ed., University of Western Australia, Australia, SAGE.
- Uwe Flick, Introducing Research Methodology: A Beginner's Guide to Doing a Research Project, 2nd Ed., SAGE.
- W Creswell, Research Design.: Qualitative, Quantitative, Mixed Methods Approaches, 2016.
- W. Creswell, Qualitative Inquiry and Research Design: Choosing Among Five Approaches, 3rd Ed., ISBN-13: 978-1412995306 ISBN-10: 9781412995306
- Judith Bell, Doing Your Research Project (Open Up Study Skills), 5th Ed., Paperback 2010, ASIN: B008GSHDE4

MARINE POLLUTION AND CONTROL (MTM 224)

Course Description

This course provides a convenient solution and delivers a current, comprehensive knowledge of the overall framework governing marine pollution, including applicable regulations, compliance requirements and related management strategies. It presents an integrated approach, analyzing the many sources of pollution, describing best practices for minimizing contamination, responding to accidents and exploring legal ramifications throughout the maritime and offshore sectors.

Course Content

Pollution in Context: Causes and Effects, Governance, Regulations and Enforcement, Air Pollution and Greenhouse Gas Emissions, Ballast Water and Other Marine Pollutants, Oil Pollution and Offshore Activities, Measurement and Management Systems, Legal Issues, Including Insurance and Compensation.

Reading Material

- Iliana Christodoulou-Varotsi, Marine Pollution Control: Legal and Managerial Frameworks, 2018, Taylor & Francis Ltd. ISBN10 1138856681
- Jerome Williams, 1979. Introduction to Marine Pollution Control (Ocean engineering), John Wiley & Sons Inc, ISBN-10: 0471019046.

NATURAL HAZARDS AND MANAGEMENT (MTM 603)

Course Description

Broadly, the course is designed to learn the collection and analysis of scientific data concerning natural hazards. To study the hazards, their history, trends and definitions. How and why placesare hazardous, including the human geographic processes that put people at risk. Understanding of human nature and responses to disasters, and how science can be appliedin the face of such disturbance.

Course Content

Energy Sources & Earth Interior, Bathymetry and Plate Tectonics, Plate Tectonics & Earthquakes, Tsunami, Volcanoes, Bathy Charts, Earthquakes/ Volcanoes, Introduction of Atmosphere, its dynamics, Ocean Conveyor Belt, Ocean Dynamics, Ocean Storms, Ocean Waves, Waves as Hazards, Tides & Standing Waves, Ocean Currents, Hurricanes, Hurricane Dynamics, Hurricane Damage, Global Climate Change, Hurricane Forecasts, ENSO, Cooling and Warming, Anthropogenic Climate Change, Natural Climate Change.

Reading Material

- Bryant, E.A., Natural Hazards.
- Ebert, C.H., Disasters, An Analysis of Natural and Human-induced Hazards.
- Hyndman, D. and Hyndman, D., Natural Hazards and Disasters.
- Keller, E. A. and Blodgett, R. H., Natural Hazards; Earth's Processes as Hazards, Disasters, and Catastrophes.
- Murck, B.W., Skinner B.J. and Porter S.C., Dangerous Earth, An Introduction toGeologic Hazards.

COASTAL AND MARINE SEDIMENTOLOGY (MTM 604)

Course Description

This course is designed to acquire knowledge about various types of sedimentary environment and processes. This will help the students to understand the dynamics and natural processes involved in the coastal and marine system.

Course Outline:

Introduction to sedimentology, origin, transportation and deposition of sediments. Sedimentary structures, their classification, morphology and significance. Origin and classification of sedimentary facies. The provenance of sediments. Diagenesis. Concepts ofsedimentary facies and facies associations. Physico-chemical controls of the sedimentary environments. In-situ deposition of evaporates, authigenic and biogenic sediments.

Reading Material

- Boggs Jr. S., 1992. Petrology of Sedimentary Rocks. Merril Publishing Co.
- Friedman, G.M. and Sanders, J.E., 1978. Principles of Sedimentology. John Wiley.
- Pettijohn, F.J., 1975. Sedimentary Rocks. Harper and Row.
- Pettijohn, F.J., Potter, P.E. and Siever, R., 1972. Sand and Sandstone. Springer.
- Prothero, D. and Schwab, F., 1996. Sedimentary Geology. W.H. Freeman & Co.
- Reading, H.G., 1986. Sedimentary Environment and Facies. Blackwell.
- Reineck, H.E. and Singh, I.B., 1980. Depositional Sedimentary Environments. Springer-Verlag.
- Selly, R.C., 1988. Applied Sedimentology. Chapman & Hall.
- Tucker, M.E. and Wright, V.P., 1990. Carbonate Sedimentology. Blackwell.

