Minutes of the 38th

Special Meeting of the Board of Studies

Faculty of Engineering Sciences

held on 26th March 2025

Via MS Teams

Bahria University Islamabad

Contents

Minutes of the 38th Special Meeting of Faculty Board of Studies Engineering Sciences held on 26th March 2025

Attendance:

BUIC

Dr. Faisal Bashir Hussain	Dean ES	Chair
Dr. Syed Umair Ullah Jamil	HoD(E&ES)	Member
Dr. Khurram Ehsan	HoD (CS)	Member
Dr. Adeel M Syed	HoD (SE)	Member
Dr. Shahzad Khalid	Principal H-11	Member
Dr. Moneeb Gohar	HoD (CS)	Member
Dr. M Hassan Danish	HoD (EE)	Member
Dr. Syed Khawar Hussain Shah	HoD (CE)	Member

BUKC

Dr. Haroon Rasheed	Principal	Member
Dr. Shaista Iftikhar	HoD (E&ES)	Member
Dr. Taha Jilani	HoD (CS)	Member
Dr. Abdul Attayab Khan	HoD (EE)	Member
Dr. Shoaib Mughal	HoD (CE)	Member
Dr. Hina Shakir	HoD (SE)	Member

BULC

Dr. Khawaja Qasim Maqbool	HOD (CS)	Member

Proceedings

Preliminaries

FBoS-ES meeting took place on 26th March 2025, with the quorum complete, the proceedings commenced at 0930 hours, with recitation from the Holy Quran.

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

Item 3801: Re-offering of MS EPM Program

Sponsor: HOD E&ES H-11 Referral Authority: Respective DBoS

Summary:

1. The Department of Earth and Environmental Sciences previously offered MS program in Environmental Policy and Management (EPM), which was frozen around 7 years ago.
2. The need for environmental policy and management experts has increased significantly in recent years, driven by climate change, sustainability, and environmental governance concerns.
3. The current academic market lacks a comprehensive graduate program in EPM, creating an opportunity for our department to fill this gap.
4. Reviving the MS EPM program aligns with the university's strategic goals of promoting sustainability, environmental stewardship, and interdisciplinary research.
5. Graduates of the MS EPM program will have diverse career opportunities in government, non-profit, private sectors, and academia.
6. The Relaunch plan of MS in Environmental Policy and Management (EPM) has been prepared by the department of Earth & Environmental Science. In this regard, PEOs, PLOs and roadmap of MS EPM program of E&ES Dept BUIC are aligned according to new HEC GEP Policy.

Discussion

7. HoD E&ES BUIC presented the agenda and he highlighted on the following points:
    a. The MS in Environmental Policy and Management (EPM) is an interdisciplinary graduate program designed to equip students with the knowledge and skills necessary to address pressing environmental challenges through effective policy development and sustainable management practices. This program integrates environmental science, public policy, law, and economics to prepare professionals capable of designing, implementing, and evaluating policies that promote environmental sustainability and resilience.
    b. As recommended by DBOS, the revised road map of MS EPM will be implemented on relaunch of MS EPM program.
    c. The road map is well aligned with HEC GEP policy. Therefore, it is suggested to relaunch the program, implement and approve the PEOs, PLOs and roadmap of MS EPM from Fall 2025 intake.

Decision 3801

8. The relaunch of MS EPM along with revised curriculum of MS EPM program is recommended by FBoS for implementation from Fall 2025 intake and is attached at Appendage 3801. Final approval of the relaunch of MS EPM with revised MS EPM program curriculum and roadmap to be solicited from the ACM.

Item 3802: Revision Program Roadmaps - BS Geology and Geophysics

Sponsor: HOD E&ES Referral Authority: Respective DBoS

Summary of the Case

9. The Department of Earth and Environmental Sciences, established in 2005, used to offer Bachelor programs in Geology and Geophysics. Due to decline in number of applicants, the BS Geology program was discontinued whereas BS Geophysics is still offered by the E&ES department BUIC H-11.
10. The downturn in E&ES domain is attributed to several factors, including shifts in student preferences, changes in industry demands, and global economic fluctuations, especially in the energy sector. During the last 5 years, 10 new departments offering BS Geology programs have started in government sector universities especially in KPK. These new additions provide students with alternative options to study in the said domains at a relatively lower financial cost.
11. Recognizing these challenges, the department aims to revitalize its bachelor programs of BS Geology and BS Geophysics to increase the scope of E&ES programs. This is further attributed by the advertised job opportunities mentioning these degree titles of BS Geology, explicitly. The initiative seeks to broaden the appeal of the programs to a wider audience of prospective students while addressing industry demands for interdisciplinary skill sets and practical training.
12. There are significant number of common courses (113 common credits out of 137 credit hours) among the two degree programs – BS Geology and BS Geophysics. The E&ES department has revised the degree program roadmaps of BS Geology and BS Geophysics, so that students registered in said degree programs can study together till 6th semester. The eight elective courses will be offered to students during the last three semesters from Geology and Geophysics streams.

Discussion

13. Rebranding and revision of BS Geology and BS Geophysics programs with a combined roadmap and intake target (20 students) presents an opportunity for the Department of Earth and Environmental Sciences to adapt to changing student preferences and industry demands while maintaining academic rigor and relevance.
14. During the first five semesters, in accordance with HEC policy, both core and general education courses will be offered to instill a solid foundation in the fundamentals of Earth science and to foster the development of strong analytic, communication, and social skills. Students will opt for the field of specializing in either Geology or Geophysics beginning with the sixth semester of their studies.
15. In the final three semesters, students will have the opportunity to tailor their learning experience with specialization based (eight) elective courses. These elective courses are carefully designed to deepen students' understanding of their chosen specialization, whether it be Geology or Geophysics.
16. This will provide an opportunity to catch and regain the strength of Geology program by offering admissions to those students who want to get admission in BS Geology program.

17. By implementing the proposed recommendations, the department can regain its strength, attract a larger audience of prospective students, and ensure graduates are well-equipped to thrive in the dynamic field of Earth sciences.
18. In previous years, due to low intake of BS Geology, the students had to refund their fee by the start of semester. This not only damaged the reputation of the university but also poses significant loss to students as they missed precious time. Ultimately, these circumstances also became the reason for the negative image among the potential students.
19. Therefore, by offering admissions through combined intake and roadmap, it would be possible to target the students of BS Geology as well. If a batch of 20 comprises of 15 students of Geophysics discipline and 5 students of Geology still the program remains financially feasible as those 5 students will be paying fee for the 39 common courses.

Decision 3702

20. The following is recommended by the FBoS for implementation from Fall 2025:
    a. Re-offering of BS Geology Program at E&ES Department BUIC H-11
    b. Combined admission intake target for BS Geology and BS Geophysics
    c. Revision of program roadmaps BS Geology and BS Geophysics as attached at Appendage 3802.

Item 3803: Revision of BS Remote Sensing and GIS Program Curriculum

Sponsor: HOD E&ES BUKC | Referral Authority: DBOS E&ES BUKC & BUIC H 11

Summary of the Case

21. The curriculum of BS Remote Sensing and GIS (RS&GIS) program has been revised by the Higher Education Commission (HEC). After comprehensive review and deliberation, both E&ES departments (BUKC & BUIC) have designed the revised roadmap of BS program that is aligned with the HEC's Feb 2025 revised BS program roadmap. The revised roadmap of BS RS&GIS as recommended by Departmental Board of Studies is attached at Appendage 3803.

Discussion

22. HoD E&ES BUKC presented the agenda and she highlighted on the following major changes in the revised BS (RS&GIS) Roadmap:
    a. In the new roadmap 23 major core courses with 68 credit hours are proposed. Digital Cartography, Mobile Data Acquisition & mapping, GIS Programming and Customization and Unmanned Aerial Vehicle & Data Processing are the new major courses added in the roadmap.
    b. A total of 6 elective courses are offered from 6th semester onwards (2 in each semester), with a total of 18 credit hours.
    c. General education courses Statistics, Fundamentals of International Relation are added to the roadmap. The course Ideology & Constitution of Pakistan is added in the 4th semester and Urban & Town Planning (41st ACM) is re-introduced as an interdisciplinary course. The 4 courses, Museology,

Chemistry, Geodesy and Computing with MATLAB are removed from the roadmap.

d. The Field Work & Report Writing course is offered in 5th semester and Capstone Project is offered in the 8th semester. The total credit hours of the proposed roadmap are 136 credit hours.

Decision 3803

24. The revised curriculum of BS (RS&GIS) program as attached at Appendage 3803 is recommended by the FBoS for implementation from Fall 2025 intake.

Item 3804: Launch of BS Artificial Intelligence Program at CS Dept BULC

Sponsor: HOD CS BULC Referral Authority: DBOS CS Dept BULC

Summary of the Case

25. CS Dept BULC intends to launch BS AI programs based on the success of its existing BSCS and BSIT programs.

Discussion

26. The curriculum of the BS (AI) program includes coursework in computing, mathematics, automated reasoning, statistics, computational modeling, introduction to classical artificial intelligence languages and case studies, knowledge representation and reasoning, artificial neural networks, machine learning, natural language processing, vision and symbolic computation. The program also offers students courses in ethics and social responsibility, with the opportunity to participate in long term projects in which artificial intelligence can be applied to solve problems that can change the world for the better — in areas like agriculture, defense, healthcare, governance, transportation, e-commerce, finance and education.
27. Lahore, is a growing hub of technological education in Pakistan, hosts several reputable universities offering BS Artificial Intelligence programs. Institutions like Punjab University, Information Technology University (ITU), University of Management and Technology (UMT), and COMSATS University Lahore have launched BS AI degrees to cater to the rising demand for AI professionals.
28. The job market for graduates of the BS Artificial Intelligence program is rapidly expanding, both locally and globally, driven by the increasing integration of AI across industries. In Pakistan, sectors such as healthcare, finance, agriculture, e-commerce, and telecommunications are actively adopting AI solutions, creating a high demand for skilled professionals in machine learning, data analytics, natural language processing, and computer vision. Globally, AI specialists are among the most sought-after roles, with competitive salaries and opportunities in leading tech firms and startups. As organizations continue to invest in automation and intelligent systems,

the BS AI program opens doors to diverse and future-proof careers, making it a highly promising and strategic academic choice.)

26. As recommended by DBOS, already approved road map of BS AI in the 45th ACM will be implemented for the BS AI program with the addition of new electives proposed in 37th FBOS i.e (Quantum Computing for Artificial Intelligence, Explainable Artificial Intelligence, Cloud and Devops Engineering, AI Ethics and Safety).
27. The road map is well aligned with HEC UG policy, and contains PEOs, PLOs, course Admission Criteria and Course outlines. The complete roadmap of the program along with Program Launch Proposal is attached at Appendage 3804.
28. The BSAI program is regulated by the National Computing Education Accreditation Council (NCEAC). Zero Visit/Permission will be required from NCEAC prior to the launch of the program.

Decision 3804

29. It is recommended that BS AI program may be launched from Fall 2025 semester at CS Dept BULC after obtaining approval from NCEAC.

Item 3805: Revision of MS Mathematics Curriculum

Sponsor: HOD CS BUIC E-8 Referral Authority: DBOS

Summary of the Case

30. The curriculum of MS Mathematics program has been revised by the Higher Education Commission (HEC). The revised degree program has 30 credit hours, comprising of 12 credits of Core courses, 12 credits of elective courses and 06 credits of MS Thesis. The mandatory/core courses for the program are now to be defined by the Department/HEI.

Discussion

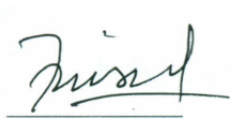
31. It was highlighted that MS Mathematics provides advanced education in mathematical theory and analysis. It covers core areas such as algebra, calculus, differential equations, functional analysis, integral equations, group theory, geometry and numerical analysis.
32. The revised roadmap of MS Mathematics Program as available at Appendage 3805 was presented by Dr Jafar Hasnain.

Decision 3805

33. The revised curriculum of MS Mathematics as attached at Appendage 3805 is recommended by the FBoS for implementation from Fall 2025 intake.

Closing of the Meeting

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



Prof. Dr Faisal Bashir Hussain
Dean (ES), Chair FBOS

Appendages:

Appendage 3801

MS EPM Roadmap

Program Title: MS Environmental Policy and Management (EPM)
Duration: 2 Years
Total Credit Hours: 30

Program Educational Objectives (PEOs)

1. Demonstrate interdisciplinary knowledge of environmental policy, sustainability principles, and management strategies to design and implement solutions for national and global problems.
2. Exhibit leadership and collaboration skills to engage with stakeholders, including policymakers, communities, and industry leaders, in addressing environmental issues and promoting sustainable development.
3. Build critical thinking, innovation, and evidence-based approaches to analyze environmental policies, assess their impacts, and develop adaptive strategies

Program Learning Outcomes (PLOs)

PLO1. An ability to analyse and evaluate environmental policies, regulations, and governance frameworks to assess their effectiveness in addressing environmental challenges and promoting sustainability."
PLO2. An ability to apply interdisciplinary knowledge of environmental science, economics, and social sciences to design and implement innovative solutions for complex environmental problems."
PLO3. An ability to communicate effectively with stakeholders to advocate for sustainable environmental policies and practices."
PLO4. An ability to build leadership and management skills to work with sustainable environmental strategies that balance ecological, social, and economic priorities."

Admission criteria: Bachelors (16 years of education) from HEC recognized HEI in the field of Natural Sciences, Humanities, Social Sciences, Business Studies, Defense studies, with a minimum CGPA of 2.0

Summary of Credit Hours

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

Semester 1 (Compulsory Courses)

Course Code	Title	Credit hours
ENV 702	Environmental Management	3
ENV 705	Environmental Policies and Legal Framework	3
ENV 740	Climate Crisis Adaptation and Mitigation	3
ESC 701	Research Methodology	3

Semester 2 (Elective Courses)

Course Code	Title	Credit hours
ENV XXX	Elective 1	3
ENV XXX	Elective 2	3
ENV XXX	Elective 3	3
ENV XXX	Elective 4	3

Semester 3

Course Code	Title	Credit hours
THS 701	Thesis	3

Semester 4

Course Code	Title	Credit hours
THS 701	Thesis	3

List of Electives

S. No	Course Code	Title	Credit Hours
1	ENV 710	Environmental Auditing	3
2	ENV 711	Circular and Green Economy	3
3	ENV 703	Ecofriendly Energy Sources	3
4	ENV 720	Innovation in Waste Management Approaches	3
5	ENV 713	Health, Safety and Environment	3
6	ENV 715	Environmental Risk Assessment and Management	3
7	ENV 709	Population Dynamics, Environment and Sustainability	3
8	ENV 714	Remote Sensing and GIS Applications in Environment	3
9	ENV 719	Environmental Epidemiology	3
10	ENV 704	Environmental Impact Assessment	3
11	ENV 722	Disaster Mitigation and Emergency Management	3
12	ENV 707	Sustainability and Environmental Management	3
13	ENV 712	Project Management	3
14	ENV 716	Wildlife, Forestry and Wetland Management	3
15	ENV 708	Emerging Trends in Environmental Sociology	3
16	ENV 732	Introduction to Climate Financing	3
17	ENV 724	Air and Noise Pollution Control	3

Course Outlines
MS EPM

Course Title Climate Crisis Adaption and Mitigation

Course Outline: Climate science, Natural and Anthropogenic causes of climate crisis, Role of atmospheric and ocean circulation in climate regulation, Present rapid warming, Projection of future climate change, Uncertainty in climate change projections Climate Change Policy, Impacts of Climate Change in Pakistan, Green Economy, Carbon Footprint, Carbon capture and storage, Technological Development and Changing climate, Climate Change matters, Climate change mitigation in developing countries, climate and human rights, societal systems, Social 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 Title Environmental Auditing

Course Outline: Principle functions of environmental audit, Compliance and management in audit system, 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 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. Life cycle assessment, Periodic evaluation. 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 Title Environmental Policies and Legal framework

Course Outline: Carrying capacity and sustainable development. Cultural values and flexibility to environment, Conservation Strategies; WCS, NCS, Provincial and Local Strategies. A detailed study of Environmental Problems of Pakistan, National policy for environment protection, Laws for the protection of terrestrial, aquatic and atmospheric system Ecosystems. Treaties, Conventions and Protocols in Global, Transboundary policies and implementation framework, Regional and International Environmental Issues. 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. Role of the State and International Policy, Trade and Globalization.

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 Title Sustainability and Environmental Management

Course Outline: The concept of Sustainability, History and discourses of Sustainable Development. resources problems for sustainability, 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 goals, 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, The Green Revolution.

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

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

Reference Books/Materials:

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

Course Title Disaster Mitigation and Emergency Management

Course Outline: Natural hazards and disasters: The need for hazard and disaster studies, Historical background on Hazard and Disaster research; Disaster types: Natural vs anthropogenic; 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, Mapping of disaster prone areas, 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 catastrophes, 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); International phenomenon, Role of Media in Disaster Management; Techniques and methods to assess hazard, vulnerability and risk: Qualitative and Quantitative approaches

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 Title Environmental Management (3CH)

Course Outline: Fundamental concepts of Environmental Management, Historical Development of environmental concerns, sustainable development concept. Efficient allocation of resource, control and optimum utilization of energy and non renewable resources, Approaches for waste minimization amnd management of waste in process, Ecological foor printing, circular economy, management of gaps and loopholes, 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 Title Ecofriendly Energy Sources

Course Outline: Environment as a framework of energy, 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. Methods for energy conversion, environmental impacts for electricity, heating and cooling, Energy conversions in industry and buildings, 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 Title Circular and Green Economy

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, Externalities, Market Failure, Trade off, Carbon footprint assessment, carbon trading and carbon sequestration, Circular economy key ideas, butterfly diagram, visualization of circular economy, circular economy principles, don't buy product buy services 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.

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 Title Environmental 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. Exposure pathways between humans and environment. 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: Disease mapping on various scales case control studies, cohort studies, double cohort studies. Role of confounding factors in causation of disease. Web of causation. Sensitivity and Specificity. 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 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 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. Workplace 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. Industrial hygiene, 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, Behaviour, 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. Workplace 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 nc. New Jersey, USA.
4. OHSAS BS 18001 Standard

Course Title Population Dynamics, Environment and sustainability

Course Outline: World Population: current scenario and future trends. Framework for understanding population environment nexus, population size and environment, Population composition, distribution and environment, Biocapacity, carrying capacity, overshoot, 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. Transition of population migration and urbanization on environmental integrity, pool growth and disease incidence 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. 8th ed. John Wiley and Sons
2. Cunningham W.P., & Saigo, B.W., 2017. Environmental Science, 6th Ed. McGraw Hill.

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 Title Innovation in Waste Management Approaches

Course Outline: Hazardous Wastes: Sources, Classification, Characteristics, and Generation. On site handling and storage, Techniques for measuring and characterizing waste, collection, transfer, optimization of solid waste transport, recycling and disposal techniques of municipal Solid Waste, including equipment and logistics considerations , 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. Health and environmental issues related to solid waste management, Incineration and non incineration thermal techniques, Regulations and policies: An understanding of relevant regulations and policies governing the handling, treatment, and disposal of waste, as well as compliance requirements. 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 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 Title Emerging Trends in 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". Local and space based environmental issues, 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, Rise of ecological modernization, 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 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 Title Wildlife, Forestry and Wetland Management

Course Outline: Introduction to wildlife and their relationship with human population. Concepts of wildlife conservation: sustainable development and ecosystem. Conservation and preservation, 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. Wildlife Parks in the world; their habitat and conservation, Case studies of forestry management

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 Title Air and Noise Pollution Control

Course Outline: Physical and chemical composition of the atmosphere; Physical and chemical characteristics of gaseous and particulate air pollutants; Air pollution meteorology; Classification, pathways and atmospheric reactions of air pollutants; Monitoring / control techniques and strategies

for air pollutants Carbon foot printing. 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).

Course Title Emerging trends in 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". Local and space based environmental issues, 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, Rise of ecological modernization, 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: The course aims at developing an understanding of key theoretical perspectives, debates, topics, and new directions within environmental sociology, and the importance of this critical area of sociological study for understanding global environmental problems and change.

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 Title Introduction to Climate Financing

Course Outline: Introduction to climate finance and the carbon markets, carbon pricing, sustainable business models, project finance to finance renewable energy, venture and growth capital to finance emerging climate technologies, and public equity strategies including divestment and ESG investing. Financial products in the fixed income and insurance markets are examined for climate impact, development finance to understand the unique challenges and solutions to investing in climate solutions in emerging markets, the strategies used by banks and investment firms for the transition to net zero, impact of the climate crisis on opportunities and careers in finance.

Course Aims and Objectives: The main aims of the course include a substantial insight of climate change and its risks and consequences, different climate initiatives and related governance.

To expose carbon pricing and accounting with an understanding of sustainable economy and business models and finding the market green solutions.

Course outcomes: Gain a solid foundational understanding of climate change and its risks and consequences • Understand different climate initiatives and related governance and disclosure frameworks • Demystify carbon pricing and accounting • Understand the proposition of a sustainable economy and business models • Gain practical knowledge for integrating climate risk into investment analysis and portfolio construction

Reference books/ Materials

1. Climate Change and Finance, Navigating the Challenges and opportunities in Capital Market, 2024 (Editors: Nadar Naifar)

2. Climate Finance, Taking a Position on Climate Futures, Gareth Bryant and Sophie Webber

Appendage 3702

Roadmap of BS Geology and Geophysics Programs

BS GEOLOGY PROGRAM

Programme Title: BS Geology
Duration: 4 Years Total
Credit Hours: 137

Sr. No.	Category as per HEC new UG Policy	Credit Hours/Contact Hours
1.	General Education (Mandatory)	35
2.	Major/Disciplinary (Mandatory)	81
3.	Interdisciplinary (Mandatory)	12
4.	Electives toward specialization	-
5.	Tajweed, Quran and Hadith (Compulsory – non-credit course, only for Muslim Students)	8 Contact Hours (non-credited)
6	Field Experience	6
7.	Capstone Project (Mandatory)	3
8	Double Major (Optional)	-
9.	Minor (Optional)	-
	Total	137

Programme Educational Objectives (PEOs)

Following are the sample programme educational objectives that are expected to be exhibited by the Geology graduates.

1. **PEO-1:** Demonstrate sound scientific knowledge and skills.
2. **PEO-2:** Work, manage and illustrate effective teamwork, interpersonal skills and professional growth.
3. **PEO-3:** Undertake professional practice considering ethical, societal and geological implications.

Programme Learning Outcomes (PLOs)

1. **Academic Education:** Prepare graduates as geological professionals.
2. **Scientific Knowledge:** Ability to acquire a solid base of knowledge and skills in the science of geology.
3. **Problem Analysis:** Analyze/investigate geological materials, features, and processes both qualitatively and quantitatively.
4. **Design and Development:** Apply critical thinking skills to develop solutions for geological problems using the scientific tools/techniques/methods.
5. **Investigation:** Investigate the complex geological problems/phenomenon in a systematic way including literature survey, design and conduct of experiments, analysis and interpretation of experimental data, and synthesis of information to derive valid conclusions
6. **Modern Tool Usage:** Create, select and apply appropriate techniques, resources, and modern geological and IT tools for solutions of geological problems
7. **Individual and Teamwork:** Function effectively as an individual and as a member or leader in diverse teams and in multi-disciplinary settings

8. **Ethics:** Understand and commit to professional ethics, responsibilities, and norms of scientific practices.
9. **Life-long Learning:** Develop the aptitudes and dispositions necessary to help democratize society by obtaining and maintaining employment as a professional geologist.