MARINE GEOPHYSICS (CMS 605)

Course Description

A wide spectrum of marine geophysical exploration methods has been developed in the last two decades. The range of application extends from marine resource exploration to scientific investigations in the deep ocean. Introduction to Marine Geophysics course is designed to provide the student with knowledge of basic field skills in applied marine geophysics. The aim is to introduce the basic physical principles of offshore exploration and practical application to geophysical techniques. At the undergraduate level, marine science students will highly benefit from understandings the role of geophysics particularly in hydrocarbon and mineral exploration.

Course Outline:

Scope of Marine geophysics. Introduction to different geophysical techniques. Gravity, Magnetic, Electrical and Seismic methods. High resolution and low-resolution geophysical methods. Offshore Geophysical logging for resource evaluation. Instrumentation and Usages. Introduction to geophysical data acquisition, processing and interpretation.

Lab Outline:

Analysis and interpretation of geophysical data, Seismic images interpretation and understanding of subsurface geological features.

Reading Material

- Applied Geophysics by W.M. Telford, L.P. Geldart R.E. Sheriff, 2010. Cambridge University Press; 2nd edition.
- Introduction to Geophysical Exploration by Philip Kearey, Michael Brooks, Ian Hill; 2002, 3rd ed. Blackwell Scientific Publications, London.
- Introduction to Well Logs and Subsurface Maps by Jonathan C. Evenick, 2008: PennWell Corp.; illustrated edition.
- Introduction to Geophysical Prospecting by Dobrin, M.B. & Savit, C.H., 1988, McGraw Hill.
- Basic Exploration Geophysics by Robinson, E.S. & Coruh, C., 1988, John Wiley and Sons.
- Geophysical methods in geology by Sharma, P.V., 1987, Elsevier Scientific Publishing Company.

SEA LEVEL CHANGES AND COASTAL ZONES (MTM 605)

Course Description

The main aim is to understand the sea-level changes processes and their effects on the coastal environment. How a coastal system responds to different sea-level variations scenarios. To understand the delicate and complex dynamics of coastal zones concerning the recent rise in sealevel and associated coastal dynamics.

Course Outline:

Sea level changes and causes, Eustasy and Isostasy, Regional and global effects of sea-level changes. Effects of sea-level changes on shorelines. Sea level Processes and indicators. Changes in coastal environments, Coastal dunes, Estuaries and Lagoons, Deltas. Physical processes, Coastal ecosystem, Human activities, Coastal issues.

Reading Material

- Basco, D.R.1982. Surf Zone Currents. MR-82-7, Coastal Eng. Res. Centre, US Army.
- Bird, E.C.F, 1984. Coasts, An Introduction to coastal geomorphology. Basil Blackwell.
- Bird, E.C.F, 1985. Coastline Changes. Wiley Interscience.
- Bird, E.C.F. and Schwartz, M.L. (eds.) 1985. The words Coastlines. Van NostrandRheinhold, New York.
- Carter, R.W.G; 1988. Coastal Environments, An introduction to the Physical, Ecological and cultural systems of coastlines. Academic Press.

COASTAL ECOSYSTEM AND CLIMATE CHANGE (CMS 607)

Course Description

To explore how the predicted changes in climate during the present century may affect coastal ecosystems and to examine the likely impacts of climate change on mangroves and corals. To understand the basic concepts of climate change and resilience. To identify various ecosystems based tools for climate change adaptation.

Course Content

Terms and definitions: IPCC and UNFCCC, Climate Change, Weather and Climate. Overview on a component on climate change covering principal components of global climate change that most affect coastal ecosystems: Carbon Dioxide, Acidification of the Oceans, Temperature, Sea Level Rise, Extreme

Weather Events and Changes in Precipitation. Introduction to Disaster Risk Reduction for coastal communities. Why do disasters matter to sustainable development? Disaster trends. Explain the definitions of disaster, disaster risk, and disaster risk reduction making the linkages to climate change. Case study analysis to understand disaster risk. Explore why ecosystems matter to reducing disasters, including a comparison of Eco-DRR and Ecosystems Based Approach.