Mapping of PLOs to PEOs

No.	Programme Learning Outcomes (PLOs)	PEOs		
		PEO-1	PEO-2	PEO-3
PLO-1	Academic Education	✓	✓	
PLO-2	Scientific Knowledge	✓		
PLO-3	Problem Analysis	✓		
PLO-4	Design and Development	✓		✓
PLO-5	Investigation	✓		
PLO-6	Modern Tool Usage	✓	✓	
PLO-7	Individual and Teamwork		✓	✓
PLO-8	Ethics		✓	✓
PLO-9	Life-long Learning			✓

BS GEOLOGY ROADMAP

Semester - 1

Course code	Course Title	HEC Category	Credit Hours	17 UN SDGs alignment
ENG 101	Functional English	Gen. Edu. Course (Functional English)	3	4
PHY 103	Physics	Gen. Edu. Course (Natural Sciences)	2	4,9
PHL 103	Physics Lab		1	
CSC 102	Introduction to Computers & Programming	Gen. Edu. Course (Quantitative Reasoning)	2	4,8,9
CSL 102	Introduction to Computers & Programming Lab		1	
PAK 105	Pakistan Studies	Gen. Edu. Course (Ideology & Constitution of Pakistan)	2	4,10,16
ISL 101	Islamic Studies	Gen. Edu. Course (Islamic/Religious Studies)	2	4,10,16
GEO 105	Physical & General Geology	Major (Disciplinary)	3	4, 7, 9
MAT 105*	Mathematics	Zero Credit Course	0	4
ISL 107**	Tajweed	Non-Credit course Tajweed, Quran and Hadith (1 Contact Hour)	0	4,10,16
	Total Credit Hours		**16**	

***Academic credit of this course is zero but its contact hours, teaching material and tuition fee are equal to a 3 credit hours course.**

****Only for Muslim students**

Semester - 2

Course code	Course Title	HEC Category	Credit Hours	17 UN SDGs alignment
HSS 320	Technical Writing and Presentation Skills	Gen. Edu. Course (Expository Writing)	3	4
GSC 340	Chemistry	Gen. Edu. Course (Natural Sciences)	2	3,4,6,7
GSL 340	Chemistry Lab		1	
MAT 115	Calculus & Analytical Geometry	Gen. Edu. Course (Quantitative Reasoning)	3	4,11

GEO 110	Fundamental of Geography & Geomorphology	Major (Disciplinary)	3	11.14.15
GEO 115	Introduction to Geophysics	Major (Disciplinary)	3	4,9,11
GEO 120	Field Geology	Major (Disciplinary)	3	4,9,11
ISL 108*	Understanding Quran - I	(1 Contact Hour)	0	4, 10, 16
	Total Credit Hours		**18**	

***Only for Muslim students**

Semester - 3

Course code	Course Title	HEC Category	Credit Hours	17 UN SDGs alignment
GEO 201	Museology	Gen. Edu. Course (Arts and Humanities)	2	4
GEO 206	Civics and Community Engagement	Gen. Edu. Course (Civics and Community Engagement)	2	16,17
PSY 102	Introduction to Psychology	Gen. Edu. Course (Social Sciences)	2	3,4
GEO 212	Geostatistics	Interdisciplinary/Allied courses	3	4,8
GEO 205	Structural Geology	Major (Disciplinary)	3	4,9,11
GEO 210	Mineralogy & Crystallography	Major (Disciplinary)	3	4,11
GEO 215	Sedimentology	Major (Disciplinary)	3	4,11
ISL 109*	Understanding Quran - II	(1 Contact Hour)	0	4,10,16
	Total Credit Hours		**18**	

***Only for Muslim students**

Semester - 4

Course code	Course Title	HEC Category	Credit Hours	17 UN SDGs alignment
xxx xxx	Ideology and Constitution of Pakistan	Gen. Edu. Course (Ideology & Constitution of Pakistan)	2	4,10,16
HSS 423	Entrepreneurship	Gen. Edu. Course (Entrepreneurship)	2	4,8,9,17
GEO 207	Applications of Information and Communication Technologies	Gen. Edu. Course (Applications of	2	4,9

GEL 207	Applications of Information and Communication Technologies Lab	Information and Communication Technologies (ICT))	1	
GEO 230	Geotectonics	Major (Disciplinary)	3	4
GEO 305	Environmental Geology	Major (Disciplinary)	3	4,8,11
GEO 325	Stratigraphy of Pakistan	Major (Disciplinary)	3	4,11
GEO 335	Earthquake Seismology	Major (Disciplinary)	3	4,11
ISL 110*	Understanding Quran - III	(1 Contact Hour)	0	4,10,16
	Total Credit Hours		**19**	

***Only for Muslim students**

Semester - 5

Course code	Course Title	HEC Category	Credit Hours	17 UN SDGs alignment
GEO 321	Computing with Matlab	Interdisciplinary/Allied courses	2	9,11
GEL 321	Computing with Matlab Lab		1	
GEO 315	Igneous & Metamorphic Petrology	Major (Disciplinary)	3	4,7,9
GEO 345	Petroleum Geology	Major (Disciplinary)	3	4,7,9
GEO 350	Geology of Pakistan	Major (Disciplinary)	3	4,11
GEO 415	Economic Geology	Major (Disciplinary)	3	4,8,9
GEO 250	Field Work Report-1	Field Experience	3	4,13,15
ISL 111*	Understanding Quran - IV	(1 Contact Hour)	0	4,10,16
	Total Credit Hours		**18**	

***Only for Muslim students**

Semester - 6

Course code	Course Title	HEC Category	Credit Hours	17 UN SDGs alignment
GEO 425	Research Methodology	Interdisciplinary/Allied courses	3	4
GEO 340	Wireline logging	Major (Disciplinary)	3	4,9,11
GEO 484	Quaternary Geology	Major (Disciplinary)	3	4
GEO xxx	Elective - I	Elective (Disciplinary)	3	As per list of Electives
GEO xxx	Elective - II	Elective (Disciplinary)	3	
GEO 375	Field Work Report-2	Field Experience	3	4,13,15
ISL 112*	Understanding Quran - V	(1 Contact Hour)	0	4,10,16
	Total Credit Hours		**18**	

***Only for Muslim students**

Semester - 7

Course code	Course Title	HEC Category	Credit Hours	17 UN SDGs alignment
GEO 435	GIS & Remote Sensing	Interdisciplinary/Allied courses	3	4,8,11
GEO 405	Petroleum Engineering	Major (Disciplinary)	3	4,6,8
GEO 420	Hydrogeology	Major (Disciplinary)	3	8,11,12
GEO xxx	Elective - III	Elective (Disciplinary)	3	As per list of Electives
GEO xxx	Elective - IV	Elective (Disciplinary)	3	
GEO xxx	Elective - V	Elective (Disciplinary)	3	
ISL 113*	Seerah - I	(1 Contact Hour)	0	4,10,16
	Total Credit Hours		**18**	

***Only for Muslim students**

Semester - 8

Course code	Course Title	HEC Category	Credit Hours	17 UN SDGs alignment
GEO xxx	Elective – VI	Elective (Disciplinary)	3	As per list of Electives
GEO xxx	Elective – VII	Elective (Disciplinary)	3	
GEO xxx	Elective – VIII	Elective (Disciplinary)	3	
GEO 442	Thesis	Capstone Project	3	4,9
ISL 114*	Seerah - II	(1 Contact Hour)	0	4,10,16
	Total Credit Hours		**12**	

***Only for Muslim students**

List of Geology Elective Courses

	Course code	Course Title	Credit Hours	17 UN SDGs alignment
Semester 6 Elective I and II	GEO 221	Optical Mineralogy	3	4,11
	GEO 225	Geochemistry	3	4,10,11
	GEO 310	Paleontology	3	4,11
	GEO 320	Marine Geology	3	4,6,14
Semester 7 Elective III, IV and V	GEO 330	Micropaleontology & Biostratigraphy	3	4,11
	GEO 336	Neotectonics	3	4,11
	GEO 406	Reservoir Geology	3	8,12
	GEO 407	Clastic Sedimentology	3	4,9
	GEO 408	Carbonate Sedimentology	3	4,9
	GEO 410	Engineering Geology	3	4,9,11
Semester 8 Elective VI, VII and VIII	GEO 430	Geochemical Exploration Techniques	3	4,8,9
	GEO 431	Introduction to Geotechnical Engineering	3	4,9,11
	GEO 432	Rock Mechanics	3	4,9,11
	GEO 433	Soil Mechanics	3	4,9,11
	GEO 469	Industrial Mineralogy	3	4,8,9
	GEO 476	Mining Geology	3	4,8,9
	GEO 482	Software Applications in Petrophysics	3	4,9,11

BS GEOPHYSCS PROGRAMME

Programme Title: BS Geophysics
Duration: 4 Years Total
Credit Hours: 137

Sr. No.	Category as per HEC new UG Policy	Credit Hours/Contact Hours
1.	General Education (Mandatory)	35
2.	Major/Disciplinary (Mandatory)	81
3.	Interdisciplinary (Mandatory)	12
4.	Electives toward specialization	-
5.	Tajweed, Quran and Hadith (Compulsory – non-credit course, only for Muslim Students)	8 Contact Hours (non-credited)
6	Field Experience	6
7.	Capstone Project (Mandatory)	3
8	Double Major (Optional)	-
9.	Minor (Optional)	-
	Total	137

Programme Educational Objectives (PEOs)

The educational objectives of Geophysics undergraduate programme are for the graduates to attain the following within a few years of graduation:

1. **PEO-1:** Secure employment in governmental or private sector or engage in entrepreneurship.
2. **PEO-2:** Pursue careers by demonstrating leadership and interpersonal skills by teamwork and communication skills.
3. **PEO-3:** Advance their professional development through self-learning or pursue advanced degrees.

Programme Learning Outcomes (PLOs)

1. **Academic Education:** A fundamental understanding of the academic field of Geophysics, its different learning areas and application
2. **Knowledge:** Apply knowledge of geosciences, for the solution of defined problems.
3. **Problem Analysis:** Demonstrate the ability to use skills in Geophysics and its related areas of technology for formulating and tackling geosciences related problems.
4. **Design/Development of Solutions:** Plan and execute Geophysics-related investigations, analyze and interpret data collected using appropriate methods to report accurately the findings of the investigations while relating the conclusions to relevant theories in Geophysics.
5. **Modern Tool Usage:** Create, select, adapt and apply appropriate techniques, resources, and modern computing tools to complex earth processes, with an understanding of the limitations.
6. **Individual and Teamwork:** Function effectively as an individual and as a member or leader in diverse teams and in multi-disciplinary settings.
7. **Communication:** Communicate effectively with the geoscience community and with society at large about activities by being able to comprehend and write effective reports, design documentation, make effective presentations, and give and understand clear instructions.
8. **Professionalism and Society:** Understand and assess societal, health, safety, legal, and cultural issues within local and global contexts, and the consequential responsibilities relevant to professional practices

9. **Ethics:** Understand and commit to professional ethics, responsibilities, and norms of professional geoscience practice.
10. **Life-long Learning:** Recognize the need, and have the ability, to engage in independent learning for continual development as a computing professional.

Mapping of PLOs to PEOs

No.	Programme Learning Outcomes (PLOs)	PEOs		
		PEO-1	PEO-2	PEO-3
PLO-1	Academic Education	✓	✓	
PLO-2	Knowledge	✓	✓	
PLO-3	Problem Analysis	✓		
PLO-4	Design/ Development of Solutions	✓	✓	
PLO-5	Modern Tool Usage	✓		✓
PLO-6	Individual and Teamwork		✓	✓
PLO-7	Communication			✓
PLO-8	Professionalism and Society		✓	✓
PLO-9	Ethics		✓	✓
PLO-10	Life-long Learning			✓

BS GEOPHYSICS ROADMAP

Semester -1

Course code	Course Title	HEC Category	Credit Hours	17 UN SDGs alignment
ENG 101	Functional English	Gen. Edu. Course (Functional English)	3	4
PHY 103	Physics	Gen. Edu. Course (Natural Sciences)	2	4,9
PHL 103	Physics Lab		1	
CSC 102	Introduction to Computers & Programming	Gen. Edu. Course (Quantitative Reasoning)	2	4,8,9
CSL 102	Introduction to Computers & Programming Lab		1	
PAK 105	Pakistan Studies	Gen. Edu. Course (Ideology & Constitution of Pakistan)	2	4,10,16
ISL 101	Islamic Studies	Gen. Edu. Course (Islamic/Religious Studies)	2	4,10,16
GEO 105	Physical & General Geology	Major (Disciplinary)	3	4, 7, 9
MAT 105*	Mathematics	Zero Credit Course	0	4
ISL 107**	Tajweed	Non-Credit course Tajweed, Quran and Hadith (1 Contact Hour)	0	4,10,16
	Total Credit Hours		**16**	

***Academic credit of this course is zero but its contact hours, teaching material and tuition fee are equal to a 3 credit hours course.**

****Only for Muslim students**

Semester -2

Course code	Course Title	HEC Category	Credit Hours	17 UN SDGs alignment
HSS 320	Technical Writing and Presentation Skills	Gen. Edu. Course (Expository Writing)	3	4
GSC 340	Chemistry	Gen. Edu. Course (Natural Sciences)	2	3,4,6,7
GSL 340	Chemistry Lab		1	
MAT 115	Calculus & Analytical Geometry	Gen. Edu. Course (Quantitative Reasoning)	3	4,11

GEO 110	Fundamental of Geography & Geomorphology	Major (Disciplinary)	3	11.14.15
GEO 115	Introduction to Geophysics	Major (Disciplinary)	3	4,9,11
GEO 120	Field Geology	Major (Disciplinary)	3	4,9,11
ISL 108*	Understanding Quran - I	(1 Contact Hour)	0	4, 10, 16
	Total Credit Hours		**18**	

***Only for Muslim students**

Semester -3

Course code	Course Title	HEC Category	Credit Hours	17 UN SDGs alignment
GEO 201	Museology	Gen. Edu. Course (Arts and Humanities)	2	4
GEO 206	Civics and Community Engagement	Gen. Edu. Course (Civics and Community Engagement)	2	16,17
PSY 102	Introduction to Psychology	Gen. Edu. Course (Social Sciences)	2	3,4
GEO 212	Geostatistics	Interdisciplinary/Allied courses	3	4,8
GEO 205	Structural Geology	Major (Disciplinary)	3	4,9,11
GEO 210	Mineralogy & Crystallography	Major (Disciplinary)	3	4,11
GEO 215	Sedimentology	Major (Disciplinary)	3	4,11
ISL 109*	Understanding Quran - II	(1 Contact Hour)	0	4,10,16
	Total Credit Hours		**18**	

***Only for Muslim students**

Semester -4

Course code	Course Title	HEC Category	Credit Hours	17 UN SDGs alignment
xxx xxx	Ideology and Constitution of Pakistan	Gen. Edu. Course (Ideology & Constitution of Pakistan)	2	4,10,16
HSS 423	Entrepreneurship	Gen. Edu. Course (Entrepreneurship)	2	4,8,9,17
GEO 207	Applications of Information and Communication Technologies	Gen. Edu. Course (Applications of	2	4,9

GEL 207	Applications of Information and Communication Technologies Lab	Information and Communication Technologies (ICT))	1	
GEO 230	Geotectonics	Major (Disciplinary)	3	4
GEO 305	Environmental Geology	Major (Disciplinary)	3	4,8,11
GEO 325	Stratigraphy of Pakistan	Major (Disciplinary)	3	4,11
GEO 335	Earthquake Seismology	Major (Disciplinary)	3	4,11
ISL 110*	Understanding Quran - III	(1 Contact Hour)	0	4,10,16
	Total Credit Hours		**19**	

***Only for Muslim students**

Semester -5

Course code	Course Title	HEC Category	Credit Hours	17 UN SDGs alignment
GEO 321	Computing with Matlab	Interdisciplinary/Allied courses	2	9,11
GEL 321	Computing with Matlab Lab		1	
GEO 315	Igneous & Metamorphic Petrology	Major (Disciplinary)	3	4,7,9
GEO 345	Petroleum Geology	Major (Disciplinary)	3	4,7,9
GEO 350	Geology of Pakistan	Major (Disciplinary)	3	4,11
GEO 415	Economic Geology	Major (Disciplinary)	3	4,8,9
GEO 250	Field Work Report-1	Field Experience	3	4,13,15
ISL 111*	Understanding Quran - IV	(1 Contact Hour)	0	4,10,16
	Total Credit Hours		**18**	

***Only for Muslim students**

Semester -6

Course code	Course Title	HEC Category	Credit Hours	17 UN SDGs alignment
GEO 425	Research Methodology	Interdisciplinary/Allied courses	3	4
GEO 340	Wireline logging	Major (Disciplinary)	3	4,9,11
GEO 484	Quaternary Geology	Major (Disciplinary)	3	4
GEO xxx	Elective - I	Elective (Disciplinary)	3	As per list of Electives
GEO xxx	Elective - II	Elective (Disciplinary)	3	
GEO 375	Field Work Report-2	Field Experience	3	4,13,15
ISL 112*	Understanding Quran - V	(1 Contact Hour)	0	4,10,16
	Total Credit Hours		**18**	

***Only for Muslim students**

Semester -7

Course code	Course Title	HEC Category	Credit Hours	17 UN SDGs alignment
GEO 435	GIS & Remote Sensing	Interdisciplinary/Allied courses	3	4,8,11
GEO 405	Petroleum Engineering	Major (Disciplinary)	3	4,6,8
GEO 420	Hydrogeology	Major (Disciplinary)	3	8,11,12
GEO xxx	Elective - III	Elective (Disciplinary)	3	As per list of Electives
GEO xxx	Elective - IV	Elective (Disciplinary)	3	
GEO xxx	Elective - V	Elective (Disciplinary)	3	
ISL 113*	Seerah - I	(1 Contact Hour)	0	4,10,16
	Total Credit Hours		**18**	

***Only for Muslim students**

Semester -8

Course code	Course Title	HEC Category	Credit Hours	17 UN SDGs alignment
GEO xxx	Elective – VI	Elective (Disciplinary)	3	As per list of Electives
GEO xxx	Elective – VII	Elective (Disciplinary)	3	
GEO xxx	Elective – VIII	Elective (Disciplinary)	3	
GEO 442	Thesis	Capstone Project	3	4,9
ISL 114*	Seerah - II	(1 Contact Hour)	0	4,10,16
	Total Credit Hours		**12**	

***Only for Muslim students**

List of Geophysics Elective Courses

	Course code	Course Title	Credit Hours	17 UN SDGs alignment
Semester 6 Elective I and II	GEO 240	Gravity and Magnetic Exploration Techniques	3	4,10,11
	GEO 327	Environmental Geophysics	3	4,8,11
	GEO 332	Rock Physics	3	4,7,9
	GEO 367	Seismic Data Acquisition & Planning	3	4,8,7
Semester 7 Elective III, IV and V	CSC 413	Introduction to Machine Learning	2	4,9,11
	CSL 413	Introduction to Machine Learning Lab	1	
	GEO 368	Electrical & Radioactive Exploration Techniques	3	4,9,12
	GEO 390	Borehole Geophysics	3	4,12
	GEO 470	Seismic Data Processing	3	4,9,11
	GEO 411	Reservoir Geophysics	3	4,9,11
	GEO 413	Sequence Stratigraphy	3	4,9
Semester 8 Elective VI, VII and VIII	GEO 421	Ground Water Investigation	3	4,6,8
	GEO 445	Seismic Stratigraphy	3	4,9,11
	GEO 475	Seismic Data Interpretation	3	4,9,11
	GEO 479	Geospatial Techniques	3	4,9,11
	GEO 481	Mining Geophysics	3	4,9,11
	GEO 483	Applications of Geoscience Software	3	4,9,11
	GEO 485	Shallow Surface Geophysics	3	4,9,11

COURSE DESCRIPTIONS

Course Name: Functional English
Credit Hours: 3
Contact Hours: 3
Course Code: ENG 101
Contents:
Improvement of vocabulary, writing and speaking skills by using various modern language improvement tools. Practicing précis and comprehension exercises. Structural format of scientific reports and papers. Planning for writing scientific reports and papers. Significance of abstracts, introduction, illustration, tables, reference and acknowledgements. Editing techniques and their practice. Presentation, publication.
Reference Books:
Effective Writing" by Turk & Kirkman
Secrets of Successful Speakers" by Lilly Walters "Effective Speaking" by Verderber/Verderber

Course Name: Physics
Credit Hours: 2
Contact Hours: 2
Course Code: PHY 103
Contents:
Newton's gravitation law; Kepler laws; Electro statistics; Magnetisms; Amperes law; Magnetic flux density B; Reflection and refraction interference and diffraction; Natural and artificialradioactivity; Heat and Conductivity; Pressure and Density; Thermodynamic Principles; Electricityand Magnetism; Semi-Conductor; Transistors; Satellite Communication; Introduction to Meteorology.
Reference Books:
Physics by Holiday, Resnik and Krane (Latest edition). Mechanics by A. B. Pal (Latest edition). Physics by A.B. Paul (Latest edition).

Course Name: Physics Lab
Credit Hours: 1
Contact Hours: 2
Course Code: PHL 103
Contents:
Practical lab work on Newton's gravitation law; Kepler laws; Electro statistics; Magnetisms; Amperes law; 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 andMeteorology.
Reference Books:
Physics by Holiday, Resnik and Krane (latest edition).Physics by A. B. Paul (latest edition).

Course Name: Introduction to Computers & Programming
Credit Hours: 2

Contact Hours: 2

Course Code: CSC 102

Contents:

History of Computer development; application of Computers; Classification and types of computers; Basic block diagram of computer; Hardware (input, output, memory, CPU and software (system software & Application software); social impact of computer age; Computer ineducation and Scientific research; Introduction to, and history of Internet; Internet service providers and connections; the World Wide Web. Problem solving and algorithm development. Computer hardware and software. Introduction to programming: machine, assembly and high level languages. C programming language. Arithmetic and logical statements, data types, input/output, basic control structures (selection, iteration etc.).Array data type and usage of character strings. Functions: Callby-value and call-by-reference, scopes, recursion. Structures. Pointers. Bit manipulation. File processing.

Reference Books:

Basic Category Theory for Computer Scientists, C. Benjumin Piercce, 1991.

An Introduction to Computing Infrastructure: Hardware and Operating Systems, John Williams,1996, Que E and T.

Introduction to Computers, Peter Norton, 2004, Technology Education.

Introduction to Computers, Gary B. Shelly, Steven M. Freund, Misty E. Vermaat, Edition 8, 2010, Technology Education.

Course Name: Introduction to Computers & Programming Lab

Credit Hours: 1

Contact Hours: 2

Course Code: CSL 102

Contents:

Introduction to Microsoft Word, Excel, PowerPoint; Basic operations of Microsoft PowerPoint; Bibliography in MS Word; Graph plotting in MS Excel, Introduction to CorelDraw; Introduction toAdobe Photoshop; Structure of C; Input and output function of C++; Variable and Operators; Decision and Loops.

Reference Books:

An Introduction to Operating Systems-Concepts and Practice, Pramod Chandra P. Bhatt, 2004, PHI Learning Pvt. Ltd.

Introduction to Computers, Rajmohan Joshi, 2009.

Computer Networks, Andrew S. Tanenbaum, 5th Edition, Andrew S. Tanenbaum, 2010.

Course Name: Pakistan Studies

Credit Hours: 2

Contact Hours: 2

Course Code: PAK 105

Contents:

Historical background of Pakistan: Muslim society in Indo-Pakistan, the movement led by the societies, the downfall of Islamic society, the establishment of British Raj- Causes and consequences. Political evolution of Muslims in the twentieth century: Sir Syed Ahmed Khan; Muslim League; Nehru; Allama Iqbal: Independence Movement; Lahore Resolution; Pakistan culture and society, Constitutional and

Administrative issues, Pakistan and its geopolitical dimension, Pakistan and International Affairs, Pakistan and the challenges ahead.