Lab. Work:

Comparative analysis of ecosystem-based adaptation and engineering options. Other case studies also available for lab exploration.

Reading Material

- IPCC., 2012. IPCC Special Report on Extreme Events, Summary for Policymakers. 29. Geneva: Intergovernmental Panel on Climate Change First Joint Session of Working Groups I and II.
- McLeod, E. and Salm, R.V., 2006. Managing Mangroves for Resilience to Climate Change. IUCN, Gland, Switzerland. 64 pp.
- Renaud, K. F., Sudmeier-Rieux and Estrella, M., 2015. The Role of Ecosystems in Disaster Risk Reduction, eds. Bonn: United Nations University. UN/ ISDR. Global Assessment Report. Geneva: UN/ ISDR.
- Souter, D.W. and Linden, O., 2000. The health and future of coral reef systems. Ocean and Coastal Management 43: 657-688.

COASTAL RESILIENCE AND DISASTER RISK REDUCTION (CMS 608)

Course Description

To understand the concept and components of resilience for providing a conceptual framework for managing socio-ecological systems. To understand the basic concepts of disasters, disaster risk reduction and resilience. To identify various ecosystem-based tools in reducing disaster risk and climate change adaptation.

Course Content

Importance of implementing resilience concepts, strategy building and planning, ecosystem services and reduction of vulnerability in disasters. The importance of DRR in reducing sensitivity and exposure and establishing systems for detection, response and recovery. How the integration of resilience data can secure and strengthen ecosystem service delivery, promote the adaptation of ecosystems and economic activity. How data can support the development of adaptation action plans, to measure and communicate changes overtime etc. Introduction to Disaster Risk Reduction for coastal communities. Why do disasters matter to sustainable development? Disaster trends. Definitions of disaster, disaster risk, and disaster risk reduction making the linkages to climate change. Case study analysis to understand disaster risk. Why ecosystems matter to reducing disasters, comparison of Eco-DRR and Ecosystems Based Approach.

Lab. Work:

Comparative analysis of ecosystem-based adaptation and engineering options. Other case studies also available for lab exploration.

Reading Material

- IPCC. 2012. IPCC Special Report on Extreme Events, Summary for Policymakers. 29. Geneva: Intergovernmental Panel on Climate Change First Joint Session of Working Groups I and II.
- McLeod, E. and Salm, R.V., 2006. Managing Mangroves for Resilience to Climate Change. IUCN, Gland, Switzerland. 64 pp.

- Renaud, K. F., Sudmeier-Rieux and Estrella, M., 2015. The Role of Ecosystems in Disaster Risk Reduction, eds. Bonn: United Nations University. UN/ ISDR. Global Assessment Report. Geneva: UN/ISDR.
- Souter, D.W. and Linden, O., 2000. The health and future of coral reef systems. Ocean and Coastal Management 43: 657-688.
- UNEP EBM guidance, EbA decision support framework

COASTAL TOURISM MANAGEMENT (MTM 606)

Course Description

To explore the opportunities and threats of coastal tourism development on coastal ecosystems and local communities and how these can be managed using tried and tested tools and the ICM approach.

Course Content

The connections between coastal tourism development and the impacts on local environments and communities. How the ICM principles and practices are applied to understand the tradeoffs involved in coastal tourism development using select case studies?Introduction to sustainable coastal management and tourism development. Understanding the linkages between coastal tourism development and the impacts on the local environment and the local community. Understanding Carrying Capacity as an essential part of sustainable management decision making and the basic approach for managing tourism. Applying the ICM principles to explore the issues, threats and opportunities of coastal tourism development. Introducing recognized codes of conduct that support sustainable coastal tourism. Explore case studies that highlight good and bad practice in coastal tourism development.