Reference Books

Ideology of Pakistan by Sharif al-Mujahid

Course Name: Islamic Studies
Credit Hours: 2
Contact Hours: 2
Course Code: ISL 101
Contents:

The course introduces students to the Holy Quran and throws light on its different aspects. Selected verses from the Holy Quran and Hadith have been also included in the course. The course also throws light on the life of Prophet (Peace Be Upon Him).

Reference Books

Hameed ullah Muhammad, 'Introduction to Islam'.

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 Jrisprudence and the Quranic Law of Crimes"

H.S. Bhatia, "Studies in Islamic Law, Religion and Society" Deep and Deep Publications New Delhi, 1989.

Dr. Muhammad Zia-ul-Haq, "Introduction to Al Sharia Al Islamia" Allama Iqbal Open University, Islamabad, 2001.

Course Name: Physical & General Geology
Credit Hours: 3
Contact Hours: 3
Course Code: GEO 105
Contents:

Introduction and scope of geology; importance and relationship with other sciences; history and philosophy of geology; Earth as a member of the solar system; its origin, age, composition and internal structure; introduction to plate tectonics, Isostasy; mountain building processes; earthquakes and volcanoes; weathering and erosion; introduction, identification and classification of rocks; sedimentary, igneous and metamorphic structures; physical properties of mineral; introduction to fossils in sedimentary rocks; introduction to folds, faults, joints, cleavage, foliation, lineation; Geological Time Scale; Concept and techniques of geological dating, relative and absolute dating;; Use of Brunton Compass and GPS, etc. Energy and mineral resources, including origin, uses, and environmental consequences.

Reference Books

Physical Geology (15 th Edition) by Charles Plummer, Diane Carlson, Lisa Hammersley, 2015, McGraw-Hill

Laboratory Manual in Physical Geology (9th Edition), Richard M. Busch, 2011, AmericanGeological Institute, Pearson Education

Physical Geology, By Plummer, (14th Edition), Charles (Carlos) Plummer, Diane Carlson, Lisa Hammersley, 2012 McGraw-Hill
Principles of Physical Geology by Holmes, A., 1978, Nelson.

Course Name: Mathematics
Credit Hours: 0
Contact Hours: 3
Course Code: MAT 105
Contents:
Polynomials, Linear Functions, Quadratic Equations and their solution, Algebra of Matrices, Determinants, Inverse of a square matrix, Cramer's Rule, Rational fractions into partial fractions,Partial fractions for non-repeated linear, repeated linear and non-separable roots, Binomial Theorem, Mathematical Induction, Converting logarithmic functions into exponential functions,Sequences and series, Limits, Average and Instantaneous rate of change, Scalars and Vectors, Dot product, Cross Product, Angles of Measurement, Trigonometric Ratios and Trigonometric Identities, Analytical Geometry, Classifications of conics, Differentiation, Integration.
Reference Books
Dolciani MP, Wooton W, Beckenback EF, Sharron S, Algebra 2 and Trigonometry, 1978, Houghtonand Mifflin,Boston (suggested text).
Kaufmann JE, College Algebra and Trigonometry, 1987, PWS-Kent Company, Boston SwokowskiEW, Fundamentals of Algebra and Trigonometry (6th edition), 1986, PWS-Kent Company, Boston.

Course Name: Technical Writing and Presentation Skills
Credit Hours: 3
Contact Hours: 3
Course Code: HSS 320
Contents:
The Writing Process, Objectives in Technical Writing, Audience Recognition and Involvement, Criteria for Writing Reports, Summaries, Letters and Proposals, Research Paper Writing, Oral Communication, Writing Technical Descriptions, Instruction and User Manuals, The Job Search. Public Speaking & Presentation Skills, Meeting & Interviewing Skills, Non Verbal Communication,Project Reviewing.
Reference Books
Writing. Advanced by Ron White. Oxford Supplementary Skills. Third Impression 1992.College Writing Skills by John Langan. McGraw-Hill Higher Education. 2004.
Patterns of College Writing (4th edition) by Laurie G. Kirszner and Stephen R. Mandell. St. Martin's Press.
Collins COBUILD Students' Grammar. London: Longman Eastwood, J. 2004. Oxford Practice Grammar. New Ed., with tests and answers. O UP Goatly, A. 2000Critical Reading and Writing: An Introductory Course. London: Taylor & Francis

Course Name: Chemistry
Credit Hours: 2
Contact Hours: 2
Course Code: GSC 340

Contents:

Periodic Table, chemical bonding: ionic, covalent, coordinate covalent bond.Solution chemistry. Surface chemistry. Colloids chemistry. Thermodynamics and chemical kinetics. General chemistryof functional groups of organic compounds (alcohols, carbonyls, esters, carboxylic acids, amines).Aromatic compounds, ions, radicals. Photochemical reactions. Radioactivity. Weak Acids & Bases; Water Hardness; Redox Reactions, Chemical Kinetics; Radioactivity. Organic and Inorganic Compounds, Solubility of compounds.

Reference Books

A Comprehensive Treatise on Inorganic and Theoretical Chemistry Vol II By J. W. Mellor

Course Name: Chemistry Lab

Credit Hours: 1

Contact Hours: 2

Course Code: GSL 340

Contents:

Preparation of molar, molar, normal solutions and buffers. Osmosis and Diffusion. Measurementof pH, EC, DO and TDS in waste water. Use of titrimetric and gravimetric analysis. Use of spectrophotometric techniques. Paper Chromatography (one and two dimensional)

Reference Books

A Comprehensive Treatise on Inorganic and Theoretical Chemistry Vol II By J. W. Mellor

Course Name: Calculus & Analytical Geometry

Credit Hours: 3

Contact Hours: 3

Course Code: MAT 115

Contents:

The main contents are Preliminaries (Real-number line, functions and their graphs, solution of equations involving absolute values, inequalities). Limits and Continuity (Limit of a function, left-hand and right-hand limits, continuity, continuous functions). Derivatives and their Applications (Differentiable functions, differentiation of polynomial, rational and transcendental functions, derivatives). Integration and Definite Integrals (Techniques of evaluating indefinite integrals, integration by substitution, integration by parts, change of variables in indefinite integrals).

Reference Books

Anton H, Bevens I, Davis S, Calculus: A New Horizon (8th edition), 2005, John Wiley, New York.Stewart J, Calculus (3rd edition), 1995, Brooks/Cole (suggested text).

Swokowski EW, Calculus and Analytic Geometry, 1983, PWS-Kent Company, Boston. Thomas GB, Finney AR, Calculus (11th edition), 2005, Addison-Wesley, Reading, Ma, USA.

Course Name: Fundamental of Geography & Geomorphology

Credit Hours: 3

Contact Hours:

Course Code: GEO 110

Contents:

This course examines the concepts and processes of physical geography that govern the functionof the atmosphere, lithosphere, hydrosphere, and biosphere using an earth-systems approach. Course lectures and lab topics introduce the sciences of cartography, meteorology, climatology, geomorphology, hydrology, biogeography, and soils. A focus on how human activities impact the environment, such as climate change and other real-world issues will also be addressed. Periglacial processes and landforms.

Reference Books

"Key Concepts in Geomorphology" by Paul R. Bierman and David R. Montgomery, published by Freeman & C (2021).

Geomorphology: The Mechanics and Chemistry of Landscapes, Robert S. Anderson, Suzanne P. Anderson, 2010, Cambridge University Press.

Process Geomorphology by Ritter, Kochel and Miller, 2002, the McGrawHill Company.Fundamentals of Geomorphology by Richard Huggett · 2016

Fundamentals of Physical Geography by James Petersen, Dorothy Sack, Robert E. Gabler · 2014

Course Name: Introduction to Geophysics

Credit Hours: 3

Contact Hours: 3

Course Code: GEO 115

Contents:

Introduction to geophysics and geodynamics of earth. Classification and brief description of various methods of geophysics such as seismic; gravity, magnetic; electrical. Geophysical data acquisition, processing, and interpretation; applications of geophysical techniques for exploration of natural resources i.e., oil, gas, metallic minerals, ground water and engineering works. Operating geophysical equipment and analyzing data collected using a wide array of geophysical techniques.

Reference Books

Whole Earth Geophysics: An Introductory Textbook for Geologists and Geophysicists, Robert J.Lillie, 2008, Prentice Hall.

Gravity and Magnetic Exploration: Principal, Practices, and Application, William J. Hinze, Ralph R. B. von Frese, Afif H. Saad, 2013.

Introduction to Applied Geophysics by Burger R. H., Sheehan, A. and Jones, C. 2000, W. W.Norton.

Course Name: Field Geology

Credit Hours: 3

Contact Hours: 3

Course Code: GEO 120

Contents:

Instruments used in field mapping. Introduction to topographic and Geological maps. Methods and techniques of surface and subsurface Geological mapping. Correlation techniques. Field description of igneous, metamorphic and sedimentary rocks. Modes of Geological illustration including structural contour, isopach and litho-facies maps, block and fence diagrams. Field mapping, preparation of Geological maps and cross-section. Fieldwork: Each student is requiredto do Fieldwork and submit a report in the examination. The Fieldwork should cover; observationof physical features and their plotting on topographic sheet. Study of geomorphic feature. Measurement of stratigraphic sections.

Recognition of structural features. Fauna observation. Study of primary and secondary structures. Field description of sedimentary, igneous and metamorphic rocks. Practical Semi-Independent Field And Geological Mapping.

Reference Books

Introduction to Field Geology, Bevier, M.L., 2006. McGraw-Hill RyersonLecture Series by University of Nairobi; SGL:308.

Course Name: Museology

Credit Hours: 2

Contact Hours: 2

Course Code: GEO 201

Contents:

Introduction to Museology provides a broad, theory-based introduction to the museum sector and the research field of museology. Focusing on museum ethics, the course also give attention to all museum activities. Excursions to different museums and guest lectures from the museum sector give the students insights into the museum practice and provide present day examples and discussions, which they may study by using museological theories, dilemmas in museum ethics, and knowledge in museum history.

Reference Books

The International Handbooks of Museum Studies by Sharon Macdonald et al. (2015). Manual of Museum Exhibitions by Barry Lord (2014)

Museum Collections Management by Freda Matassa (2011). Dictionary of Museology by François Mairesse · 2023

New Horizons for Asian Museums and Museology Naoko Sonoda · 2016

Course Name: Civics and Community Engagement

Credit Hours: 2

Contact Hours: 2

Course Code: GEO 206

Contents:

This course aims to bring responsible citizenship and active engagement between Universities/HEIs (through their students) and local communities. The course will provide students with a foundational understanding of the principles, institutions, and processes of civic engagement in a democratic society. Moreover, the course will build the capacity of students asleaders and influencers by gaining fundamental understanding of leadership, citizenship, communication, advocacy, network building as well as having first-hand experience of community development through volunteer works.

Reference Books

Managing Civic and Community Engagement by David Watson · 2007

Higher Education and Civic Engagement: Comparative Perspectives by L. McIlrath, A. Lyons 2012

Course Name: Introduction to Psychology

Credit Hours: 2

Contact Hours: 2

Course Code: PSY 102

Contents:

The course is designed to introduction to understand the vocabulary and concept of psychology. Understand how critical thinking is proclaimed to be scientific or based on research. Describe thecritical development and led to the present discipline of psychology contrast and compare the three majors, also apply psychology theory in some area of his /her life.

Reference Books

Introduction to Psychology by Charles Stangor · 2021

Introduction to Psychology: Gateways to Mind and Behavior by Dennis Coon, John O. Mitterer,Tanya S. Martini · 2021.

Course Name: Geostatistics

Credit Hours: 3

Contact Hours: 3

Course Code: GEO 212

Contents:

Descriptive statistics and exploratory data analysis, random variable; moments; probability distributions; normal and lognormal distributions, random function model, modeling spatial continuity; experimental variograms covariance functions; correlograms and madograms; variogram and covariance function models; isotropy and anisotropy, estimation methods: simplekriging.

Reference Books

Kitanidis, P.K. (1997) Introduction to geostatistics: applications in hydrology.Goovaerts,Pierre (1999) Geostatistics for Natural Resource Evaluation.

Olea, R. A. (1999) Geostatistics for Engineers and Earth Scientists. Christakos, G (2000) Modern Spatiotemporal Geostatistics.

Webster, R. and Webster, M (2001) Geostatistics for Environmental Scientists.

Course Name: Structural Geology

Credit Hours: 3

Contact Hours: 3

Course Code: GEO 205

Contents:

Dynamics of rock deformation and mechanical properties of rocks; Stress and strain concepts; Factors controlling mechanical behavior of Materials; Folds classification based on morphology, geometry, and vergence; Mechanics of fold formation; Faults classification based on geometry and genesis; Structures in compressional and extensional regimes; Classification of Joints, foliations and lineation; Unconformities, their classification and recognition. Laboratory exercises on geologic map interpretation and cross sections; Field trips to area where good Geological structures are exposed. Map exercises, linear and planar structures, and construction of geological cross-sections; orthographic projections (geometrical exercises); stereographic projections, fault plane solutions, stress and strain analysis using oriented samples and use of structural computer software. Kinematic analysis, paleostress and folding, microscale deformation

Reference Books

Physical geology by plummer, Turbak and MarshikField geology by Kompton

Structural geology of rocks and regions by Davies

Geological structures and maps by Richard j lisle

Course Name: Mineralogy & Crystallography
Credit Hours: 3
Contact Hours: 3
Course Code: GEO 210
Contents:
Introduction to Crystallography; elements of symmetry, symmetry operations, crystal notation, crystal systems study of normal classes of crystallographic systems; Classification and system study of minerals with an emphasis on their crystallographic features, physical properties, Chemical composition, occurrences, associations and uses; Introduction to X-ray crystallography.Study of crystal morphology, preparation of crystal models, orientation of crystallographic axes in different systems, identifying elements of symmetry, symmetry of different crystal systems, crystal forms. Identification and description of different physical properties of the minerals. Introduction to Thermodynamics.
Reference Books
Dana's textbook of mineralogy

Course Name: Sedimentology
Credit Hours: 3
Contact Hours: 3
Course Code: GEO 215
Contents:
Introduction; Sediments, their origin, transportation and deposition; Stratification, digenesis, lithification and origin of sedimentary rocks; Depositional environments; Sedimentary basins; Sedimentary structures, their morphology and interpretation: Classification, composition and textures of sedimentary rocks and their descriptive study. Genetic stratigraphy.
Reference Books
Sand and Sandstone by Pettijohn, F. J., Potter, P. E. and Siever, R., 1972, Springer-Verlag.
Principles of Sedimentology by Friedman, G. M. and Sanders, J. E., 1978, John Wiley and Sons.
Depositional Sedimentary Environments by Reineck, H. E. and Singh, I. B., 1980, Springer-Verlag.
Carbonate Sedimentology by Tucker, M. E. and Wright, V. P., 1990, Blackwell.

Course Name: Ideology and Constitution of Pakistan
Credit Hours: 2
Contact Hours: 2
Course Code: xxx xxx
Contents:
Defining ideology and its significance, Difference between Philosophy, Ideology and Theory, The Historical Framework to the Creation of Pakistan, The Ideological Framework of Pakistan, Founding Fathers and their Contributions to the Ideology, Evolution of the Constitution of Pakistan, The Government of India Act, 1935, and its impact on Pakistan, The first Constitution of Pakistan (1956), The Constitution of 1962 and its significance, The 1973 Constitution and its main features, Amendments and major changes in the Constitution over the years, Citizen's duties and responsibilities
Reference Books

"Pakistan: A Modern History" by Ian Talbot
"Constitution of Pakistan" by Hamid Khan
"The Making of Pakistan: A Study in Nationalism" by K.K. Aziz
"Constitutional and Political History of Pakistan" by Hamid Khan
"Pakistan's Foreign Policy: An Historical Analysis" by M. Rasul Bakhsh Rais

Course Name: Entrepreneurship
Credit Hours: 2
Contact Hours: 2
Course Code: HSS 423
Contents:
The Nature and Importance of Entrepreneurship: Nature and Development of Entrepreneurship; Entrepreneurial Decision Process; Role of Entrepreneurs in Economic development; Ethics and Social Responsibility of Entrepreneurship; The Future of Entrepreneurship The Entrepreneur and Entrepreneurial Mind: The Entrepreneurship process; Myths of Entrepreneurs, Managerial VS Entrepreneurial Decision Making; Entrepreneurial Leadership Characteristics The Nature and Importance of SMEs: Nature and Scope of Entrepreneurship; SMEs Definitions / Understanding by various Regulatory Authorities in Pakistan; SMEs contribution to GDP of any country, and of Pakistan; SMEDA' s Role in promoting and developing SMEs. The Individual Entrepreneur, and Techniques for Idea Generation Process; Entrepreneur VS Intrapreneur. Inside the Entrepreneurial Mind: From Ideas to reality: Creativity, Innovation and Entrepreneurship; Creativity A necessity for survival; Creative Thinking; Barriers to creativity; How to enhance creativity; The creative Process; Techniques for improving the creative process; Protecting your ideas.The Customer and Product Plan/Feasibility: Understanding of Customer through Demand and Desire, and of Product (Good and/or Service) The Industry and Marketing Plan/Feasibility: Understanding of Marketing Plan, Characteristics of Marketing Plan; and Environment Analysis and Steps in preparing the Marketing Plan The Financial Plan/Feasibility: Operating and Capital Budgets, Break Even Analysis; Cash Flows and Balance Sheets The Organizational Plan/Feasibility: Developing the management team; Building the successful Organization, The Role of BODs. Components, and Classification of Business Plans Financing Options: e.g. Leveraged Buyouts; Preparing for the new Launch; Execution & Growth; Managing early growth of the New ventures.Analysis, and Competitive Environment Analysis. Growth Options: Joint Venture; Franchising; Acquisitions; Synergy; Mergers; Hostile Takeovers; Licensing etc.
Reference Books
An Introduction to Entrepreneurship Eamonn Butler 2020

Course Name: Applications of Information and Communication Technologies
Credit Hours: 2
Contact Hours: 2
Course Code: GEO 207
Contents:
Brief history of Computer, Four Stages of History, Computer Elements, Processor, Memory, Hardware, Software, Application Software its uses and Limitations, System Software its Importance and its Types, Types of Computer (Super, Mainframe, Mini and Micro Computer), Introduction to CBIS (Computer Based Information System), Methods of Input and Processing, Class2. Organizing Computer Facility,

Centralized Computing Facility, Distributed Computing Facility, Decentralized Computing Facility, Input Devices. Keyboard and its Types, Terminal (Dump, Smart, Intelligent), Dedicated Data Entry, SDA (Source Data Automation), Pointing Devices, Voice Input, Output Devices. Soft- Hard Copies, Monitors and its Types, Printers and its Types, Plotters, Computer Virus and its Forms, Storage Units, Primary and Secondary Memories, RAM and its Types, Cache, Hard Disks, Working of Hard Disk, Diskettes, RAID, Optical Disk Storages (DVD, CD ROM), Magnetic Types, Backup System, Data Communications, Data Communication Model, Data Transmission, Digital and Analog Transmission, Modems, Asynchronous and Synchronous Transmission, Simplex. Half Duplex, Full Duplex Transmission, Communications, Medias (Cables, Wireless), Protocols, Network Topologies (Star, Bus, Ring), LAN, LAN, Internet, A Brief History, Birthplace of ARPA Net, Web Link, Browser, Internet Services provider and Online Services Providers, Function and Features of Browser, Search Engines, Some Common Services available on Internet.

Reference Books:

Information Communication Technologies Concepts, Methodologies, Tools and Applications by Craig Van Slyke · 2008

Course Name: Applications of Information and Communication Technologies Lab

Credit Hours: 1

Contact Hours: 2

Course Code: GEL 207

Contents:

Practical exercises will be carried out in lab.

Reference Books:

Information Communication Technologies Concepts, Methodologies, Tools and Applications by Craig Van Slyke · 2008

Course Name: Geotectonics

Credit Hours: 3

Contact Hours: 3

Course Code: GEO 230

Contents:

Review of various tectonic theories; Historical development of the plate tectonic theory; Plate Movements, Mantle Plumes, Plate Boundaries, Detail study of plate tectonics; Orogenic belts and evolution of folded mountains; Young folded mountains of the earth with special emphasis on mountain belt in Pakistan; Regional Tectonics of Pakistan. Isotope Dating.

Reference Books

Global Tectonics (Philip Kearey, Keith A. Klepeis and Frederick J. Vine) Plate Tectonics & Crustal Evolution (Kent C. Condie)

Plate Tectonics, Continental Drift and Mountain Building - Wolfgang Frisch, Martin Meschede and Ronald C Blakely Springer 2011)

Course Name: Environmental Geology

Credit Hours: 3

Contact Hours: 3

Course Code: GEO 305

Contents:

Fundamental concepts of Environmental Geology; Soil; Earth Materials & Processes; Application of Geology to a broad environmental concerns of Society; Evaluation of natural hazards, floods, landslides, subsidence, earthquakes, volcanic activity and coastal erosion; Water resources; Waste disposal management; environmental related health effects; Environmental impacts of mining, petroleum and gas exploitation; Geology in land use and urban planning; Environmental Geology mapping; Preparation of environmental impacts Statements.

Reference Books

Environmental Geology by Carla W. Montgomery 2013

Environmental Geology Workbook by Jack W. Travis · 2019

Course Name: Stratigraphy of Pakistan

Credit Hours: 3

Contact Hours: 3

Course Code: GEO 325

Contents:

Principle of stratigraphy; laws of superposition and faunal succession. Geological time scale with divisions. Classification and nomenclature of strati graphics units: lithostratigraphic units, biostratigraphic units and chronostratigraphic units. Geological time scale with divisions. Stratigraphic Code of Pakistan. Principle of stratigraphic correlation. Outline of stratigraphy of Pakistan. Stratigraphy of Indus Basin and Baluchistan Basin.

Reference Books

Shah, S. I. (2000). Stratigraphy of Pakistan. Quetta: Geological Survey of Pakistan.

Kazmi, A. H., & Abbasi, I. A. (2008). Stratigraphy & historical geology of Pakistan. Peshawar: Department & National Centre of Excellence in Geology.

Boggs Jr, S. (2014). Principles of sedimentology and stratigraphy.

Course Name: Earthquake Seismology

Credit Hours: 3

Contact Hours: 3

Course Code: GEO 335

Contents:

Causes and effects of earthquakes; Methods to locate and to assign magnitudes to earthquakes;Types of seismic waves, their propagation; Estimation of Omori's coefficient and its role towardsearthquake location, Computation of dynamic ranges and memory size; Seismic phases at the rock boundaries; man-made earthquakes; Seismometery. Seismic waves and their analysis in earthquake seismology. Frequency, magnitude of earthquake and their relationship. Seismic source parameters. Composite fault plane solutions of earthquakes and their interpretation. Geographical distribution of important earthquakes. Teleseismic waves and interior of the earth,Earthquakes and their implication on the tectonics of the area. Anistropy Analysis

Reference Books:

Micro-Earthquake Seismology and Seismotectonics of South-Asia by J.R. Kayal Introduction to Seismology by Peter M. Shearer

Anatomy of Seismograms by Ota KulhanekHandouts for the lectures.

Course Name: Computing with Matlab
Credit Hours: 2
Contact Hours: 2
Course Code: GEO 321
Contents:
Matlab basics (getting mat lab to run, programming, the command prompt, simple expressions, variables and referencing matrix elements), getting mat lab to run, programming, the command prompt, simple expressions, variables, referencing matrix elements, matrices, accessing matrix elements, assigning into sub-matrices, basic tools, matrix concatenations, more expression, plotting, logical constructs, formatting text, flow control, "if" statement, "for" loops. Defining functions, "while" statements, variable scope, functions and logic, multiple input functions, more on logic, basic lab commands, programming structures, bsic graphing routines, advanced matrix operations, file input/output, writing and calling functions, data structures and input assertion, mat lab compiler, practical computer-based exercise.
Reference Books
MATLAB: A Practical Introduction to Programming and Problem Solving, 3rd edition, Stormy Attaway, Elsevier, 2013.

Course Name: Computing with Matlab Lab
Credit Hours: 1
Contact Hours: 2
Course Code: GEL 321
Contents:
Lab: Introduction to Matlab; MATLAB as Calculator (Artimatic Operations); Elementary Math Functions; Scalar variables, Predefined Variables; Complex numbers; Built-In functions for handling arrays; Writing, saving, and execute MATLAB programs; Fundamental form MATLAB uses to store and manipulate data; Matrices operations: addition and subtraction of arrays Multiplication, division, and exponentiation; element-by-element operations; Matrices operations: element-by-element operations; Matrices operations: element-by-element operations; How to input data to a script file; How data are stored in MATLAB; How to exchangedata between MATLAB and other applications; Yield 2- and 3-D plots in Matlab; Standard plots with linear axes, logarithmic and semi-logarithmic axes, bar and stairs plots, polar plots, three- dimensional contour surface and mesh plots; Relational operators; Logical operators; Conditional statements; Loops; User-defined functions and function files.
Reference Books
MATLAB: A Practical Introduction to Programming and Problem Solving, 3rd edition, Stormy Attaway, Elsevier, 2013.

Course Name: Igneous & Metamorphic Petrology
Credit Hours: 3
Contact Hours: 3
Course Code: GEO 315
Contents:

Nature and generation of magma; Magmatic crystallization and differentiation; Mode of occurrence and types of extrusive and intrusive igneous rock bodies; Structure and textures of igneous rocks; Classification and systematic study of igneous rocks; Processes and types of metamorphism and tectonism; Field and Laboratory study of igneous rocks in Hand specimen study of igneous and metamorphic rocks; Field trip to igneous & metamorphic areas.

Reference Books

An Introduction to Igneous and Metamorphic Petrology by John D. WinterIgneous petrology by Wilson Physical Geology by Charles C Plummer Physical Geology by Mark J. Crawford Metamorphic Petrogenesis by David

Course Name: Petroleum Geology

Credit Hours: 3

Contact Hours: 3

Course Code: GEO 345

Contents:

Introduction; Properties of petroleum and natural gas; Origin, migration and accumulation of hydrocarbons; Related source, reservoir and seal rocks; Reservoir properties; Various types of Geological traps for hydrocarbon accumulation; Concept of petroleum province and introductionto basin analysis. Play Fairway Analysis and Risk Assessment.

Reference Books

Petroleum Geochemistry and Geology by Hunt J M.

Hydrocarbon Exploration and Production by Jahn F and Graham M.Geology of Petroleum by Leverson.

Petroleum Geology for Geoscientists by Prof Ifeanacho Paul Orajaka and Dr Johnbosco AzubuikeOnyeji.

Course Name: Geology of Pakistan

Credit Hours: 3

Contact Hours: 3

Course Code: GEO 350

Contents:

Physiographic and tectonic divisions and their descriptions. Geology and stratigraphy of the Indian plate. Karakoram plate, Afghan block and Arabian plate. Kohistan, Chagai and Ras Koh magmatic arcs, oroclines and sutures zones. Regional metamorphism (Himalayan and Pre-Himalayan). Main episodes of magmatism and their relation to tectonics. Economic mineral andfuel deposits of Pakistan.

Reference Books

Stratigraphy of Pakistan, GSP Memoirs Vol.22 by DR. S. M. Ibrahim ShahStratigraphy and Historical Geology of Pakistan by Kazmi and Abbasi Geodynamics of Pakistan by De Jong

Metallogeny and Mineral Deposits of Pakistan by Kazmi and Abbasi

Course Name: Economic Geology

Credit Hours: 3

Contact Hours: 3

Course Code: GEO 415

Contents:

Introduction and historical development of economic Geology; Processes of formation, classification and importance of mineral deposits; Physical and Chemical controls of mineral deposition; Wall rock alteration; Para genesis and zoning; Occurrence, association of ore deposits; Hand specimen studies of common metallic and industrial mineral.

Reference Books

Metals and Society: An Introduction to Economic Geology by Arndt, and C. Ganino – 2012, Springer.

Economic Geology: Principles and Practice by Walter L. Pohl – 2011, John Wiley and Sons.

Introduction to mineral exploration by Charles and Micheal. 2006, Blackwell.

Hand book of mineral and coal exploration in British Colombia by Aime and MABC.2009, Springer.

Directory of Mineral Deposits of Pakistan by Zaki, A., 1969, Geological Survey of Pakistan.

Ore Deposits by Park, C.F. and Mac Diarmid, R.A.,1970, W. H. Freemanand Co.

Course Name: Field Work Report-1

Credit Hours: 3

Contact Hours: 3

Course Code: GEO 250

Contents:

Four days fieldwork in geologically important areas to further train the students in geological field techniques; Method of data collection and measurement of stratigraphic section; Identification of complex structures, sample collection techniques. Use of field instruments and Geological mapping procedures; Rock and mineral identification and collection. A written Geological report at the end of semester.

Reference Books

Stratigraphy of Pakistan (2009) by S.M.I. Shah.Petroleum Geology by George F.K. North.

Petroleum Geosciences by Knut Bjørlykke.

Published research articles on the study area.

Course Name: Research Methodology

Credit Hours: 3

Contact Hours: 3

Course Code: GEO 425

Contents:

An Overview of Research Methods and Methodologies; Difference Between “Method” and “Methodology”; Epistemology, Methodology, and Method; An Overview of Empirical Research Methods: Descriptive (Qualitative) & Experimental (Quantitative); Assessing Methods; Ethnographies; Case Studies; Survey Research; Focus Groups; Discourse/Text Analysis; Quantitative Descriptive Studies; Prediction and Classification Studies; Meta-Analysis; Validity in Research; Reliability in Research; Rigor in Research; Key Considerations to Design Your ResearchApproach; The Importance of Methods and Methodology.

Reference Books

Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, by John W. Creswell

Course Name: Wireline Logging

Credit Hours: 3
Contact Hours: 3
Course Code: GEO 340
Contents:
Introduction; Types of Logs; Methods and principles; Factors influencing Logs; Resistivity logs; SPlogs; Gamma Ray logs; Formation density logs; Neutron logs; Sonic logs; Caliper logs. Applicationof logs; Porosity determination; Lithology and Hydrocarbon Detection; Structural interpretation;Correlation. Identification of lithologies and crossplots, Class exercises to compute petrophysical properties using wireline logs. Laboratory petrophysics application, borehole Logging design.
Reference Books
Petrophysics by Glover, P. W. (2000). University of Aberdeen.
The geological interpretation of well logs by Rider, M. H. (1986).
Basic well log analysis by Asquith, G. B., Krygowski, D., & Gibson, C. R. (2004).
Schlumberger – Log interpretation Principles/Applications

Course Name: Quaternary Geology
Credit Hours: 3
Contact Hours: 3
Course Code: GEO 484
Contents:
The Quaternary period: Character, duration, development and climatic changes; soil characteristics; soil stratigraphy; morphological evidence and landforms; Quaternary environments; Pleistocene glaciation and sea level changes; lithological evidence of environments; types of sediments; isotopes in deep-sea sediments; biological evidence; plant fossils and animal remains; dating methods; Quaternary stratigraphy and correlation; Quaternary geology, geochronology and neotectonics; Quaternary deposits of Pakistan and its importance (alluvial, fluvial, colluvial, lacustrine, glacial and eoline deposits).
Reference Books
Quaternary Geology by An Zhisheng, Weijian Zhou. Glacial and Quaternary geology by Richard Foster Flint.

Course Name: Field Work Report-2
Credit Hours: 3
Contact Hours: 3
Course Code: GEO 375
Contents:
Four days fieldwork in geologically important areas to further train the students in geological field techniques; Method of data collection and measurement of stratigraphic section; Identification of complex structures, sample collection techniques. Use of field instruments and Geological mapping procedures; Rock and mineral identification and collection. A written Geological report at the end of semester.
Reference Books
Stratigraphy of Pakistan (2009) by S.M.I. Shah.Petroleum Geology by George F.K. North.
Petroleum Geosciences by Knut Bjørlykke.

Published research articles on the study area.

Course Name: GIS & Remote Sensing
Credit Hours: 3
Contact Hours: 3
Course Code: GEO 435
Contents:
Introduction to Geographical Information System; data types, data models and structures; data sources and capturing techniques; displaying and manipulating spatial information, vector data preparation, 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. Introduction to ArcGIS, Exploring GIS Data set in Arc Catalog, working on vector data in ArcGIS(Scanning, Digitization and Editing), Integrating GPS data in GIS Environment, Applications of GIS, ERDAS Imagine, ENVI - Environnent, Noise Corrections, Geometric Corrections, RadiometricCorrections.
Reference Books
Remote Sensing by Siamak Khorram, Frank H. Koch, Cynthia F. Van der Wiele. 2012. Springer. Introduction to Geographic Information Systems by Kang-Tsung Chang. 2010. McGraw-HillPublishers. GIS: Fundamentals, Applications and Implementations by Elangovan. 2006. McGraw-HillPublishers. Remote Sensing of the Environment by John R. Jensen. 2009. Amazon publishers.
Matt Duckham, Michael F. Goodchild, Michael F. Worboys, 2003, Foundations of Geographic Information Science, Tylor and Francis, New York, USA.

Course Name: Petroleum Engineering
Credit Hours: 3
Contact Hours: 3
Course Code: GEO 405
Contents:
Origin and formation of the hydrocarbons (mainly petroleum), methods and processes to drill a well bore, well types, rig components, drilling equipment, drilling fluids, cores, coring methods and their analysis, casing and cementation of the well bore to make it stable, introduction to mud logs and logging method, pressure calculation, lag time calculations, production testing, well completion, logging techniques used in well analysis,
Reference Books
Reservoir Engineering Handbook by Tarek Ahmed (2010) 4th Edition, Gulf Professional Publishing, Elsevier
Hydrocarbon Exploration and Production by Frank Jahn, Mark Cook and Mark Graham (2008) 2nd Edition, Elsevier.
Well Engineering & Construction by Hussain Rabia (2002), London: Entrac Consulting Limited.
Petroleum Engineering: Drilling and Well Completions by Carl Gatlin (1960), Prentice Hall.

Course Name: Hydrogeology
Credit Hours: 3
Contact Hours: 3

Course Code: GEO 420

Contents:

The hydrologic cycle. Aquifer system and types; occurrence and movement of groundwater; hydrologic properties of rocks and their measurements, fluctuation of groundwater levels and causes; recharge and discharge of ground water; groundwater exploration by geological, hydro- geological and geophysical methods and remote sensing techniques; well hydraulics, tube well drilling techniques, designing, development; flow-net analysis and pumping tests; water loggingand causes of water table declination; groundwater chemistry, salinity, quality analysis and deterioration of water quality. Groundwater resources of Pakistan.

Reference Books

Hydrogeology: objectives, methods, applications by Ric Gilli, Eric Gilli, Christian Mangan, 2012,CRC Publishers Taylor and Francis Group, USA.

Hydrogeological Conceptual Site Models: Data Analysis and Visulization by Neven Krešić, Alex Mikszewski. 2012. CRC Publishers Taylor and Francis group, USA.

Fundamentals of Hydrology by Tim Davie. 2012. Rourledge for Taylor and Francis Group, USA. Elementary Hydrogeology by Singh. 2010. Prentice Hall, USA.

Hydrogeology Lab Manual by Lee. 2010. Prentice Hall, USA. Hydrogeology, Principles and Practice by Geofluids, S. Q. L., 2

Course Name: Thesis

Credit Hours: 3

Course Code: GEO 442

Contents:

Involves research work in any field of interest related to Geology and submission of a dissertation.

Geology Elective Courses

Course Name: Optical Mineralogy
Credit Hours: 3
Contact Hours: 3
Course Code: GEO 221
Contents:
Review of the rock-forming minerals – occurrences and associations, light & its nature, basic principles of polarized light microscopy (PLM) & its applications to mineral identification, optical properties of minerals, types of microscopic samples, refractometry, optics of isotropic minerals, optics of anisotropic minerals, uniaxial optics, biaxial optics, reflected light optics. Practical use of different parts of petrographic microscope. Centering of microscopic stage. Identification and description of common minerals; study of rocks and minerals in thin sections, texture and composition; classification of rocks using different techniques, volume estimates and other elementary petrographic techniques. Use of bertrand lens, use of accessory plates, indicatrices and interference figures.
Reference Books
Optical Mineralogy by William D NesseOptical Mineralogy by Paul F Kerr

Course Name: Geochemistry
Credit Hours: 3
Contact Hours: 3
Course Code: GEO 225
Contents:
Introduction; Nature of geochemical data and methods of analysis; Composition of solar system, meteorites and the earth; Geochemical classification of elements; Factors governing behavior of elements in Geological processes; Eh and pH diagrams; Geochemistry of igneous, sedimentary, and metamorphic rocks; Geochemical cycle; Introduction to exploration, environmental and analytical geochemistry; Laboratory instrumentation and common analytical methods involving rocks, soils, minerals and water.
Reference Books
Krauskopf & Bird (1995): Introduction to GeochemistryAlbarede: Essentials of Geochemistry
Rollinson: Using Geochemical Data
Petroleum Formation and Occurrence by B.P. Tissot and D.H. WelteHarry, steven, Maria: Geochemistry Tulane University, Prof. Stephen A. Nelson notes

Course Name: Paleontology
Credit Hours: 3
Contact Hours: 3
Course Code: GEO 310
Contents:
General introduction of paleontology and fossils occurrence; Modes of preservation, limitations and Geological distribution of fossils; Evolutionary trends; Systematic study of the principal phyla of invertebrates; Fossils habitats and time ranges of fossils; Practical include the systematic study of

important genera of the main invertebrate fossil phyla; Field trips to fossil bearing localities. Introduction to vertebrate paleontology.

Reference Books

Invertebrate Paleontology & Evolution (E.N.K. Clarkson).

Invertebrate Fossils (Raymond C. Moore, Cecil G. Lalicker, Alfred G. Fisgher).

Course Name: Marine Geology

Credit Hours: 3

Contact Hours: 3

Course Code: GEO 320

Contents:

Development of marine geology, contribution of deep sea drilling projects (DSDP) an Oceanic Drilling Program (ODP), Hypsometry, topographic features of the ocean. Plate tectonics and sea floor spreading, major ocean basins, gulfs and seas. Geology of continental margins, estuaries, deltas, barrier islands and coral reefs. Sediment types and distributions, shelf sedimentation in marine geology. Worldwide level changes through time.

Reference Books

Marine Geology: A planet Earth Perspective by Anderson, R. N.,1986, New York: John Wiley.

A Work book in Oceanography by Dudley, W. C and Min Lee, 1982, Alpha Editions, A division ofBurgess Publishing Co. Minnesota.

Marine Geology by James P. Kennett, 1982, Prentice-Hall, INC, Englewood Cliffs, N.J.

Initial Reports of the Deep Sea Drilling Project, 1975, Vol. 29/ 32/ Washington, D. C.; U. S. Government Printing Office.

The submerged continental margin by McGregor, B. A.,1984, American Scientist 72 (3): 275-81.

Course Name: Micropaleontology and Biostratigraphy

Credit Hours: 3

Contact Hours: 3

Course Code: GEO 330

Contents:

Introduction to Foraminifera, Bryozoa, Ostracoda, Conodonts, Algae, Pollen and Spores; Organicwalled microplanktons and nano-fossils; Principles of bio-stratigraphy and bio-stratigraphic zones; Biostratigraphic techniques and procedures; Tertiary bio-stratigraphy with special reference to Pakistan. Basic micro-paleontological and bio-stratigraphic techniques. Morphological and taxonomic studies of selected microfossils. Sampling techniques, Thin section study for the study of micropaleontological samples, field excursion to Permian/Tertiary rocks of Salt Range/Kohat Sub-basin.

Reference Books

Introduction to Marine Micropaleontology (Bilal U. Haq, Anne Boersma)

Biostratigraphy: microfossils and geological time by McGrowan, B., 2005, Cambridge Universitypress, London.

Non marine Permian biostratigraphy and biochronology by Lucas, S.G., Cassinis, G. andSchneider, J.W., 2006, Geological Society of London, London.

Applied micropaleontology by Jenkins, D.J., 1993. Kluwer Academic publishers, Netherlands.

Recent developments in applied biostratigraphy by Powell, A. J. And Ridding, J. B., 2005.Geological Society of London and British Micropaleontological society, London.

Course Name: Neotectonics
Credit Hours: 3
Contact Hours: 3
Course Code: GEO 336
Contents:
Active tectonics and neotectonics: definitions, active faults and criteria for identifying active faulting; direct measurements of tectonic movements; direct measurement with geodetic networks; triangulation of sites with reference to satellites; global positioning systems; geology and earthquakes; earthquake seismology; paleoseismology; trenching and seismic trenching; Quaternary dating methods; tectonic geomorphology; offset geological-geomorphological features (paleoseismic indicators, changes in elevations of coast lines, stream offsets, slope retreat, terraces, incised meander); fault scarp morphology; neotectonics behavior of faults and folds; hazards of active tectonics: earthquakes and mass movements; remote sensing andsatellite imageries applications in neotectonics and related hazards; active tectonics and nuclearwaste disposal; neotectonics of Pakistan and Himalayas.
Reference Books
Himalayan Neotectonics and Channel Evolution by Harendra Nath Bhattacharya, Soma Bhattacharya, Balai Chandra Das.
Neotectonics in Earthquake Evaluation by Ellis L. Krinitzsky, D. B. Slemmons.
Neotectonism in the Indian Subcontinent: Landscape Evolution by K S Valdiya, Jaishri Sanwal.Current Progress in Tectonics by Agnes Nolan.

Course Name: Reservoir Geology
Credit Hours: 3
Contact Hours: 3
Course Code: GEO 406
Contents:
Petrophysical evaluation; reservoir rock types: elastic, carbonates and nonmarine reservoirs. Reservoir properties, depositional and diagenetic controls; fluid properties and their saturation;hydrocarbon distributing and fluid contacts; reservoir zonation and thickness mapping, reservoir pore spaces configuration; mapping reservoir heterogeneity; reservoir estimation and calculation of reservoir volumetric, material balance and production, decline curve methods; appraisal and development of reservoir basic concepts.
Reference Books
Introduction to Petroleum Reservoir Analysis by Koederitz I. F. Heaveey., A. H. and Honarpour1989, Contribution in Petroleum/Geology and Engineering-6 Gulf Publishing Co.
Development and Exploration of Oil and Gas Field by Muravyor, R. et al., latest Edition., Peace publishers.
Petroleum Geology by North F. K. 1985. Allen and Unwin London.

Course Name: Clastic Sedimentology

Credit Hours: 3
Contact Hours: 3
Course Code: GEO 407
Contents:
Texture of clastic sedimentary rocks, Sedimentary structures, their classification and hydrodynamic conditions, Paleocurrent analysis and provenance of clastic rocks, Sedimentary environments and facies Continental environments: Deserts, rivers lakes, glaciers and wind. Transitional environments: Delta, estuary and interdeltaic complexes, Marine environments: Shelf, slope and deep marine. Diagenesis of clastic rocks.
Reference Books
Sedimentary Environments and Facies by Reading, H. G., 1986, Blackwell Scientific Publications Depositional Sedimentary Environments by Renieck, H. E. and Singh, I. B., 1980, Springer-Verlag. Petrology of Sedimentary Rocks by Boggs Jr. S., 1992, Merril Publishing Co.
Sedimentary Rocks by Pettijohn, F. J., latest Ed., Harper and Row.

Course Name: Carbonate Sedimentology
Credit Hours: 3
Contact Hours: 3
Course Code: GEO 408
Contents:
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 microfacies and microfacies types ofWilson; major controls on carbonate sedimentation; depositional processes and facies in carbonate rocks; carbonte depositional 99 models, platforms, rimmed shelves, ramps, epieric platforms and isolated platforms; cyclicity in carbonates; modern carbonate environments of Bahamas, Florida and Persion Gulf; carbonate depositional systems; lacustrine, shoreline, peritidal reefs, shallow and deep water; diagnetic processes and sequences and models.
Reference Books
Carbonate Sediments and their Diagenesis by Bathurst, R. G., latest Edition., Elsevier. Marine Carbonate by Milliman, J. D., 1974, Springer-Verlag.
Carbonate Depositional Environment by Scholle, P. A. Bebout, D. G. and Moore, C. H., AAPG Mem. Carbonate Sedimentology by Tucker, M. E. and Wright, V. P., 1990, Blackwell Scientific Publications.
Carbonate Depositional Environments by Scholle, P. A.,, Bebout, D. G. and Moore, C. H., 1993, Mem. Am. Assoc. Petrol. Geol.

Course Name: Engineering Geology
Credit Hours: 3
Contact Hours: 3
Course Code: GEO 410
Contents:

Basic concept of Engineering Geology; Mass-wasting, landslide and other rock movements; Introduction to soil mechanics; Classification and characteristics of soil; Engineering properties of soil; Introduction to rock mechanics, stress and strain characteristics in deformation of rocks; rock classification; rock engineering properties; Geology of the engineering structures: dams, tunnels, bridges. Uplift and settlement problems; Excavation and tunneling; Sieve analysis, moisture content, determination of liquid limit, determination of elastic limit, determination of plasticity limit, void ratios, porosity, angle of repose, compaction of soil and other geotechnical properties.

Reference Books

Engineering Geology (F.G.Bell 2nd Edition)

Engineering Geology Principles and Practices (M. H. de Freitas) Principles of Engineering Geology (P.B. Attewell and I.W. Farmer)

Engineering Geology Lab Manual Kindle Edition by Anshul Jain.Engineering Geology Laboratory

Course Name: Geochemical Exploration Techniques

Credit Hours: 3

Contact Hours: 3

Course Code: GEO 430

Contents:

Geochemistry application to mineral prospecting; Geochemical analyses; Geochemical anomalies in relation to mineralization; regolith types; path-finding minerals; Geochemical exploration for metallic minerals; Assaying; geochemical exploration technology for petroleum; MacroSeepages; Geochemical Indices of Petroleum; Hydrochemical Indicators of Oil, Classification of Waters; Fluorescence of Bitumens; Microbiological Prospecting Techniques; SurfaceGeochemical Prospecting; Generation of Biogenic Gas; Application of Carbon Isotopes; Advancesin Mud Logging; Applications to Production; Philosophy of Anomaly Selection; Contractor Technology; Future Technology.

Reference Books

Geochemical exploration by Joyee, A. S.,1984, Australian Mineral Foundation. Incorporated. Geochemical Exploration by Elliott, I. L. and Fletcher, W. K., latest Ed., Elsevier ScientificPublishing Company.

Petroleum Geochemistry and Basin Evaluation by Gerard Demaison and Relof J. Murris, 1984,AAPG Memoir 35.

Geochemistry Pathways and Processes by McSween, H. Y., jr, Richardson, S. M. and Uhle, M. E., 2003, Columbia University Press, New York.

Course Name: Introduction to Geotechnical Engineering

Credit Hours: 3

Contact Hours: 3

Course Code: GEO 431

Contents:

Scope of geotechnical engineering; Engineering significance of geotechnical investigation; Geotechnical investigation at selected sites; Geotechnical mapping procedure; Construction material and uses; Types of concrete; Asphalt; Introduction to slope stabilization methods; Basicmechanics of slope 79 failure; Slope classification. Slope stability; rock and soil mechanics and itsapplication in civil

engineering; study of geological factors in relation to the construction of buildings and foundations, roads, highways, excavation and tunneling.

Reference Books

Principles of Engineering Geology by Attewell, P. B. and Farmer, I. W., latest Edition., John Willeyand Sons.

Engineering Geology by Beavis, F. C., 1985, Blackwell Scientific Publications.

Principles of Engineering Geology by Johnson, R. B. and Degraff, J. V., latest Edition., John Willeyand Sons.