Reading Material

- Buckley, R., 2003. Environmental inputs and outputs in ecotourism: Geotourism with a positive triple bottom line? Journal of Ecotourism 2(1): 76-82.
- Burke, L., Reytar, K., Spalding, M., & Perry, A., 2011. Reefs at Risk Revisited. Washington, DC, USA: World Resources Institute.
- Daldeniz, B., and Hampton, M. P., 2012. Dive Tourism and Local Communities: Active Participation or Subject to Impacts? Case Studies from Malaysia. International journalof tourism research.
- Graci, S., and Dodds, R., 2010. Sustainable tourism in island destinations. London, England: Earthscan.
- Hall, C. M., 2001. Trends in the ocean and coastal tourism: the end of the last frontier? Ocean & Coastal Management, 44: 601-618.
- Hawkins, J. P., Roberts, C. M., Kooistra, D., Buchan, K., and White, S., 2005. Sustainability of scuba diving tourism on coral reefs of Saba. Coastal Management, 33(4): 373-387.
- Kokkranikal, J., McLellan, R., and Baum, T., 2003. Island tourism and sustainability: A case study of the Lakshadweep Islands Journal of Sustainable Tourism, 11(5): 426-447.

SOCIO-ECOLOGICAL FUNDAMENTALS OF COASTAL ZONES (CMS 609)

Course Description

To consolidate their understanding of the terminology used in ecology and to understand key ecological processes of high relevance and application in integrated coastal management. The course will identify and categorize the role and functions of natural ecosystems and their provision of ecosystem services and benefit to man, and to understand how human impacts on ecosystems can change the status and value of these services.

Course Content

An introduction to the fundamental concepts of ecosystem-based management, a systems-analysis approach, a) plant-animal interactions; b) trophic relationships; c) population dynamics; and d) species life cycle strategies (vital to conservation management). Relationship between people and the environment. Public attitudes, perceptions, and beliefs influence coastal management decision-making. Relationship between a community and its natural resources. Overview of the multidisciplinary approach to coastal ecosystems management. Role of social sub-systems e.g. culture, economic structure, demography etc. Millennium Ecosystem Assessment (MEA, 2005). How they relate to coastal ecosystems and ICM.

Lab. Work:

Identification of examples of both a Keystone species and a Flagship species associated with coastal or marine habitats in a country or region.

Reading Material

- Ecological Principles.
- Global Species Program: how WWF classifies species.
- Keystone Species.
- Mann, K.H., 2000. Ecology of Coastal Waters: With Implications For Management, 2nd Edition. Wiley-Blackwell, UK. 432 pp.
- Millennium Ecosystem Assessment, 2005. Ecosystems and Human Wellbeing: Synthesis. Island Press, Washington, DC. 137 pp.

COASTAL LAND RECLAMATION (MTM 607)

Course Description

To understand the mechanism and drivers of large scale coastal land reclamation in Pakistan andSoutheast Asia; environmental impacts of coastal land reclamation and strategies for ecological improvement.

Course Content

Introduction: Context, Challenges, and Design Saliency. Comparison of the land reclamation history and trend between the developed and the developing countries. The broader ecological impacts of coastal land reclamation. Involvement of landscape architects, plannersand ecologists in land reclamation. Landscape Planning and Design: Role of landscape architects and planners in the land use decision making; Opportunities for ecological improvements; Introduction to the cases studies. Strategies and Feasible Design Solutions: Developer's perspective, proposing solutions based on a strong technicality, Land-fill substanceand its influences on design solutions. Phasing and Implementation: ecological goals; Integrating ecological phasing; Long term monitoring and maintenance plan for sensitive habitats.

Reading Material

- Abbott, M.B. and Price, W.A., 1993. Coastal, Estuarial and Harbour Engineer's Reference Book. CRC Press, 768 pp.
- Hudson, B.J., 1980. Coastal Land Reclamation with Special Reference to Hong Kong.
- Lo, K.F.A. and Gunasiri, C.W.D., 2014. Impact of Coastal Land Use Change on ShorelineDynamics in Yunlin County, Taiwan. Environments, 1:124-136.
- Phillips, A. J. and Knights, B., 1979. Estuarine and Coastal Land Reclamation and WaterStorage. Lexington

Books, 256 pp.
- Sekitar, J.A., 1998. Environmental impact assessment guidelines for coastal and land reclamation. Dept. of Environment, Ministry of Science, Technology and the Environment, Kuala Lumpur, Malaysia, 768 pp.

MANGROVE COASTAL FOREST MANAGEMENT (MTM 608)

Course Description

This course gives important information about mangroves forest management along the coastal area. It will be useful for environmentalist and forest protection agencies for proper management and protection of the mangroves.