Fundamentals of Engineering Geology by Bell, F. A. G., 1983, Butter Worth.Engineering Geology by Goodman, R. E., 1993, John Wiley and Sons.

Foundations of Engineering Geology by Waltham, T, 2002. 7. A Geology for Engineers (7thedition) by F. G. H Blyth PhD 1984.

Course Name: Rock Mechanics

Credit Hours: 3

Contact Hours: 3

Course Code: GEO 432

Contents:

Fabric and mechanical nature of rocks; determination of rock quality for engineering purposes; stress strain behaviors of different rocks; rock mass strength. theories of failure; types of fracture; rock deformation in compression; factors controlling mechanical behaviors of rocks; excavation methods in rocks; distribution of stresses around underground excavations; use of photo elasticity in rock mechanics. Measurement of stresses in situ; wave propagation in rocks; dynamicmodels.

Reference Books

Rock Mechanics for Underground Mining by Brady, B. H. G. and Brown, E.T., 1985, Allen andUnwin.

Engineering Geology by Beavis, F. C., 1985, Blackwell.

Structural and Geotechnical Mechanics by Newwark, N. M., latest Edition., Prentice Hall.Engineering Geology and Rock Mechanics by Duncan, N., 1969, Leonar Hill.

Rock Engineering by Franklin, J. A. and Dusseault, M. B., 1989, McGraw-Hill.

Course Name: Soil Mechanics

Credit Hours: 3

Contact Hours: 3

Course Code: GEO 433

Contents:

Introduction and concept of soil mechanics; soil formation and its classification, survey and sampling with its important engineering properties like soil grading, moisture contents, void ratios, density, permeability, shearing strength, bearing capacity, consolidation and settlements.

Reference Books

Problems in Engineering Soils by Capper, P. L., Cassie W. E. and Geddes, J. D., latest Ed., JohnWiley and Sons.

Engineering Geology by Beavis, F. C., 1985, Black well Scientific Publications.

Structural and Geotechnical Mechanics by Newwark, N. M., latest Edition., Prentice Hall.Engineering Geology and Rock Mechanics by Duncan, N., latest Edition., Leonar Hill.

Course Name: Industrial Mineralogy
Credit Hours: 3
Contact Hours: 3
Course Code: GEO 469
Contents:
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, bariteand 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.
Reference Books
"Mineralogy" by Perkins
"A Textbook of Mineralogy" by Dana E S and Ford W E
"Introduction to Mineralogy: International Edition" by William D Nesse

Course Name: Mining Geology
Credit Hours: 3
Contact Hours: 3
Course Code: GEO 476
Contents:
Introduction to Mining Geology, Terminology related to mining; mining survey techniques; surface and subsurface mining methods; opening of mines; structural controls in mining; correlation of surface and subsurface data; spatial relationship of seams; surface and underground mapping methods; calculation of ore grade and tonnage; gases in mines and spontaneous combustion; rock pressure and support; collapses in mines and their safety/remedial measures; mine-refuse disposal management; ore grade control in mining; impact of mining on environment and their remedies and rehabilitation; introduction to mining explosives; coring, core logging and data interpretation; the effects of gasses and radioactive isotopes on miners health. Miner's diseases, their monitoring and remedial measures.
Reference Books
Exploration and Mining Geology by William C PetersMining Geology by Willard C. Lacy (Editor)
Mining geology in prospect by Grosvenor Rex Davis "Applied Mineralogy in the Mining Industry" by W Petruk

Course Name: Software Applications in Petrophysics
Credit Hours: 3
Contact Hours: 3
Course Code: GEO 482
Contents:

Overview of petrophysics and its importance in the oil and gas industry. Introduction to software applications in petrophysics. Review of basic petrophysical concepts. Introduction to log analysis software. Introduction to data management and visualization software. Importing well data including LAS files, well tops, header information, and other geological data. Quality control techniques for data visualization. Data formatting and data displaying in logplots. Interpreting log data to determine petrophysical properties. Calibration of petrophysical properties with available core data. Advanced mapping techniques for petrophysical properties. Establishing well correlation. Understanding lateral and vertical variations of rock properties. Crossplot analysis to determine lithological and mineralogical variations. Plotting and printing scaled plots. Applying software skills to real-world case studies and project work. Presenting results and findings.

Reference Books

User manuals of available licensed software in Geophysics Lab

Geophysics Elective Courses

Course Name: Gravity and Magnetic Exploration Techniques
Credit Hours: 3
Contact Hours: 3
Course Code: GEO 240
Contents:
This course is a core course which introduces the students' to Gravity & Magnetic Methods. Theory of attraction and potential with applications to simple mass distributions. Green and Gauss theorems. Green's formulae and Equivalent surface layers, Instrumentation and data acquisition. Gravity data reduction; Regional, residual anomaly separation. Interpretation of gravity anomalies; Dead and total mass estimates. Application of gravity method in ocean floor and deep-sea explorations. Fundamentals of magnetic dipole interactions with applications to simple mass distributions, Gauss Theorem. Instrumentation and data acquisition procedures. Reduction of magnetic data. Anomaly separation and interpretation. Air-borne and sea-borne magnetic surveys. Data acquisition and Interpretation. Application of magnetic methods in oceanfloor and deep-sea explorations. Gravity and Magnetic Responses to 3D Variation in Density And Magnetization Of Rocks.

Reference Books:
Dobrin M. B. and Savit C. H. (1988), Introduction to Geophysical Prospecting 4th Edition.MacGraw-Hill Book Coy, New York, 867pp
Lowrie, W. (2004) Fundamentals of Geophysics, Cambridge University Press, 354pp Parasnis, D. S. (1982), Principles of Applied Geophysics. Chapman and Hall New York, 275pp
Reynolds, J. M., (1997), An Introduction to Applied and Environmental Geophysics, John Wileyand Sons Ltd, 796pp
Telford, W.M., Geldart, L.P., Sheriff, R.E. and Keys, D.A. (1982). Applied Geophysics Cambridge University Press 860p.
Peter Dehlinger (1978) Marine Gravity, Elsevier Science. 314pp 5
Richard A. Geyer and Margaret Ashwell (1991) Handbook of Geophysical Exploration at Sea, CRCPress; 2nd edition. 496pp
William J. Hinze, Ralph R. B. von Frese, Afif H. Saad (2013) Gravity and Magnetic Exploration: Principles, Practices and Applications, Cambridge University Press. 525pp
Jones J. W. (1999) Marine Geophysics. Wiley Publishers, 474pp

Course Name: Environmental Geophysics
Credit Hours: 3
Contact Hours: 3
Course Code: GEO 327
Contents:
This course aims to provide skills required in research and consulting environments in hydrology, hydrogeology, climatology and environment sciences. Lectures on the theory behind various environmental geophysical methods used in the analysis of air, water, soil, vegetation or the subsurface. Field measurements to enable everyone to get hands-on experience of geophysical

techniques. Methods covered will include a selection of the following environmental geophysical techniques: weather station design and hydrology measurements using geophysical techniques; infra-red measurements of soil and atmospheric carbon dioxide concentrations; x-ray fluorescence analysis of soil mineral properties; optical geophysics, using fluorescence and absorbance, to measure river organic matter water quality; cavity-ringdown and off-axis mass spectrometry measurements for mapping methane and carbon dioxide processes in the landscape. Radar data acquisition, processing, interpretation and field applications.

Reference Books

An Introduction to Applied and Environmental Geophysics 2nd Editionby John M. Reynolds

Course Name: Rock Physics

Credit Hours: 3

Contact Hours: 3

Course Code: GEO 332

Contents:

The purpose of the course is to give an overview of rock physics observations and models relating reservoir properties such as saturation, lithology, clay content, and pore pressure and their seismic signatures. Understanding this relation can help to improve quantitative seismic interpretation. The course covers fundamentals of Rock Physics ranging from basic laboratory and theoretical results to practical “recipes” that can be immediately applied in the field. Application of quantitative tools for understanding and predicting the effects of lithology, pore fluid types and saturation, saturation scales, stress, pore pressure and temperature, and fractures on seismic velocity. Use of rock physics models requires understanding the assumptions and pitfalls of each model and the uncertainties associated with the interpretations using these models. Analysis of case studies and strategies for quantitative seismic interpretation using statistical rock physics work flows, and suggestions for more effectively employing seismic-to- rock properties transforms in Bayesian machine learning for reservoir characterization and monitoring, with emphasis on seismic interpretation and uncertainty quantification for lithology and subsurface fluid detection. Fluid and Lithology Substitution During Prospect Evaluation

Reference Books

The Rock Physics Handbook 3rd Edition by Gary Mavko, Tapan Mukerji, Jack Dvorkin

Course Name: Seismic Data Acquisition & Planning

Credit Hours: 3

Contact Hours: 3

Course Code: GEO 367

Contents:

It will include Overview of the Course, Books recommendation, Evaluation Criteria, Concept of Hook’s Law, Bulk, Shear & Young’s Modulus, Poisson’s Ratio, Stress and Strain, Types of Strain, Elasticity, Stiffness, Deformation. Attenuation, Refraction, Reflection and Diffraction of Elastic Waves, Wave Convergence, Snell’s Law, Huygens’s Principle, Fermets Principal, Ray path & wave front, Head Waves, Critical refraction, Travel time of direct, reflected and refracted waves in a layered earth, Seismic Refraction Method, Seismic Reflection Method, Spherical Divergence, Ray parameters, Geometrical

Spreading & absorption, Acoustic Impedance, Offset, Seismic Sources, minimum & zero phase data, Recording Instruments and their requirements. Principle of geophone, Acquiring Seismic Reflection data on Land, Geometry, String, Group Channel & Array designing, CMP & CDP shooting, Advantages of CDP shooting, Borehole geophysics including Sonic Log, VSP and Checkshot Analysis.

Reference Books

Introduction to Geophysical Prospecting by Milton B. Dobrin and Carl H. Savit,4th Edition
Applied Geophysics by W. M. Telford, L. P. Geldart, R. E. Sheriff Paperback Edition
Basic Exploration Geophysics by Edwin S. Robinson, Cahit Coruh Paperback Edition An
Introduction to Geophysical Exploration by P. Kearey, et al Paperback Edition

Course Name: Introduction to Machine Learning
Credit Hours: 2
Contact Hours: 2
Course Code: CSC 413
Contents:

This course provides a thorough introduction to the theoretical foundations and practical applications of ML. We will learn fundamental algorithms in supervised learning and unsupervised learning. We will not only learn how to use ML methods and algorithms but will explain the underlying theory building on mathematical foundations. While reviewing the several problems and algorithms to carry out classification, regression, clustering, dimensionality reduction, core fundamentals will be focused which unify all the algorithms

Reference Books

Introduction to Machine Learning by Alex Smola and S.V.N. Vishwanathan

Course Name: Introduction to Machine Learning Lab
Credit Hours: 1
Contact Hours: 2
Course Code: CSL 413
Contents:

Students will gain an introductory-level understanding of both supervised and unsupervised machine learning (ML), including deeper knowledge of a number of algorithms of each type. Students will learn how to evaluate and quantify predictive performance of ML systems. Students will also become familiar with one or more ML development environments with practical assignments and demonstrations

Reference Books

Introduction to Machine Learning by Alex Smola and S.V.N. Vishwanathan

Course Name: Electrical & Radioactive Exploration Techniques
Credit Hours: 3
Contact Hours: 3
Course Code: GEO 368
Contents:

Electrical methods Basic Theory; Electrical properties of rock and minerals; self-potential method Basic; self-potential methods field and interpretation; self-Induce polarization methods principles and

theory; IP methods field survey and interpretation study of a Case history; resistivity methods basic theory; Electrical resistivity relation and measurements; Resistivity and properties of materials; Acquisition and Processing of Data interpretation; Radioactive methods Basic theory Radioactive minerals and survey interpretation. Transient Electro-Magnetic method.

Reference Books

Introduction of Geophysics by Dr. El-Arabi H. Shendi

Course Name: Borehole Geophysics

Credit Hours: 3

Contact Hours: 3

Course Code: GEO 390

Contents:

Overview of borehole geophysics, Importance and applications in the petroleum industry, Rock properties and their geophysical significance, Elastic properties of rocks, Fluid properties and their effects on rock physics, Types of well logs (e.g., gamma ray, density, neutron, resistivity), Interpretation of well logs, Applications of well logs in reservoir characterization, Introduction to borehole seismic methods, Vertical Seismic Profiling (VSP), Crosswell seismic tomography, Data acquisition and processing principles, Calibration of surface seismic data using boreholes, Electromagnetic methods, Nuclear magnetic resonance (NMR) logging, Acoustic and sonic logging, Reservoir characterization and monitoring, Hydrocarbon detection and quantification, Enhanced oil recovery (EOR) techniques, Design and implementation of borehole geophysical surveys, Data processing and interpretation, Software tools and techniques

Reference Books

A Practical Guide to Borehole Geophysics in Environmental Investigations* by W. Scott Keys

Geophysical Logging for Hydrogeology* by John H. Williams and Frederick L. Paillet

A Practical Introduction to Borehole Geophysics: An Overview of Wireline Well Logging Principles for Geophysicists* by J. Labo

Course Name: Seismic Data Processing

Credit Hours: 3

Contact Hours: 3

Course Code: GEO 470

Contents:

Introduction: Basic Principles with emphasis on mathematical analysis; Review of Fourier transforms and matrices; Basic Field procedure; Computational Fundamentals of interpretation techniques, and application of the geophysical methods: Development of theories of the discrete Fourier ad z-transform; Wavelets; Design of digital filters (recursive, inverse); Convolution; Auto- correlation and cross-correlation theorem; Deconvolution; transfer function; Maximum, minimum and mixed delay wavelets; Application to geophysical data. Software based learning and contents needs to be added.

Reference Books

Yilmaz, Ozdogan. (1987). Seismic data processing. Investigations in geophysics.

Course Name: Reservoir Geophysics

Credit Hours: 3

Contact Hours: 3

Course Code: GEO 411

Contents:

Overview of reservoir geophysics, Importance and applications in the petroleum industry, Rock properties and their geophysical significance, Elastic properties of rocks, Fluid properties and their effects on rock physics, Basics of seismic wave propagation, Seismic data acquisition and processing, Seismic attributes and their applications, Seismic inversion techniques, Amplitude Variation with Offset (AVO) analysis, Direct Hydrocarbon Indicators (DHIs), Time-lapse (4D) seismic monitoring, Integration of geophysical data with reservoir models, Reservoir characterization and monitoring, Hydrocarbon detection and quantification, Enhanced oil recovery (EOR) techniques, Design and implementation of geophysical surveys, Data processing and interpretation, Software tools and techniques

Reference Books

Methods and Applications in Reservoir Geophysics edited by David H. Johnston, William L. Abriel, and others

Reservoir Geophysics by Wayne D. Pennington

Petrophysics: Theory and Practice of Measuring Reservoir Rock and Fluid Transport Properties by Djebbar Tiab and Erle C. Donaldson

Course Name: Sequence Stratigraphy

Credit Hours: 3

Contact Hours: 3

Course Code: GEO 413

Contents:

Fundamental concepts and laws, historical development and key figures, Accommodation space and its controls, sea level changes, Basin architecture and its influence, sediment supply to basin and its role, identifying sequences, systems tracts, other stratigraphic surfaces, relation of surfaces to depositional environments and basin architecture, Sequence Stratigraphic Surfaces and Units, Sequence Stratigraphic Methodology, Well log behaviors of stratigraphic surfaces and system tracts, Correlation and Basin Analysis, practical applications of the discipline, Application regarding petroleum Exploration, Case studies.

Reference Books

Sequence Stratigraphy by Dominic Emery, Keith Myers

Principal of sequence Stratigraphy" by O.Catuneanu

Sea-level changes: an integrated approach by Wilgus, C. K., Hastings, B. S., Posamentier, H., Van Wagoner, J., Ross, C. A., & Kendall, C. G. S. C. (1988).

An Online Guide to Sequence Stratigraphy by Holland, S.M., 1999.

Sequence Stratigraphy by Kendall, C., 2002. USC

Eustatic Controls on Clastic Deposition I - Conceptual Framework by Posamentier, H.W., Jervey, M.T., and Vail, P.R., 1988..

Eustatic Controls on Clastic Deposition II - Sequence and Systems Tract Models by Posamentier, H.W., and Vail, P.R., 1988.

Course Name: Ground Water Investigation

Credit Hours: 3
Contact Hours: 3
Course Code: GEO 421
Contents:
This course cover the details and criteria employed in groundwater investigations. Basic concepts and methods used to determine subsurface conditions pertaining to groundwater levels, pore water pressures and the permeability of subsurface materials are considered. Installation methods for observation wells and devices commonly used for sensing and measuring water levels in boreholes and observation wells are covered. Permeability is measured in the field by a variety of tests, which include seepage, pressure or packer, pumping, slug and the piezocone dissipation tests. Quality assurance for testing, obtaining measurements and logging subsurface data are considered. The AASHTO and ASTM designations for the commonly used tests are provided.
Reference Books
Investigating Groundwater by Ian Acworth

Course Name: Seismic Stratigraphy
Credit Hours: 3
Contact Hours: 3
Course Code: GEO 445
Contents:
Introduction, Seismic Stratigraphic approach, Recognition and discrimination of depositional sequence, Boundaries of depositional sequence, Principal types of seismic facies, Stratigraphic interpretation of seismic facies, Factors controlling deposition of cyclic sequences; Recognizing and evaluating unconformities; Origin of cyclic sequence; Application of seismic stratigraphy in hydrocarbon exploration; Basin classification; Classification and structural styles related to strike- slip, Thrust tectonic; Source rocks and its types. Interpretation of logs and other relevant data to identify areas favorable for hydrocarbon exploration. Techniques applicable to regional and field scale Analysis in G&G Industry.
Reference Books
Sequence Stratigraphy by Dominic Emery, Keith Myers
Principal of sequence Stratigraphy" by O.Catuneanu
Sea-level changes: an integrated approach by Wilgus, C. K., Hastings, B. S., Posamentier, H., Van Wagoner, J., Ross, C. A., & Kendall, C. G. S. C. (1988).
An Online Guide to Sequence Stratigraphy by Holland, S.M., 1999.
Sequence Stratigraphy by Kendall, C., 2002. USC
Eustatic Controls on Clastic Deposition I - Conceptual Framework by Posamentier, H.W., Jervey, M.T., and Vail, P.R., 1988..
Eustatic Controls on Clastic Deposition II - Sequence and Systems Tract Models by Posamentier, H.W., and Vail, P.R., 1988.

Course Name: Seismic Data Interpretation
Credit Hours: 3
Contact Hours: 3

Course Code: GEO 475

Contents:

Seismic data analysis techniques, Geological constraints regarding seismic data interpretation, Importance of seismic data quality, QC of data, Geological implementation in the seismic data, Seismic to well tie, Tying methods, Seismic correlation techniques, e.g Jump tie, loop tie, Interpretation ways, Mapping, 3 D surfaces, Practical implementation of different Software like Surfer, Open Tect, Kingdom, Geographix.

Reference Books

Seismic Data Interpretation and Evaluation for Hydrocarbon Exploration and Production by Niranjan C. Nanda

Course Name: Geospatial Techniques

Credit Hours: 3

Contact Hours: 3

Course Code: GEO 479

Contents:

Study of geospatial technology, including Geographic Information Systems (GIS), Global Positioning Systems (GPS), cartography, remote sensing, and spatial analysis. Application of Geographic Information Systems (GIS) science to spatial data management. Assessment of vector and raster systems, scale, resolution, map projection, coordinate systems and georeferencing. Identification and acquisition of spatial data.

Reference Books

Geospatial Data Science Techniques and Applications By Hassan A. Karimi, Bobak Karimi

Course Name: Mining Geophysics

Credit Hours: 3

Contact Hours: 3

Course Code: GEO 481

Contents:

Role of Geophysical prospecting in Mining techniques like; 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. Practical experience in collecting, processing and interpreting geophysical data sets and how those data sets can be used for ore deposit exploration and characterization.

Reference Books

Mining Geophysics by D Parasnis

Course Name: Applications of Geoscience Software

Credit Hours: 3

Contact Hours: 3

Course Code: GEO 483

Contents:

Overview of software functionalities, Setting up a project, Data import and management, Importing well data, seismic data, and other geological data, Creating and editing geological maps, Quality control techniques for data visualization, Basic concepts of 3D structural modeling, Creating and editing geometrical properties, Configuring geometrical modeling methods, Picking horizons in the time domain, Applying seismic attributes, Converting horizons to depth using well data, Creating simple surfaces and grids, Advanced mapping techniques, Plotting and printing scaled plots, Real-world projects and case studies, Integrated geological and geophysical modeling, Final evaluation and conclusions, Fundamentals of petrophysics, Reservoir simulations and modeling, Property modeling and analysis

Reference Books

User manuals of available licensed software in Geophysics Lab

Course Name: Shallow Surface Geophysics

Credit Hours: 3

Contact Hours: 3

Course Code: GEO 485

Contents:

Introduction to engineering geophysics & geology, role of engineering geoscientist in a project, introduction to civil engineering projects, soil analysis and ground models, site investigations, role of geophysics in site investigation, sub-surface investigation, Environmental hazards, seismicity and code designing, laboratory tests, geotechnical parameters, types of foundations, tunnels and caverns, tunnel support, underground mining, deterministic and probabilistic approaches in landslide hazard assessment, back analysis of slope failures, linear and nonlinear failure envelopes in slope stability analysis, seismic aspects of slope stability, earthquake-induced catastrophic landslides in liquefiable soils, rainfall-induced shallow landslides on steep slopes, field instrumentation

Reference Books

Exploration Geophysics of the Shallow Subsurface by Sampul Depan, Henry Robert Burger, Douglas C. Burger

Near-Surface Applied Geophysics by Mark E. Everett

Appendage 3803

REVISED CURRICULUM OF BS REMOTE SENSING & GIS

A. ACADEMIC DETAILS	
1	**Faculty/Department:** Faculty of Engineering and Sciences, Department of Earth & Environmental Sciences
2	**Name of the Program:** Bachelor of Remote Sensing & GIS (BS RS & GIS)

3	**Mission of the Program:** To prepare students who can learn emerging knowledge of Remote Sensing and GIS and develop their skills to serve in interdisciplinary research projects using geospatial sciences.
4	**Objectives of the Program:** a. To provide understanding about fundamental concepts of Remote Sensing and Geographical Information System (GIS). b. To impart practical knowledge based skills through theory, practical work/lab and field exercises c. To learn about the tools which are used in GIS related field work meant for exploring natural resources and environmental management. d. To augment team work ethics for any industrial project. e. To provide computing, mathematical and logical skills critical for solving problems through Thesis/internship in technological projects.. f. To develop effective presentation, oral and written communication skills
5	**Outcomes of the Program:** Graduates capable of fulfilling developmental and research needs in the domain of Remote Sensing and GIS.
6	**Rationale for the Program:** The Department of Earth & Environmental Sciences (BUKC) has proposed to offer BS RS & GIS (4 years). BS RS&GIS is designed to provide a platform for students getting knowledge about emerging geospatial technologies including Remote Sensing and GIS. This program provides a foundation to focus on the application of the Remote Sensing and GIS technologies for the management of Pakistan's natural and environmental resources. E&ES is aimed that the young scientists utilize the knowledge and skills of these disciplines towards identification and mitigation of the most profound challenges in the domains of RS and GIS Applications through research initiatives. It is envisioned that the graduates of BS RS&GIS may find their possible careers over a wide canvas that includes the following; Natural Resources and Environments (exploration, monitoring, management) Geosciences (minerals exploration, earthquake, tsunami mapping) Water Resources (river, lakes, flood mapping, monitoring, and prediction) Social Sciences (crime monitoring, revenue collection, health care, elections) Urban Planning (city planning, transportation & utility network planning) Agriculture (crop planning, crop health monitoring, yield forecasting) Meteorology and Climatology (monitoring, mapping, prediction) Navigation and Tracking Applications (mapping and modeling) Geographical location-based geospatial research projects etc.
7	**Brief Description of the Program:** The curriculum of the BS RS & GIS program includes coursework in geography, remote sensing, GIS, computer sciences, modelling, and related courses. The courses are based on theoretical knowledge, practical, fieldwork, case studies, and research thesis. The program also encourages students to take courses in ethics and social responsibility, with the opportunity to participate in some of the internship programs at

	relevant organizations and industries to solve specific problems in various applications of both geospatial fields of Remote sensing and GIS
8	**Duration:** 04 Years (8 Semesters)
9	**Venue(s):**
10	**Program Scheduling Format:**
11	**Proposed Date of Commencement of revised curriculum:** Fall 2025
12	**Mode of study** for BS (RS&GIS) is based on class room learning and Research Seminars, Assessments, i.e. Assignment, Quizzes, mid-term and final term will be conducted as per BU policy.
13	**Additional Faculty Member(s) Required:** *(Indicate if there is a requirement for additional faculty members, fulltime/visiting, along with qualifications.)* ***None***
14	**Additional Skilled-Worker(s) Required:** *(Indicate if there is a requirement for additional Skilled Staff, fulltime/part-time, along with their qualifications/skill sets.)* **None**
15	**Additional Classroom(s) required:** *None*
16	**Additional Requirement for Laboratories:** *None*
17	**Additional Requirement for Books, Subscriptions, Memberships to Online Research Sites/ Repositories: None**
18	**Minimum Entry Level:** Minimum 50% marks in Intermediate (HSSC) Examination (Pre-Medical/Pre-Engg./ICS/ General Science/Diploma of Associate Engineering) or equivalent qualification.
19	**Admission Criteria:** As per BU Policy related to Admission Matric/O-level: 10% Intermediate/A-level: 40% CBT/Entry Test Score: 50%
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)*
25	**Course Outlines, Descriptions, Pre-Requisites & Readings (Compulsory & Recommended)** *(Attached)*

Program Title: **BS Remote Sensing & GIS**
Duration: **4 Years**
Total Credit Hours: **136**

Sr. No.	Courses as per HEC revised curriculum 2025	Credit Hours/Contact Hours		
		Existing Road Map	Total Credit Hours as per HEC Policy	Proposed New Road Map
1.	Major Courses	84	22 x 3 = 66 1 x 2 = 02	68
2.	Electives Courses		6 x 3 = 18	18
3.	General Education	30	6 x 3 = 18 7 x 2 = 14	32
4.	Interdisciplinary courses (4)	12	4 x 3 = 12	12
5.	Thesis/Capstone Project	3	1 x 3 = 3	3
6.	Internship/Fieldwork	3	1 x 3 = 3	3
	Total	**132**		**136**

Course Summary

	Number of Courses	Course Code	Course Title
Courses Removed	4	GEO 201	Museology
		GSC 340	Chemistry
		RGS 350	Geodesy
		RGS 316	Computing with MATLAB
Courses Retained	9	MAT 105	Mathematics,
		ENG 103	Functional English
		RGS 101	Introduction to GIS
		PHY 103	Physics
		MAT 115	Calculus & Analytical Geometry
		RGS 106	Introduction to Remote Sensing,
		HSS 219	Civics And Community Engagement
		RGS 212	Active Remote Sensing, Spatial Data Infrastructure & Standardization
		RGS 303	Infrastructure & Standardization
Courses Shifted	22	RGS 105	Fundamentals of Earth Sciences
		RGS 107	Introduction to Physical Geography

		RGS 108	Map Work and Projections
		GEO 207	Application Of Information and Communication Technologies
		PSY 102	Introduction to Psychology
		ISL 101	Islamic Studies
		PAK 105	Pakistan Studies
		RGS 331	Digital Image Processing
		RGS 205	Global Navigation Satellite System
		HSS 423	Entrepreneurship
		RGS 360	Spatial Data Analysis
		RGS 208	Photogrammetry
		RGS 320	Geospatial Project Management
		GEO 324	Research Methodology
		RGS 302	Spatial Decision Support System
		RGS 304	Hyper-Spectral Remote Sensing
		RGS 330	Web GIS
		RGS 401	Artificial Intelligence in RS & GIS
		RGS 454	Spatial Data Modelling
		RGS 404	Machine Learning in Spatial Data
Courses Added	8	MAT 205	Statistics
		HSS 331	Fundamentals of International Relation
		PAK 109	Ideology & Constitution of Pakistan
		RGS 210	Digital Cartography
		GEO 223	Urban & Town Planning
		RGS 301	Mobile Data Acquisition & Mapping
		RGS 305	GIS Programming and Customization

		RGS 402	Unmanned Aerial Vehicle & Data Processing

SEMESTER-WISE ROAD MAP

Semester 1

Sr. No.	Existing Road Map				Sr. No.	Proposed Road map aligned with HEC new PG Policy						
	Pre-requisite Course Code	Course Code	Course Title	Credit Hours		Pre-requisite Course Code	Course Code	Course Title	Credit Hours	SDG's	Remarks	Category As Per HEC Policy
1		PAK 103	Pakistan Studies & Global Perspective	2	1		MAT 205	Statistics	3	4	New Addition	Quantitative Reasoning-I
2		ISL 102	Islamic Studies/Ethics	2	2		RGS 105	Fundamental of Earth Sciences	3	4, 6, 7, 15	Shifted from S2	IDS-I
3		ENG103	Functional English	3	3		ENG 101	Functional English	3	4	Already offered in S1	General Education
4		MAT 105	Mathematics *	0	4		MAT 105	Mathematics*	0	4	Already offered in S1	Zero Credit Course
5		CSC 102	Introduction To Computers and Programming	2	5		RGS 107	Introduction To Physical Geography	3	4,11, 14, 15	Shifted from S2(Title changed)	Major
		CSL 102	Introduction To Computers and Programming Lab	1								
6		RGS 103	Fundamental Of GIS	2	6		RGS 101	Introduction To GIS	2	4, 8, 11	Already offered in S1 (Title	Major

		RGL 103	Fundamental Of GIS Lab	1			RGL 101	Introduction To GIS Lab	1		Changed)	
7		PHY 103	Physics	2	7		PHY 103	Physics	2	4, 9	Already offered in S1	General Education (Natural Science)
		PHL 103	Physics Lab	1			PHL 103	Physics Lab	1			
8		ISL 107	Tajweed	1 contact hour	8		ISL 107	Tajweed	1 contact hour	4, 10, 16	Already offered in S1	Non-credit course
Total Credit Hours					Total Credit Hours				18			

*This is a deficiency course of BS RS & GIS. Academic credit hour of this course is zero and will not be counted in total academic credit hours. However, its contact hours, teaching materials and tuition fee are equal to a 3-credit hour course.

Semester 2

Sr. No.	Existing Road Map				Sr. No.	Proposed Road map aligned with HEC new PG Policy						
	Pre-requisite Course Code	Course Code	Course Title	Credit Hours		Pre-requisite Course Code	Course Code	Course Title	Credit Hours	SDG's	Remarks	Category As Per HEC Policy
1		GSC 340	Chemistry	2	1		PSY 102	Introduction to Psychology	2	3, 4	New Addition	General Education (Quantitative Reasoning – II)
		GSL 340	Chemistry Lab	1								
2		MAT 115	Calculus & Analytical Geometry	3	2		MAT 115	Calculus & Analytical Geometry	3	4	Already offered in S2	General Education (Social Sciences)
3		HSS 320	Technical Writing	3	3		HSS 320	Technical Writing and Presentation Skills	3	4, 8, 10	Already offered in S2	General Education

			And Presentation Skills									(Expository Writing)
4		RGS 104	Physical Geography	2	4		GEO 207	Application Of Information and Communication Technologies	2	4, 8, 9	Shifted from S4	General Education
		RGL 104	Physical Geography Lab	1			GEL 207	Application 0f Information and Communication Technologies Lab	1			
5		RGS 105	Fundamental Of Earth Sciences	2	5		RGS 108	Map Work and Projections	2	4, 8, 9, 11	Shifted from S3 (Title changed)	Major
		RGL 105	Fundamental Of Earth Sciences Lab	1			RGL 108	Map Work and Projections Lab	1			
6	RGS 103	RGS 106	Introduction To Remote Sensing	2	6		RGS 106	Introduction To Remote Sensing	2	3, 4, 14, 15	Already offered in S2	Major
	RGL 103	RGL 106	Introduction To Remote Sensing Lab	1			RGL 106	Introduction To Remote Sensing Lab	1			
7		ISL 108	Understanding Quran – I	1 contact hour	7		ISL 108	Understanding Quran – I	1 contact hour	4, 10, 16	Already offered in S2	Non-credit course
Total Credit Hours					**Total Credit Hours**				**17**			

Semester 3

Sr. No.	Existing Road Map				Sr. No.	Proposed Road map aligned with HEC new PG Policy						
	Pre-requisite Course Code	Course Code	Course Title	Credit Hours		Pre-requisite Course Code	Course Code	Course Title	Credit Hours	SDG's	Remarks	Category As Per HEC Policy
1		GEO 206	Civics and Community Engagement	2	1		HSS 219	Civics And Community Engagement*	2	4, 13, 16, 17	Already offered in S2	General Education
2		GEO 201	Museology	2	2		ISL 101	Islamic Studies (Religious Education / Ethics for non-Muslim students)	2	4, 10, 16	Shifted from S1	General Education
3		HSS 107	Introduction to Psychology	2	3		PAK 105	Pakistan Studies	2	4, 10, 16	offered in S1 as 3 credit hour course General Education	General Education
4	CSC 103	RGS 201	Introduction to Cartography	2	4	RGS 106	RGS 331	Digital Image Processing	2	4, 9, 11	Shifted from S5	Major
		RGL 201	Introduction to Cartography Lab	1		RGL 106	RGL 331	Digital Image Processing Lab	1			
5		RGS 202	GPS & Surveying	2	5		RGS 203	Land Surveying	2	4, 8, 9, 11	Shifted from S3 (Title Changed)	Major
		RGL 202	GPS & Surveying Lab	1			RGL 203	Land Surveying Lab	1			
6	RGS 106	RGS 204	Introduction to Photogrammetry	2	6		RGS 205	Global Navigation Satellite System	2	4, 9	Shifted from S6 (Title Changed)	Major
	RGL 106	RGL 204	Introduction to Photogrammetry lab	1			RGL 205	Global Navigation Satellite System Lab	1			

7		RGS 315	Human Geography	3	7		ENV 201	Climatology	3	4, 6, 7, 11, 12, 13, 14, 15	New Addition	IDS II
8		ISL 109	Understanding Quran – II	1 contact hour	8		ISL 109	Understanding Quran – II	1 contact hour	4, 10, 16	Already offered in S3	Non-Credit course
Total Credit Hours					**Total Credit Hours**				**18**			

Semester 4

Sr. No.	**Existing Road Map**				**Sr. No.**	**Proposed Road map aligned with HEC new PG Policy**						
	Pre-requisite Course Code	Course Code	Course Title	Credit Hours		Pre-requisite Course Code	Course Code	Course Title	Credit Hours	SDG's	remarks	Category As Per HEC Policy
1		HSS 410	Entrepreneurship	3	1		HSS 423	Entrepreneurship	2	4, 8, 9, 17	Already offered in S4	General Education
2		RGS 319	Multidisciplinary Applications Of GIS & RS	2	2		HSS 331	Fundamentals of International Relation	2	16	New Addition	General Education (Arts and Humanities)
		RGL 319	Multidisciplinary Applications Of GIS & RS Lab	1								
3		GEO 207	Application Of Information and Communication Technologies	2	4		PAK 109	Ideology & Constitution of Pakistan	2	4, 16	New Addition	General Education

		GEL 207	Application Of Information and Communication Technologies Lab	1								
4		GEO 212	Geo-Statistics	3	5		RGS 208	Photogrammetry	2	4, 8, 9, 11	Shifted from S3 (Title Changed)	Major
							RGL 208	Photogrammetry Lab	1			
5		RGS 206	Database Management System	2	6	RGS 203	RGS 210	Digital Cartography	2	4, 8, 9, 11, 12	New Addition	Major
		RGL 206	Database Management System Lab	1		RGL 203	RGL 210	Digital Cartography Lab	1			
6		RGS 207	Active Remote Sensing & Space Law	3	7		RGS 212	Active Remote Sensing	2	4, 9, 11	Already offered in S4	Major
							RGL 212	Active Remote Sensing Lab	1			
					8		RGS 360	Spatial Data Analysis	2	4, 8, 9	Shifted from S6	Major
							RGL 360	Spatial Data Analysis Lab	1			
7		ISL 110	Understanding Quran – III	1 contact hour	**9**		ISL 110	Understanding Quran – III	1 contact hour	4, 10, 16	Already offered in S4	Non-Credit Course

Total Credit Hours		**Total Credit Hours**	**18**				

Semester 5

Sr. No.	Existing Road Map				Sr. No.	Proposed Road map aligned with HEC new PG Policy						
	Pre-requisite Course Code	Course Code	Course Title	Credit Hours		Pre-requisite Course Code	Course Code	Course Title	Credit Hours	**SDG's**	Remarks	Category As Per HEC Policy
1	RGS 206	RGS 317	Spatial Decision Support Systems	3	1		GEO 223	Urban & Town Planning	3	4, 6, 7, 8, 9, 11,	New Addition	IDS III
2	RGS 207	RGS 316	Microwave & Hyper Spectral RS	2	2		RGS 320	Geospatial Project Management	3	4, 13, 15	Offered as elective	IDS IV
		RGL 316	Microwave & Hyper Spectral RS Lab	1								
3		RGS 316	Computing With MATLAB	2	3		RGS 301	Mobile Data Acquisition & Mapping	2	4	New Addition	Major
		RGL 316	Computing With MATLAB Lab	1			RGL 301	Mobile Data Acquisition & Mapping Lab	1			
4	RGS 202	RGS 318	Spatial Data Infrastructure & Visualization	2	4		RGS 303	Spatial Data Infrastructure & Standardization	3	4, 9, 11	Already offered in S5	Major
	RGL 202	RGL 318	Spatial Data Infrastructure & Visualization Lab	1								
5	RGS 106	RGS 331	Digital Image Processing	2	5		RGS 305	GIS Programming and Customization	2	4, 8	New Addition	Major

	RGL 106	RGL 331	Digital Image Processing Lab	1			RGL 305	GIS Programming and Customization Lab	1			
					6		RGS 307	Field Work & Report Writing	3	4, 8, 14, 15	Shifted from S6	Major
6		ISL 111	Understanding Quran - IV	1 contact hour	7		ISL 111	Understanding Quran - IV	1 contact hour	4, 10, 16	Already offered in S6	Non-Credit Course
Total Credit Hours					Total Credit Hours				18			

Semester 6

Sr. No.	Existing Road Map				Sr. No.	Proposed Road map aligned with HEC new PG Policy						
	Pre-requisite Course Code	Course Code	Course Title	Credit Hours		Pre-requisite Course Code	Course Code	Course Title	Credit Hours	**SDG's**	Remarks	Category As Per HEC Policy
1		RGS 360	Spatial Data Analysis	2	1		GEO 324	Research Methodology	3	4	Shifted from S7	Major
		RGL 360	Spatial Data Analysis Lab	1								
2		RGS 330	Web GIS	2	2	RGS 303	RGS 317	Spatial Decision Support System	3	4,12, 15,16	Shifted from S4	Major
		RGL 330	Web GIS Lab	1								
3		RGS 350	Geodesy	2	3	RGS 303	RGS 302	Spatial Database	2	4, 8	Shifted from S4 (Title Changed)	Major
		RGL 350	Geodesy Lab	1			RGL 302	Spatial Database Lab	1			

4		RGS 332	Satellite Navigation Systems	3	4		RGS 304	Hyper-Spectral Remote Sensing	2	4, 11	Shifted from S5 (Title Changed)	Major
							RGS 304	Hyper-Spectral Remote Sensing Lab	1			
5		-	Elective I	3	5		-	Elective I	3			Major
6		RGL 251	Geospatial Field Work And Report-I	3	6		-	Elective II	3			Major
7		ISL 112	Understanding Quran – V	1 Contact Hour	7		ISL 112	Understanding Quran – V	1 Contact Hour	4, 10, 16	Already Offered in S6	Non-Credit course
Total Credit Hours					**Total Credit Hours**				**18**			

Semester 7

Sr. No.	Existing Road Map				Sr. No.	Proposed Road map aligned with HEC new PG Policy						
	Pre-requisite Course Code	Course Code	Course Title	Credit Hours		Pre-requisite Course Code	Course Code	Course Title	Credit Hours	SDG's	Remarks	Category As Per HEC Policy
1			Elective-II	3	1	RGS 305	RGS 330	Web GIS	2	4, 8, 9	Shifted from S6	Major
						RGL 305	RGL 330	Web GIS Lab	1			
2		RGS 453	GIS For Disaster Management	3	2	RGS 305	RGS 401	Artificial Intelligence in RS & GIS	2	4, 9	Offered as Elective (Title Changed)	Major
						RGL 305	RGL 401	Artificial Intelligence in RS & GIS Lab	1			
3		RGS 458	Geospatial Techniques	2	3		RGS 454	Spatial Data Modelling	2	4, 13, 15	Offered as Elective	Major

		RGL 458	Geospatial Techniques Lab	1			RGS 454	Spatial Data Modelling Lab	1			
4		EES 424	Research Methods	3	4		-	Elective III	3			Major
5		ENV 425	Occupational Health & Safety	3	5		-	Elective IV	3			Major
6		ISL 113	Seerah -I	1 Contact Hou	6		ISL 113	Seerah -I	1 Contact Hou	4, 10, 16	Already offered in S7	Non-Credit course
Total Credit Hours					**Total Credit Hours**				**15**			

Semester 8

Sr. No.	Existing Road Map				Sr. No.	Proposed Road map aligned with HEC new PG Policy						
	Pre-requisite Course Code	Course Code	Course Title	Credit Hours		Pre-requisite Course Code	Course Code	Course Title	Credit Hours	SDG's	Remarks	Category As Per HEC Policy
1		-	Elective-III	3	1	RGS 301	RGS 402	Unmanned Aerial Vehicle & Data Processing	2	4, 9, 13, 15	New Addition	Major
						RGL 301	RGL 402	Unmanned Aerial Vehicle & Data Processing Lab	1			
2		RGS 451	Computer Aided Drafting/Drawing	2	2	RGS 401	RGS 404	Machine Learning in Spatial Data	2	3, 4, 9	Offered as elective	Major
		RGL 451	Computer Aided Drafting/Drawing Lab	1		RGL 401	RGL 404	Machine Learning in Spatial Data Lab	1			

3		RGS 471	Legal And Social Issues in Geospatial Sciences	3	3		-	Elective V	3			Major
4		RGS 456	GIS Programming & Python	2	4		-	Elective VI	3			Major
		RGL 456	GIS Programming & Python Lab	1								
5		RGS 490	Thesis	3	5		RGS 410	Capstone Project	3	4	Already offered in S8 (Title Changed)	Major
6		ISL 114	Seerah -II	1 Contact Hour	6		ISL 114	Seerah -II	1 Contact Hour	4, 10, 16	Already offered in S8	Non-Credit course
Total Credit Hours					**Total Credit Hours**				**15**			

REVISED LIST OF ELECTIVE COURSES TO BE OFFERED

Revised List of Elective Courses with HEC New UG Policy						
S. No.	**Pre-requisite Course Code**	**Course Code**	**Course Title**	**Credit Hour**	**HEC Category**	**17 UN SDGs Alignment**
Elective I (To be offered in 6th semester)						
1	RGS 106	RGS 319	Multidisciplinary Application of GIS & RS	3	Major (Disciplinary) Requirements	4, 8, 9, 14, 15
2		RGS 306	GIS in Agriculture	3	Major (Disciplinary) Requirements	2, 4, 6, 8, 12
3		ENV 361	Natural Resource Management	3	Major (Disciplinary) Requirements	**4**, 6, 7, 9, 11, 12
Elective II (To be offered in 6th semester)						
4	MAT 205	GEO 212	Geostatistics	3	Major (Disciplinary) Requirements	4, 8
5		RGS 471	Legal and Social Issues in Geospatial Sciences	3	HEC Recommendation	4, 16
6		ENV 425	Occupational Health & Safety	3	Major (Disciplinary) Requirements	3, 11, 15
Elective III (To be offered in 7th semester)						
7	ENV 201	RGS 403	GIS in Climate Change Impact Assessment	3	Major (Disciplinary)	4, 6, 7, 11, 12, 13, 14, 15

					Requirements	
8		RGS 455	Land & Water Information System	3	HEC Recommendation	4, 6, 7, 12, 13, 14
9		ENV 412	Environmental Impact Assessment	3	Major (Disciplinary) Requirements	3, 4, 6, 7, 11, 12
Elective IV (To be offered in 7th semester)						
10		GEO 421 GEL 421	Ground water Investigation Ground water Investigation Lab	3 (2+1)	Major (Disciplinary) Requirements `	4, 6, 11, 12, 13
11	RGS 305 RGL 305	RGS 456 RGL 456	GIS Programming & Python GIS Programming & Python Lab	3 (2+1)	Major (Disciplinary) Requirements	4, 8
12		RGS 453	GIS for Disaster Management	3	Major (Disciplinary) Requirements	4, 9, 11, 17
Elective V (To be offered in 8th semester)						
13		ENV 518	Watershed management	3	Major (Disciplinary) Requirements	4, 6, 12
14	RGS 401 RGL 401	AIC 303 AIL 303	Artificial Neural Network Artificial Neural Network Lab	3	Major (Disciplinary) Requirements	3, 8, 9
15		RGS 406	Remote Sensing based Geographical monitoring	3	Benchmark Course Major (Disciplinary) Requirements	8, 9
Elective VI (To be offered in 8th semester)						
16	RGS 108 RGL 108	RGS 451 RGL 451	Computer Aided Drafting/Drawing Computer Aided Drafting/Drawing Lab	3	Major (Disciplinary) Requirements	4, 9, 11
17		RGS 361 RGL 361	Integrated Geospatial Technologies Integrated Geospatial Technologies Lab	3	Major (Disciplinary) Requirements	4, 8, 9
18		RGS 408	Computer Vision to Geospatial Analytics	3	Benchmark Course Major (Disciplinary) Requirements	8, 9

DETAILS OF COURSE CONTENTS

Major Courses
Semester 1
RGS 107 Introduction to Physical Geography (3 Credit Hours)

Course Outline:
Scope and status of physical Geography, The basic concept and theories in physical Geography, Factors of Landform Development, Desert Landforms, Glaciers and their topographic effects, Karsts topography, Type of soil, Factors and elements of weather and climate, Composition and structure of atmosphere, Horizontal and vertical distribution of temperature, The distribution of pressure and seasonal variations, Wind Circulation, Humidity and forms of condensation, Classification of Climate, Characteristic features of the oceans, Temperature, salinity distribution, cause and effects, Ocean circulation: Waves, currents and tides, their nature, causes and effects and impact on man and environment.

Reference Books/Material:
1. Strahler, A.N. (2004) "Modern Physical Geography" New York: John Wiley.
2. Gabler, R.E, Sager, R.J and Wise, D.L (2012). Essentials of Physical Geography, Latest Edition. Saunders College Publishing, New York. ISBN 0-03-098237-5.
3. Scott, R.C (1996) Introduction to physical geography, West Publishing Co, New York. ISBN: 0-314-06260-2.