Course Content

Introduction to Forest Resource Management; History of Mangroves Management in Pakistan; Forest Resource Health, Safety, Assessment and Mapping; Management Planning; Essential Field Skills; Introduction to Forest Ecology; Soil properties, development and organisms; ecology of the mangroves; Coastal Harvesting Systems; Introduction to Timber Cruising, Grading and Scaling; Worksite Readiness Skills; Transportation of Dangerous Goods.

Reading Material

- Clark, J., 1996. Coastal Zone Management Handbook. CRC/Lewis Publ., Boca Raton, Florida (USA), 694 pp.
- Clark, J., 1998. Coastal Seas: The Conservation Challenge. Blackwell Science, Oxford, 134 pp.
- GIZ, 2014. Mangrove Management: A manual for appropriate mangrove conservationand planting in the Mekong Delta, Published by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.
- Hamilton, L.S. and Snedaker, S.C. (Eds.), 1984. Handbook for Mangrove Area Management. Honolulu, Hawaii: East-West Center, 123 pp.
- McHarg, I., 1969. Design with Nature. The Natural History Press, Garden City, New York, 197 pp.
- McNeely, J.A., 1988. Economics and Biological Diversity. IUCN, Gland, Switzerland, 236pp.

MARINE PROTECTED AREAS MANAGEMENT (CMS 613)

Course Description

To introduce the concept and global experiences of Marine Protected Areas (MPA) management, as applied for marine biodiversity conservation, fisheries management, and sustainable tourism. To apply the concept of coastal use zonation and MPA management through a case study exercise of Mafia Island.

Course Outline:

Defining MPAs, Role of MPAs in protecting marine biodiversity, Types and categories of MPAs, Benefits from MPAs, Evidence of the positive impacts of MPAs, Best practice in establishing MPAs, MPAs and ICM, Zoning and MPAs, Use of GIS tools in marine spatial planning, Designing resilient MPAs and MPA networks, Case studies.

Lab. Work:
This course is taught with the aid of videos and class discussion and a working group activity. Working groups of 4-5 people students will read the case study of an island experiencing some emerging coastal management issues. Let students analyze the issues and describe the approach to be taken in finding solutions to multiple and interlinked management issues. Presentation of work to the class.

Recommended Books:

- Anonymous, 2003. Commonwealth of Australia, The Benefits of Marine Protected Areas.
- Anonymous, 2006. Scaling up Marine Management: The role of Marine Protected Areas. Washington, DC, The International Bank for Reconstruction and Development, The World Bank.120.
- Anonymous, 2008. Department for Environmental, Food and Rural Affairs. The Marine and Coastal Access Bill. The United Kingdom.
- Anonymous, 2008. IUCN World Commission on Protected Areas (IUCNWCPA) Establishing resilient Marine Protected Area networks – Making it happen.

OCEAN WAVES, TIDES AND CURRENTS (MTM 610)

Course Description
This course provides information regarding ocean waves, tides and currents and the use of instruments to measure them.

Course Content
Wave hydrodynamics: wave characteristics, simple harmonic wave, Laplace equation, potential flows, Small amplitude wave theory - Airy's solution, Finite amplitude waves-Stokessolution, wave celerity and particle orbits, short waves and long waves. Wave generation, Jeffrey's theory, Sverdrup and Munk theory, wave growth and propagation. Group velocity. Ocean tides: tide characteristics, theories of tide generation, harmonic analysis, tidal prediction, Renewable energy sources from Ocean –Wave energy, tidal energy and thermal energy. Wave forecasting – Sea and swell, significant wave, SMB method of wave forecastingPNJ method of wave forecasting, co-cumulative spectrum, fetch limited and duration limited cases, swell forecasting, dispersion, angular spreading and the concept of wave forecasting filter. Tides and Currents.

Reading Material

- Ippen, A.T., Coastal and Estuarine Dynamics.
- McClellan, Elements of Physical Oceanography.
- Neumann and Pierson, Introduction to principles of dynamic oceanography.
- US Navy, Observing and forecasting of ocean waves – H.Q Pub. No. 603.
- Valeem, E. E. and Tirmizi, S.M.A., 2011. Wave climate of northern Arabian Sea during southwest monsoon season near Karachi, Pakistan: Variation and analysis of wave characteristics. VDM Verlag Dr. Müller, 284 pp. ISBN. 10: 3-639-31657-6, ISBN. 13: 978-3-639-31657-5.