RGS 101 Introduction to GIS (3 Credit Hours)

Course Outline:
Introduction, Definitions, Key components of GIS, Functional Subsystem, Raster Data Model, Vector Data Model, Attribute Data Model, Data Acquisition Techniques, Data sources, Data capturing techniques and procedures, Data Transformation, Visualization of spatial data, Layers and Projections, Map Design: Symbols to Portray Points , Lines and Volumes , Graphic Variables , Visual Hierarchy, Data Classification Graphic Approach , Mathematical Approach, Spatial Analysis: Overlay Analysis ,Spatial analysis, Neighbourhood functions, Network and overlay analysis, buffering, Spatial data Quality: Components of Data Quality , Micro Level Components , Macro Level Components , Usage Components Sources of Error, Accuracy, Project work.

Lab Outline:
Introduction to GIS Lab (hardware / software), Raster/Vector/Attribute Data Display, Scanning, Digitization, Coordinate based point mapping, Raster / Vector Conversion, Digitization of Map features, Data layer integration and display of different projections, Map layout, Data Classification and Thematic Mapping, Handling with Topological Errors, Overlay and network analysis.

Reference Books/Material:
1. Chang, K. T. (2010), "Introduction to Geographical Information Systems" Higher Education, McGraw-Hill
2. Huisman, O. and de By, R. A. (2009), "Principles of Geographic Information Systems: An Introductory Textbook", ITC Educational Textbook Series; 1, ISBN 978-90-6164-269-5
3. Bolstad, P. (2007), "GIS Fundamentals", 3rd Edition, Atlas Books. ISBN: 978-0-9717647-2-9
4. Aronoff, S. (2004) "Geographic Information Systems: A Management Perspective", WDL Publications, Ottawa, Fifth Edition. ISBN - 0912804008
5. Clarke, K. (2004) "Getting started with Geographic Information System", Prentice Hall, New York, Second Edition. ISBN – 1879102897
6. McDonald, R. and Burrough, P. (2001) "Principles of Geographic Information Systems", Oxford University Press, Oxford, Second Edition ISBN - 0198233855

Semester 2

RGS 108 Map work and Projections (3 Credit Hours)

Course Outline:

Introduction to Cartography, Nature of Cartography, Map Types. History of Cartography, Map Symbols, Lettering, Scale and direction, Coordinate systems, Map Projections Graphical and datum, Map Projections Mathematical. Perspective, non-perspective, conventional, Generalization, Thematic Maps, Descriptive Statistics, Class Intervals, Choropleth Maps, Proportional Symbol Maps, Dot Maps, Isarithmic Maps, Cartograms, Flow Maps, Graduate Colour Maps, Map Compilation, Map Design, Map Production Software.

Lab Outline:

Map reading, Assignment on Types of Maps symbology, Development of Symbol Charts, Development of Graphical Map Projections, Large to small scale map conversion, Data classification and Thematic Mapping, Map composite development, Misleading cartography.

Reference Books/Material:

1. Slocum, Robert McMaster, Fritz Kessler, Hugh Howard (2004) Thematic Cartography and Geographic Visualization, 2nd Edition, Terry. ISBN, 0130351237.
2. Robert G. Cromley (2003) "Digital Cartography". Prentice Hall Inc.
3. Campbell, B. J. (2006). Introduction to Remote Sensing, 4th Ed., The Guilford Press, New York, ISBN # 0-7484-0663-8
4. M.J. Kraak & F.J. Ormeling, (1996) "Cartography- Visualization of Spatial Data." Addison Wesley Longman Limited.
5. Robinson, A.H., Morrison,J.L., Muhrcke, A.J.,Kimerling and Guptil,S.C. (1995) "Elements of Cartography" 6th edition, John Wiley & Sons, New York.

RGS 106 Introduction to Remote Sensing (3 Credit Hours)

Course Outline:

Definition and History of satellite Remote sensing, Remote sensing and earth energy budget, Electromagnetic spectrum and radiation, Elements of Remote Sensing operation, Physical foundation of Visible, Infrared and microwaves remote sensing, high and low resolution remote sensing, Theoretical explanation of reflection, absorption and transmission, High resolution multi-spectral data, Introduction to Aerial Photograph, Sensor Systems, Platforms (Types and Orbital Characteristics),Thermal Infrared (Characteristics, TIR Band Properties, TIR Image Interpretation, Intro to Microwave (Importance and applications), Digital Image Processing (Overview of computer based image processing), Applications (agriculture, urban, natural resources etc.)

Lab Outline:

Introduction to labs, Layer stacking, Pixel Data, Single band image interpretation, False colour predictions, False colour composite Images Interpretation, Visual Interpretation of aerial photographs, Various sensors data comparison, Thermal Infrared Image interpretation, Intro to ERDAS Imagine, display, Geo-linking, Zooming, Identification of target features.

Reference Books/Material:

1. Campbell, James B. (2011). Introduction to Remote Sensing, 5th Ed. The Guilford Press.
2. Sabins S.F (2000). Remote Sensing: Principles and Interpretation, Third Edition. Freeman and Company, New York. ISBN: 0 – 7167-2442-1.
3. Lillesand, T. M. and Kiefer, R. W. (2004). Remote Sensing and Image Interpretation, 5th edition. (John Wiley and Sons), ISBN 0-471-15227-7
4. Jensen, J. (2000) Remote Sensing of the Environment: An Earth Resources Perspective, Amazon Publishers

Semester 3

RGS 203 Land Surveying (3 Credit Hours)

Course Outline:
Introduction to GPS, GPS Data, Position and Time from GPS, Pseudo-Range Navigation, Receiver Position, Velocity, and Time, Carrier Phase Tracking (Surveying), GPS Satellite Signals, GPS Error Sources, GPS survey procedure, Differential GPS Techniques. Overview of surveying, objects and classifications of surveying, scales, survey tasks, survey principles and methods, accuracy and precision, measurement and errors, coordinate systems and computation, direct distance measurements, errors in measurement of distance and corrections, height measures, levelling and its types, bench marks, levelling staff, sources of errors in levelling and accuracies, angular measurements, reading systems of optical theodolites, indirect distance measurements, reciprocal levelling, traverse survey, triangulation and trilateration.

Lab Outline:
GPS value reading, Easting Northing & elevation, Map Projections and Datum Settings, GPS based surveys, tracking and data processing, Planimetric & vertical errors calculations, Instrumental surveys will be included for measuring the distance, angles and heights. Major emphasis will be towards theodolite and levelling surveys, Theodolite, RTK instrument, total station, DJBS

Reference Book/Material:
1. Bray, H. (2014). You are here: From the Compass to GPS, the History and Future of how We Find Ourselves. Basic Books.
2. Denny, M. (2012). The science of navigation: from dead reckoning to GPS. JHU Press.
3. Wolf P R., Ghilani C, (2005), Elementary Surveying: An Introduction to Geomatics ,11th Edition, Prentice Hall, USA, ISBN 0131481894
4. Wirshing R., Wirshing R. J., (1985), Schaum's Outline of Introductory Surveying, McGraw-Hill, UK, ISBN 0070711240
5. Michael Kennedy (2002), "The Global Positioning System and GIS: An Introduction" 2nd Edition, Taylor & Francis, New York. ISBN: 0 – 415-28608-5
6. Anderson, J. M., Mikhail E. M., (1998), Surveying Theory and Practice, 7th Ed., MCB/McGraw-Hill, US, ISBN 0-07-015914-9
7. Paul Zarchan (1996), "Global Positioning System: Theory and Application, Volume I, American Institute of Aeronautics and Austronautics, Inc., Washington DC. ISBN: 1563471078

RGS 331 Digital Image Processing (3 Credit Hours)

Course Outline:
Data Sources and Procurement, Data Formats (BSQ, BIL, BIP, etc.) Theory of Image Processing Techniques; Image Sub setting & Enhancement, Image Cleaning, Atmosphere Path Correction, Image Mosaicking and Colour Balancing, Image Rectification, Registration and Re-sampling, Band Ratios, Vegetation Indices, Image Filtering, Difference Images, Principal Component Analysis, Classification Schemes, Types, Algorithms, Field data collection, Qualitative and quantitative techniques, sampling techniques, Error matrices, Ground-Verification (Field Verification). Demonstration of image processing software.

Lab Outline:
Intro to lab and software, Image Management (Import/Export & Display), Enhancement Techniques, Spectral and spatial digitizing (image masking), Mosaicking and colour balancing, Rectification and Registration and Re-sampling, Band Ratio, Vegetation Indices, Difference images, Image filters, Signature selection, Supervised, Unsupervised and Hybrid classification, ISODATA, MDM, MLC, and Baysian classification, Error Matrix Generation, Classification validation, field work. Project work will be based on data sets obtained from resource monitoring agencies such as SUPARCO).

Reference Books/Material:
1. Mather, P M (2011). Computer Processing of Remotely Sensed Images, 4th Ed. (John Wiley and Sons), ISBN: 9780470742389

2. Jensen, J. (2009) Remote Sensing of the Environment: An Earth Resources Perspective, 2nd Ed. Pearson Publishers, ISBN: 9788131716809
3. Gibson, P.J and Power, C.H (2000). Introductory Remote Sensing: Digital Image Processing and Applications. Routledge. ISBN 0-415-18962-4
4. Sonka, M; Hlavac, V and Boyle, R (1999). Image Processing, Analysis and Machine Vision (2nd Edition) International Thompson Publishing (ITP) Company. ISBN 0-534-95393-X
5. Jensen, J. R. (2002), Digital Image Processing: A Remote Sensing Perspective, Prentice Hall, New York.

RGS 205 Global Navigation Satellite System (3 Credit Hours)

Course Outline:
Fundamental framework and applications of modern global navigation satellite systems (GNSS) and inertial navigation systems (INS). Need and evolution of GPS Modernization as Global Navigation Satellite System (GNSS). The course gives an overview of satellite-based radio navigation systems such as: GPS, GLONASS, GALILEO and BEIDOU, the basics of receiver design, wave propagation in the atmosphere; Geodesy, the geodetic fundamentals of navigation e.g., positioning, reference- and coordinate systems and computational methods for navigation and positioning on the surface of the earth.

Lab Outline:
GPS value reading, Easting Northing (latitude/ longitude) and elevation, Map Projections and Datum Settings, GPS based surveys, Tracking and data processing including GPS data display, Planimetric & vertical errors calculations, GPS Project

Reference Books/Material:
1. Van Sickle, Jan (2015) *GPS for Land Surveyors*, *4th Ed*. CRC Press. (ISBN: 978-1-4665-8310-8)
2. Kaplan, E.D., Hegarthy C.J.: Understanding GPS/GNSS, Principles and Applications, 3rd Edition (ISBN: 978-1630810580).
3. McCormac J. C., McCourmac J. C., Anderson W., (1999), Surveying, 4th Edition, Wiley, UK, ISBN 0471366579

Semester 4

RGS 212 Active Remote Sensing (3 Credit Hours)

Course Outline
Introduction to Active Remote Sensing Types of Active Remote Sensing. Advantages and Disadvantages of Active Remote sensing, Types of active remote sensing, history of radar remote sensing, radar wavelength & frequency, primary and secondary advantages of active remote sensing, SAR characteristics, Electrical characteristics of SAR imagery, soil response, vegetation response, water and ice response, urban area response, interferometry, Active remote sensing satellites, Seasat-1, shuttle imaging radar (SIR-A,SIR-B, SIR-C), ALMAZ-1, ERS-1, ERS-2 and ENVISAT, JERS-1 and ALOS, RADARSAT, SRTM, InSAR, Planetary exploration, passive microwave sensing and its application, Fundamentals of LiDAR, RADAR, SONAR and SONODAR, including signal transmission, backscatter properties, and sensor configurations. Space Laws, History, International Space Agency, SUPARCO, Satellite Launching; Mechanism, Space Ethics. Applications of Active Remote Sensing and Space Laws.

Lab Outline:
Introduction to Image Processing of Active Sensors, Multispectral Image comparisons, Visual Interpretation of Images, Image pre-processing, Acquire, preprocess, and interpret LiDAR point clouds, SAR imagery, and waveform data for terrain mapping and object detection, utilize LiDAR and SAR for topographic mapping, disaster assessment, vegetation monitoring, infrastructure planning, and 3D modelling. Student Projects.

Reference Book/Material:

1. Campbell, James B. (2002) "Introduction to Remote Sensing", 3rd Ed., The Guilford Press ISBN # 0-7484-0663-8 (pbk).
2. Henderson, F.M and Lewis, A.J (Latest edition), "Principles and Applications of Imaging Radar".

RGS 208 Photogrammetry (3 Credit Hours)

Course Outline:
Introduction, history and Overview, Analog, analytical, and digital photogrammetry, Photogrammetric cameras, Sensor, films and filters, Data acquisition methods. Single photograph properties, Spatial measurement and scale calculation, Problems with aerial photograph and rectification of a single aerial photograph, Aerial Photograph Interpretation, Types of Aerial Photograph and mosaics, Stereoscopic Analysis DEM generation, Orthophotography/Orthoimage, applications, UAV imagery

Lab Outline:
Comparison of formats, Area and scale measurement, Parallax and radial displacement, Visual interpretation of aerial photographs, vertical air-photos, Mirror stereoscopic interpretation, Ortho-rectification, case studies**.**

Reference Book/Material:
1. David, P. P., & James D. K. (2012). Aerial Photography and Image Interpretation 2nd Edition. John Wiley & Sons, Inc. New Jersey.ISBN-13: 978-0470879382
2. Paul, W., DeWitt,B., & Wikinson, B. (2014). Element of Photogrammetry with Application in GIS. McGraw Hill. ISBN-13:978-0071761123
3. Sabins S.F (2000). Remote Sensing: Principles and Interpretation, Third Edition. Freeman and Company, New York. ISBN: 0 – 7167-2442-1.
4. Lo, C.P (1986). Applied Remote Sensing (Longman).
5. Philipson, W.R (1997) Manual of Photographic Interpretation (2nd edition) (American Society for Photogrammetry and Remote Sensing).
6. Colwell, R.N (ed.) (1983) Manual of Remote Sensing Second Edition in 2 volumes (American Society of Photogrammetry)

RGS 210 Digital Cartography (2 credit hour)
Course Content:
Introduction and scope of advance cartography, Introduction to Map and mapping, Essential of Maps, Need of maps, Types of maps, Basic Geodesy, Map Projections, coordinate system, Advance Cartographic Systems (Hardware and software), Geographic data collection, Data models for digital cartographic information, , Spatial data, Attribute data, data transformation, Map production and reproduction, Cartographic design, Map Compilation, cartographic abstraction/generalization, typography and lettering the map, color use guidelines, symbolization, visualization and its historical context, under represented populations in cartography, Classic Cartography Techniques, distributed GIS, internet mapping for education, commercial web mapping programs, internet mapping, Digital Cartography and Satellite Data, Terrain data (Digital Elevation Model/ Digital Terrain Model), Proximity Analysis, Tracking Analyst: Analyzing hurricanes using Tracking Analyst, Mapping Flow Data Cartographic Design: Special Topics, advance cartography and GIS, Future trends of advance cartography.

Lab outline:
Detail exercises on ARCMAP to enable the students for making digital maps, diagrams and cartograms. Maplex Label Engine, Arcscan and 3D Analyst: Viewing DEM (SRTM) Data in 3D, Classic Cartography Techniques, Proximity Analysis, Tracking Analyst: Analyzing hurricanes using Tracking Analyst Basics of Thematic Mapping: Choropleth Mapping, Proportional Symbol Mapping, Dot Density Map, Isarithmic Maps (Spatial Analyst), Pie Diagram, Landuse and land cover mapping, Mapping Flow Data.

Reference Book/Material:

1. Baker, Thomas. 2005. Internet-Based GIS Mapping in Support of K-12 Education: The Professional Geographer 57 (1): 44-50.
2. Tang, Winnie, Jan and Selwood. 2003. Connecting Our World. Redlands, CA: ESRI
3. Press: Redlands.
4. Peng, Zhong-Ren, Ming-Hsiang and Tsou. 2003. Internet GIS: Distributed Geographic Information Services for the Internet and Wireless Networks. Hoboken, NJ: John Wiley & Sons: New York.
5. Nelson, S, Elisabeth. 2000. The Impact of Bivariate Symbol Design on Task Performance in a Map Setting, Cartographica. 37(4): 61-77.
6. Van, Den, Hoonaard, Will. 2000. Getting There without Aiming at It: Women's Experiences in Becoming Cartographers, Cartographica. 37(3): 47-60.
7. H. Wood, C. Peter and Keller, Cartographic Design: Theoretical and Practical Perspectives, John Wiley & Sons: New York.
8. Robinson, A. H. 1995. Elements of Cartography, 6th edition, John Wiley: New York
9. Abrams, J. and Hall, P. 2006 "Else/Where: Mapping — New Cartographies of Networks and Territories". University of Minnesota Design Institute, Minnesota.
10. Brewe, A. C. 2005 "Designing Better Maps: A Guide for GIS Users". ESRI Press. P. 220.
11. Carey, H. H. 1983 "How to use maps and globe". Franklin Watts, London.
12. Dink, P. (latest edition): "Map Work". Atma Ram and sons, New Delhi.
13. Ehrenberg, R. E. 2005 "Mapping the world: An illustrated history of cartography". National Geographic.
14. Maginr, D. J. 1991 "Geographic Information System". Longman, London. 78
15. Shaheen, F. 1998: "A New Geography Book on Map Work and Field Work". A.H. Publishers, Lahore.
16. MONKHOUSE, F.J. & H.R. WILKISON 1963: Maps and Diagrams, Their Compilation and Construction. London (Latest Edition)
17. RAISZ, E. (1948): General Cartography. McGraw-Hill London. (Latest Edition)
18. RAISZ, E. 1962: Principles of Cartography. McGraw-Hill London. (Latest Edition)
19. ROBINSON, A.H., MORRISON, J.L, MUHRCKE P.C., KIMERLING A.J. & S.C.
20. GUPTILL 1995: Elements of Cartography. John Wiley and Sons New York. (6th Edition)
21. ROBINSON, A. 1963: Elements of Cartography. John Wiley and Sons New York. (3rd Edition)
22. SINGH, R.L. 1960: Elements of Practical Geography. Allahabad. (Latest Edition).

RGS 360 Spatial Data Analysis (3 Credit Hours)

Course Outline:

Introduction to spatial data type, Potentials of spatial data, Spatial Analysis, regression analysis, spatial sampling, Point pattern analysis, Lines and networks, Area objects and spatial autocorrelation, types of area objects, Geometric properties of areas, Boundary Analysis, Buffering and neighbourhood function, Proximity Analysis, Neighbourhood Function/Analysis, Modelling and storing field data, Spatial interpolation, type, Methods / algorithms, Derived measures on surfaces, Map overlay, Vector and raster overlay operations, Problems in simple Boolean polygon overlay, Multivariate data, multidimensional space, Distance, difference and similarity, Cluster analysis, PCA, New approaches to spatial analysis, Interpolation techniques, surface modelling, DTM/DEM, Multi-criteria and Multi-attribute Modelling, Uncertainties in spatial modelling. Spatial data interpretation.

Lab Outline:

Assignment on Spatial Analysis for various applications, Geo-coding and Point analysis exercise, Network analysis, Areal analysis exercise, Buffer analysis exercise, Multivariate analysis, Assignment on advanced spatial analysis, Interpolation of elevation data and surface modelling, Suitability analysis, Risk Modelling, Assignment on uncertainties in spatial modelling.

Reference Books/Material:

1. Chang, Krang-tsung (2002) "Introduction to Geographic Information Systems" McGraw Hill. ISBN: 0-07-049552-1
2. David O' Sullivan and David J. Unwin (2003) "Geographic Information Analysis", John Wiley & Sons, Inc., Canada. ISBN: 0-471-2117-1

3. David L. Verbyla (2002) "Practical GIS Analysis", , Taylor & Francis, London
4. John Stillwell & Graham Clarke (2004) "Applied GIS and Spatial Analysis", John Wiley & Sons, UK. ISBN: 1-57504-101-4

Semester 5

RGS 303 Spatial Data Infrastructure & Standardization (3 Credit Hours)

Course Outline:

Need and main components of Spatial Data Infrastructure (SDI), Metadata concepts, its structures and functionality, System Architecture for SDI Interoperability; Client Server Architecture, Data Quality Information (DQI) Accuracy, Precision, Bias Error Modelling, Problems of information sharing (Heterogeneities), Distributed database concept, SDI Technologies; Legal aspects of SDI. Introduction to spatial data visualization, Visualization Process, Visualization Strategies, Statistical and Visual Foundation, Principles of Symbolization, Principles of Colour, Tri-Simulate (chromatic Model, Intensity, Hue and Saturation, Map Design Process, Mapping Techniques; Map Animation, Virtual Reality, Electronic Atlases and Multimedia.

Reference Books/Material:

1. Robert, C. H. (2005) "SDI: A View from Europe" Oxford University Press, Oxford, ISBN: 089875982X.
2. Groot, R. (2001). Geospatial Data Infrastructure: Concepts, Cases, and Good Practice (Spatial Information Systems (Cloth)), Oxford University Press.
3. Beth E. Lachman (2001). Lessons for the Global Spatial Data Infrastructure: International Case Study Analysis, RAND Corporation.
4. Mapping Science Committee (1993), "Toward a Coordinated Spatial Data Infrastructure for the Nation,". National Academy Press.

RGS 301 Mobile Data Acquisition & Mapping (3 credit hour)

Course Outline:

Introduction to mobile technology, History of Mobil Technology for Data Collection, Scope & Status of Mobil Tech in modern era, Applications of GPS enabled Mobil tech in different sectors, type of mobile phone used for data collection GPRS and GPS enabled, Questionnaire Designing for Mobile Applications, ODK Tools registration & preparation and configuration for Survey, Form Uploading and Retrieving, Field orientation and practice for various types of data including x-y coordinates and its retrieval, Visualization and analysis through ODK and relevant database systems and software's.

Lab Outline:

Tools registration, preparation and designing of questionnaires in xml, field survey, categories, their uploading and implementation.

Reference Book/Material:

1. Fogg B.J. (2003) Persuasive Technology: Using Computers to Change What We Think and Do. (Interactive Technologies). Kaufmann Morgan Publishers San Francisco, USA
2. Gary, W. (2010) The Mobile Learning Edge: Tools and Technologies for Developing Your Teams. McGraw-Hill.
3. Kevin S. and Klaas, W. (2011) Building the mobile networking technology. Cisco Systems
4. Indianapolis, USA.
5. Muehlenhaus I. (2014) Web Cartography: Map Design for Interactive and Mobile Devices. CRC Publisher, London.
6. Quinn C N. (2011) The Mobile Academy: M-Learning for Higher Education. John Wiely and Sons. Trimble 2009: Mapping and GIS customer stories. URL source: http://www.trimble.com/mgis/customer_stories.aspx
7. Tsou, M.-H. (2004). Integrated mobile GIS and wireless internet map servers for environmental
8. monitoring and management. Cartography and Geographic Information Science 31(3), 153-165.

9. Wankel, LA and Blessinger P. (Eds.) (2013) Increasing Student Engagement and Retention using Mobile Applications: Smartphones, Skype and Texting Technologies (Cutting-Edge
10. Technologies in Higher Education). Emerald publishing services UK. URL Sources: http//mobile phones for data collection mobile active .org
11. http://www.theclearinitiative.org/mobile-based-tech.pdf

RGS 305 GIS Programming & Customization (3 Credit Hours)

Course Outline:

Intro to course; fundamentals of geodatabase processing; fundamentals of Python; using variables; naming conventions and reserved words; testing and printing variable values, Looping and control structures, Debugging, optional and required parameters, Objects, properties and methods; the OO paradigm; Object Model Diagrams, The geo-processor object, introduction, Functions and parameters, passing and returning values, Multiple inputs and complex parameter passing, Selections and sets, SQL basics. Advanced programming topics such as creating multiprocessing applications, using version control software, Python package management and code distribution, the design and implementation of graphical user interfaces, solving of complex geoprocessing tasks on both proprietary and open-source GIS platforms in Python.

Lab outline:

Introduction to Lab, looping statements, Getting and setting object parameters, Exploring the geo-processor object, Arcpy and object-oriented programming exercises/ projects, usage of geospatial libraries, Jupiter notebook, Anaconda, python shell

Reference Books/Material:

1. Kang-Stung Chang Programming (2005) ArcObjects with VBA: A Task-Oriented Approach, CRC Press LLC. ISBN: 0849327814
2. Ralston, B. A. (2002), Developing GIS Solutions with Map Objects and Visual Basic, On word Press, New York. ISBN: 0766854388
3. Kropla, B. (2005) “MapServer: Open-Source GIS Development” A press, Co. ISBN: 1590594908
4. Rigaux, P. Scholl, M. and Voisard, A. (2001) “Spatial Databases: With Application to GIS” Morgan Kaufmann; 2nd edition.ISBN: 1558605886.

Semester 6

GEO 324 Research Methodology (3 credit hour)

Course Outline:

Introduction to Research: Definition & Nature, The Scientific Method, The Research Process, and Errors in Research, Research Design and Data Sources: Types of research and research designs, Primary data and its sources, Secondary data and its sources, Data Collection procedures: The Measurement Process, Concepts of validity and reliability, The casual design procedures, Data Collection Methods, Observation, Documentary-Historical Method, The Survey Method, Data Collection Instruments: Questionnaire, Interview and Scheduling, Problems in Data Collection. Sampling: Sampling Concepts, The Sampling Procedures (Types of Sampling), Determining a sample size & Selection of sample Data Processing And Analysis: Basic concepts of data processing: Computer representation, Data Matrix, Data Storage Data Processing flow: Editing, Coding, Handling Blank Responses, Coding, categorization, Converting, Weighting, Storing etc., Alternative processing flows, University data analysis, Measurement of central tendency, Measurement of dispersion, Hypothesis Testing, Bavaria data analysis, Linear Correlation, Simple Regression, The Chi-Square Test, The Cross-Tabular Tables, Elaboration of relationships, Multivariate data analysis: Interdependence Methods, Factor analysis, Cluster analysis,

multidimensional analysis, multivariate data analysis: Dependence methods, Multiple Regressions, Analysis of Variance & Covariance, Discriminate analysis. Research Project Proposal: Rationale for the study defining the problem, Research Objectives, Information needs, Research design, Data collection procedure, Data processing & analysis, Research Team and its profile, Budget, Time Table.

Reference books:

1. Kothari, C. R. 2004. Research Methodology: Methods and Techniques, New Age International (P) Limited.
2. Kumar, R. 2005. Research Methodology: A Step-by-Step Guide for Beginners, 2/E, Pearson Education.
3. David E. G. 2004. Doing Research in the Real World, SAGE Publication, London.
4. Wenzhong Shi, Peter F. Fisher and Michael F. Goodchild. 2002. Spatial Data Quality, Taylor & Frances, New York.
5. Ranjit Kumar, Research Methodology, Sage Publications.
6. Ingeman Arbonor & Bjoran Berke, Methodology for Creating Business Knowledge, Sage Publications. 86
7. Dam Remenyl, Doing Research in Business and Management, Sage Publications.
8. David H. Folz, Survey Research for Public Administration, Sage Publications.
9. C. William Emory, Business Research Methods, IRWIN.

RGS 317 Spatial Decision Support System (3 Credit Hours)

Course Outline:

Decision Making Processes (Introduction, Major decision-making Paradigms, Models of decision-making, Different types of problem, Hierarchy of decisions); Methods and techniques to support spatial decisions; Performance modelling and types of criteria, Measurement Scales, Uncertainty in decision making process Decision Support Systems (Introduction, Origin, Definition and components, Fundamental Phases, Characteristics and Capabilities of DSS); GIS and Decision Support Systems, Integration of GIS and DSS Multicriteria Evaluation (Criteria properties, Criteria weighting, Pair wise comparison, Ranking techniques, Rating techniques, Sensitivity analysis, Redistribution criteria weight, Option Ranking methods, Weighted summation, Ideal point, Rank order); Methods and Tools for Collaborative Decision-Making; Consensus Evaluation; Conflict Analysis, Multi-Criteria Decision Analysis (MCDA), AHP, ANN, Fuzzy logic, Introduction: Definitions of SDSS, Spatial Decision Making, Types of Spatial Decisions. Spatial Decision-Making Problems, Spatial Decision-Making Process. Need for Decision Support Systems. SDSS Characteristics. Examples of SDSS, Evolution and Trends in SDSS, Origins of SDSS. Core Drivers for the Development of Spatial Decision Support, Technology Introduction Phase (1976–1989), Integration Phase (1990–2000), Implementation Phase (2000s). DSS to SDSS. GIS-Based Evolution. GIS to SDSS. SDSS Progression, Components of SDSS I: Geographic Information Systems. Components of Traditional DSS and GIS. Components of SDSS. Overview of Geographical Information Systems, Components of SDSS II: Model Management Component, Modeling Techniques in SDSS. Generic Models. Dialog Management Component. Stakeholders Component. Knowledge Management Component, SDSS Software Components, Building SDSS: Building Desktop SDSS. Building Web-Based SDSS, SDSS Applications, SDSS Challenges and Future Directions

Reference Books/Material:

1. A. E. Turban and J. Aronson (1998), Decision Support Systems and Intelligent Systems, 5th edition, Prentice Hall. ISBN: 0-13-781674-8
2. B. Sauter, V. (1997) “Decision Support Systems”, John Wiley & sons, HEC — RS&GIS Curricula 2005 29 Inc. ISBN: 0-471-31134-0

RGS 302 Spatial Database (3 Credit Hours)

Course Outline:
Basic database concepts; Entity Relationship modelling, Relational data model and algebra, Structured Query language; RDBMS; Database design, functional dependencies and normal forms; Transaction processing and optimization concepts; concurrency control and recovery techniques; Database recovery techniques; Database security and authorization, Database normalization process techniques, Query optimization (Relational Algebra), Small Group Project implementing a database. Concepts of database securities, Development of a GUI interface.

Lab outline:
Structured Query language commands, PL/SQL Commands, Creating & populating tables, Design of simple database, Indexing concepts, Performance of concurrency protocols, Partial & full recovery techniques, Design and implementation of a simple MIS system. Postgres SQL usage.

Reference Books/Material:
1. Date, C.J. (2004) Database Systems, Addison Wesley Pub. Co. ISBN - 0201385902
2. Connolly R. and P. Begg (2003) Database Systems: A Practical Approach to Design, Implementation and Management, Addison-Wesley Pub. Co ISBN – 0321210255
3. Elmasri, R. and Navathe, S.B (2004) "Fundamentals of Database Systems" Addison-Wesley Pub. Co ISBN – 0-201760355
4. Rigaux, P. Scholl, M. and Voisard, A. (2001) "Spatial Databases: With Application to GIS" Morgan Kaufmann; 2nd edition ISBN – 01017386802

RGS 304 Hyper Spectral Remote Sensing (3 Credit Hours)

Course Outline:
Introduction of new and advanced developments that are taking place especially in microwave and hyper spectral remote sensing. Basic concepts, Types of sensors, History, Field Verification, Data Fusion Techniques, Microwave Applications, Hyperspectral Remote Sensing Channels and Spectral Libraries Sensors (AIS, AIVIS etc.); Applications of Radar and hyper spectral datasets, Image Interpretation.

Lab Outline:
Introduction to Microwave Image Processing Module, Microwave Image Comparisons, Visual Interpretation of Radar Images, Radar Image pre-processing (Total Power Image, Like and Unlike Polarization, Ground Resolution, Rectification and Registration, Optical and RADAR data fusion case studies.

Reference Books/Material:
1. Campbell, James B. (2002) Introduction to Remote Sensing. 3rd Ed., The Guilford Press.
2. Henderson, F.M and Lewis, A.J (1998) Principles and Applications of Imaging Radar. Manual of Remote Sensing. 3rdEd. Vol. 2. John Wiley and Sons, New York.
3. Peebles, P.Z (1998) Radar Principles. Wiley Inter science, New York.
4. Elachi, C. (1988) Space-borne Radar Remote Sensing: Applications and Techniques. IEEE Press, New York.

Semester 7

RGS 330 Web GIS (3 Credit Hours)

Course Outline:
Basic concepts and theory of interactive platform, as the combination of web and GIS (Geographic Information Systems). Introduction to the expanding scope of web and mobile-based mapping applications of GIS. Cloud GIS. Introduction to Google Earth Engine. Development procedures of Web GIS

applications to e-government, e-business, e-science, and daily life, public services etc. Online maps and geospatial intelligence using various spatial data layers as web layers and maps.

Lab Outline:
Build interactive web-based GIS app that use geospatial data in an attractive format. Create a map tour application using ArcGIS Online. Create web apps with ArcGIS Web AppBuilder or HTML, ArcJava Script.

Reference Books/Material:

1. Pinde Fu, 2015, Getting to Know Web GIS. ESRI Press. Redlands, CA. ISBN-13: 978-1589483842 ISBN-10: 1589483847.
2. Pinde Fu, and Jiulin Sun. 2010. Web GIS: Principles and Applications. ESRI Press. Redlands, CA. ISBN 158948245X (Available at Amazon
3. Sui, D., Elwood, S., & Goodchild, M. (Eds.). (2012). Crowdsourcing geographic knowledge: volunteered geographic information (VGI) in theory and practice. Springer Science & Business Media.
4. Longley, P., & Batty, M. (2003). Advanced spatial analysis: the CASA book of GIS. ESRI
5. Petroutsos, E. (2014). Google Maps: Power Tools for Maximizing the API. McGraw Hill Professional.

RGS 401 Artificial Intelligence (3 Credit Hours)

Course Outline:
An Introduction to Artificial Intelligence and its applications towards Knowledge Based Systems; Introduction to Reasoning and Knowledge Representation, Problem Solving by Searching (Informed searching, Uninformed searching, Heuristics, Local searching, Minmax algorithm, Alpha beta pruning, Game-playing); Case Studies: General Problem Solver; Recent trends in AI and applications of AI algorithms; Basic architecture of neural networks.
Deep learning, KNN,

Lab Outline:
Labs to be constructed according to the scope of the subject on software like Python 3.7.2 or Latest, PyCharm IDE, Anaconda, TensorFlow, Scikit-Learn, Numpy, Keras, PyTorch, LightGBM, Eli5, SciPy.

Reference Books/Materials:

1. Russell, S. and Norvig, P. “Artificial Intelligence. A Modern Approach”, 3rd ed, Prentice Hall, Inc., 2015.
2. Norvig, P., “Paradigms of Artificial Intelligence Programming: Case studies in Common Lisp”, Morgan Kaufman Publishers, Inc., 1992.
3. Luger, G.F. and Stubblefield, W.A., “AI algorithms, data structures, and idioms in Prolog, Lisp, and Java”, Pearson Addison-Wesley. 2009.

RGS 454 Spatial Data Modelling (3 Credit Hours)

Course Outline:
Introduction to Fields, Objects, Geometry, Objects represented in raster, Vector Structure, Vector data representing the geometry of geographical objects, Networks and graphs, Properties of Graphs, graph areas and error checking procedures, Terrain object classed and generalization hierarchies, aggregation hierarchies, object association, Fuzzy set theory, fuzzy boundaries, Uncertainties of Spatial Objects.

Lab Outline:

Preparation of Symbolic Charts for representation of Earth Features, Assignment on Geometry of spatial objects, Utility Network Analysis, Spatial data generalization and aggregation.

Reference Books/Material:

1. Michael, N. D. (2003) "Fundamentals of Geographic Information Systems" Third Edition, John Wiley & sons.
2. 2. Heywood, I., Cornelius, S. and Carver, S. (1999) "An introduction to Geographic Information System", Addison Wesley Longman, New York, second edition.
3. DeMers, M. (1996) "Fundamentals of Geographic Information Systems", John Wiley & Sons, New York.

Semester 8

RGS 402 Unmanned Aerial Vehicle & Data Processing (3 credit hours)

Course outline

Introduction to UAV Technology, Historical Evolution of Drones, Types of Drones, UAV Legislations and safety measures, Basic GIS Skills for Drone Mapping, Drone Configuration and Flight Planning, GCPs logging and Geo-referencing, Data Collection and Management, Pre and Post flight Checklist, Introduction to Drone data processing, Types of Drone Maps: Ortho photo, DEM, DTM and 3D Point Cloud Generation, Creation of 3D Mesh and Fly-through video creation, Sensor Integration, Multispectral Aerial Imagery Collection and Processing, Visualizing and Analyzing Lidar Data, Applications of Drone Imagery, Environmental Mapping through Drones, UAV for Precision Agriculture, Ortho mosaic-based Precision Agriculture Analysis, Multispectral Imagery based Indices (NDRE, NDVI), UAV for Change Detection, Application of UAV in Topographical Mapping, UAV in Geography, UAV in Surveillance search and Rescue, Future of Drone Technology.

Lab Outline:

Basic GIS Skills for Drone Mapping, GCPS logging and Geo-referencing, Introduction to Drone data processing, Multispectral Aerial imagery collection and processing, 3D, Mapping through Drone Technology in Pix4D

Reference Book/Material:

1. Anderson, K., Griffiths, D., DeBell, L., Hancock, S., Duffy, J. P., Shutler, J. D., Griffiths, A. (2016). A grassroots remote sensing toolkit using live coding, smart phones, kites and lightweight drones. PLoS ONE, 11, e0151564.
2. Brooke-Holland L. (2012). Unmanned Aerial Vehicles (drones): An Introduction, House of Commons Library, UK.
3. Casagrande G. (2018a). Small Drones and Geographic Observation, in Casagrande, G., Sik, A., &Szabó, G. (Eds.). (2018). Small Flying Drones. Springer.
4. Garrett, B. and Anderson, K. (2018). Drone Methodologies: Taking flight in Human and physical Geography. Trans Inst Br Geogr. 2018; 43:341–359. 83
5. Kedia, A.C.; Kapos, B.; Liao, S.; Draper, J.; Eddinger, J.; Updike, C.; Frazier, A.E. (2021) An Integrated Spectral–Structural Workflow for Invasive Vegetation Mapping in an Arid Region Using Drones. Drones (MDPI), 5, 19. https://doi.org/10.3390/drones5010019.
6. Yavasli, D. D. (2020) Drone Applications in Geography: Game of Drones. In Current Studies of Social Sciences II. Balciogullari, A. andSahin, M. C. (Eds.). Vadi Printing Press: Ankara.

RGS 404 Machine Learning in Spatial Data (3 Credit Hours)

Course Outline:

Introduction to machine learning; concept learning: General-to-specific ordering of hypotheses, Version spaces Algorithm, Candidate elimination algorithm; Supervised Learning: decision trees, Naive Bayes, Artificial Neural Networks, Support Vector Machines, Overfitting, noisy data, and pruning, Measuring

Classifier Accuracy; Linear and Logistic regression; Unsupervised Learning: Hierarchical Agglomerative Clustering. k-means partitional clustering; Self-Organizing Maps (SOM) k-Nearest-neighbour algorithm; Semi-supervised learning with EM using labelled and unlabelled data; Reinforcement Learning: Hidden Markov models, Monte Carlo inference Exploration vs. Exploitation Trade-off, Markov Decision Processes; Ensemble Learning: Using committees of multiple hypotheses, bagging, boosting. Course Introduction, Machine Learning Overview, Supervised/Unsupervised Learning, Decision Tree Learning, Linear Regression with One Variable, Linear Regression with Multiple Variables, Logistic Regression, Regularization, Artificial Neural Networks, Machine Learning System Design, Support Vector Machines, Instance-Based Learning, Clustering, Dimensionality Reduction, Anomaly Detection, Recommender Systems

Lab Outline:

Python basics, Linear regression in one variable, Linear regression in multiple variables, Logistic, regression, Naïve Bayes Classifier, Nearest Neighbor Classifier, Support vector machine, Convolutional Neural Networks, Object Detection using Deep Neural Networks, Decision Tree / Ensemble Classification, Clustering, Unsupervised Learning, Principal Component Analysis (PCA) / Robust PCA.

Reference Books/Materials:

1. Machine Learning, Tom, M., McGraw Hill, 1997.
2. Machine Learning: A Probabilistic Perspective, Kevin P. Murphy, MIT Press, 2012
3. Artificial Intelligence: A Modern Approach, (3rdEdition) by Stuart Russell and Peter Norvig, Prentice Hall

RGL 307 Field Work & Report Writing (3 Credit Hours)

One-week field work, demonstration of field instruments; Basic mapping procedures; Identification of feature, rocks, terrains and coastal features & resources etc. One-week fieldwork for mapping of various terrains and their structures, coastal environment & morphological features by using integrated GIS/RS Techniques with other datasets.

RGS 410 Capstone Project (3 Credit Hours)

Students will be required to conduct research work during Final Year Project/Thesis work considering their keen interest in any subdomain of Remote Sensing or GIS.

Appendage 3804

BS AI PROGRAMME LAUNCH PROPOSAL

A. ACADEMIC DETAILS	
1	**Faculty/Department:** Engineering Sciences/Computer Science
2	**Name of the Program:** Bachelor of Science in Artificial Intelligence
3	**Mission of the Program:** To prepare graduates who can analyze, design, and develop effective AI solutions and contribute effectively towards society.
4	**Objectives of the Program:** **PEO-1:** Utilize knowledge to solve real-world problems by applying theory, principles, and methods of computing in general and artificial intelligence in particular. **PEO-2:** Demonstrate social and ethical responsibility in professional life. **PEO-3:** Manifest lifelong learning for sustained professional and personal progression. **PEO-4:** Practice effective communication and teamwork skills.
5	**Outcomes of the Program:** **PLO1 Academic Education:** To prepare graduates as computing professionals. **PLO2 Knowledge for Solving Computing Problems:** Apply knowledge of computing fundamentals, knowledge of computing specialization, and mathematics, science, and domain knowledge appropriate for the computing specialization to the abstraction and conceptualization of computing models from defined problems and requirements. **PLO3 Problem Analysis:** Identify, formulate, research literature, and solve complex computing problems reaching substantiated conclusions using fundamental principles of mathematics, computing sciences, and relevant domain disciplines. **PLO4 Design/ Development of Solutions:** Design and evaluate solutions for complex computing problems, and design and evaluate systems, components, or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations. **PLO5 Modern Tool Usage:** Create, select, adapt and apply appropriate techniques, resources, and modern computing tools to complex computing activities, with an understanding of the limitations. **PLO6 Individual and Teamwork:** Function effectively as an individual and as a member or leader in diverse teams and in multi-disciplinary settings. **PLO7 Communication:** Communicate effectively with the computing community and with society at large about complex computing activities by being able to comprehend and write effective reports, design documentation, make effective presentations, and give and understand clear instructions. **PLO8 Computing Professionalism and Society:** Understand and assess societal, health, safety, legal, and cultural issues within local and global contexts, and the consequential responsibilities relevant to professional computing practice. **PLO9 Ethics:** Understand and commit to professional ethics, responsibilities, and norms of professional computing practice. **PLO10 Life-long Learning:** Recognize the need, and have the ability, to engage in independent learning for continual development as a computing professional.

6	**Rationale for the Program:** The BS AI program complements BULC's established BSCS and BSIT offerings by providing a specialized pathway. While BSCS and BSIT cover broader computing and IT fundamentals, BS AI delves deeper into AI-specific domains, enabling students to pursue niche careers. This differentiation enriches the university's portfolio, allowing learners to choose aligned with their interests be it general computing, IT systems, or AI innovation without redundancy. With BS AI already thriving at Islamabad and Karachi campuses, Bahria University replicates a proven model in Lahore. Shared resources, faculty expertise, and curricular frameworks ensure quality consistency. Lahore's robust infrastructure, tech ecosystem, and large student population further guarantee program viability and sustainability. The BS AI program at Bahria University Lahore Campus is a timely response to market needs, national priorities, and global trends. By leveraging existing strengths, filling a critical educational gap, and fostering industry ties, the program will empower graduates to lead Pakistan's AI revolution while positioning the university as a trailblazer in Lahore's academic and technological landscape.
7	**Brief Description of the Programme:** The BS (AI) program gives the students an in-depth knowledge they need to transform large and complex scenarios into actionable decisions. The program and its curriculum focus on how complex inputs — such as knowledge, vision, language and huge databases — can be used to make decisions to enhance human capabilities. The curriculum of the BS (AI) program includes coursework in computing, mathematics, automated reasoning, statistics, computational modeling, introduction to classical artificial intelligence languages and case studies, knowledge representation and reasoning, artificial neural networks, machine learning, natural language processing, vision and symbolic computation. The program also encourages students to take courses in ethics and social responsibility, with the opportunity to participate in long term projects in which artificial intelligence can be applied to solve problems that can change the world for the better — in areas like agriculture, defense, healthcare, governance, transportation, e-commerce, finance and education.
8	**Duration: 4 Years**
9	**Venue(s): On Site/Off Site/Both On & Off Site: On-Site**
10	**Program Scheduling Format:** **Annual**
11	**Proposed Date of Commencement: Fall 2025**
12	**Mode of Study/Examination: Full Time**

13	**Additional Faculty Member(s) Required:** *(Indicate if there is a requirement for additional faculty members, fulltime/visiting, along with qualifications.)* **Seven FM's are required (1 PhD, 6 MS)** *1st year only: Minimum three faculty members* *1st and 2nd year: Minimum four faculty members* *1st, 2nd and 3rd year: Minimum six faculty members* *1st, 2nd, 3rd and 4th year: Minimum seven faculty member*
14	**Additional Skilled-Worker(s) Required:** *(Indicate if there is a requirement for additional Skilled Staff, fulltime/part-time, along with their qualifications/skill sets.)* **NO**
15	**Additional Infrastructure/Classroom(s) required:** *(The requirement is to include the number of classrooms and their capacities.)* **3 classrooms (50 students each)**
16	**Additional Requirement for Laboratories:** *(The requirement is to include the number of laboratories, their equipment and their capacities.)* **1 Lab (50 PC's & GPU's according to the requirements)**
17	**Additional Requirement for Books, Subscriptions, Memberships to Online Research Sites/ Repositories: Specialized books and Journals of Artificial Intelligence** *The BS AI program will offer a curated selection of specialized books and academic journals on artificial intelligence. This includes essential textbooks, research articles, and industry publications. Subscriptions to top online research sites and digital repositories will further support students and faculty, keeping them updated with the latest AI advancements and research trends.*
18	**Minimum Entry Level:**
19	**Admission Criteria:** Minimum 50% marks in Intermediate (HSSC) Examination (Pre-Medical/Pre-Engg.) or equivalent qualification with Mathematics certified by IBCC. Deficiency: For Pre-Medical students, the following two deficiency courses of mathematics will be taught during the first year. • Fundamentals of Mathematics I GSC 103 (3 Credit Hours) • Fundamentals of Mathematics II GSC 104 (3 Credit Hours) Curriculum for BS in Artificial Intelligence
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).* **No**
21	**Number of Admissions Expected for First Intake: 50**
22	**Number of Admissions Planned/Expected for Subsequent Intakes: 50 per year**
23	**Maturity Period of the Program : 4 Years**

24	**Marketing campaign requirements:** *For a successful BS AI program launch, the marketing campaign should integrate digital and traditional channels to maximize reach. This includes creating engaging content that highlights program features, running targeted social media and email campaigns, and hosting webinars or on-campus events. A strong online presence with an optimized website and SEO strategies is essential. Additionally, partnerships with industry experts and alumni can further boost credibility and engagement.*
25	**Referred by:** *(delete which is inapplicable)* **FBOS**: *(Indicate the FBOS meeting reference and Item No)* **Competent Authority**: *(Indicate the File No & date; reproduce the decision)* **DQA and Dean Mock Audit**
26	**Complete Plan of Studies, inclusive of complete Roadmap:** *(Attach as Annex 'A')*
27	**Course Outlines, Descriptions, Pre-Requisites & Readings (Compulsory & Recommended)** *(Attach as Annex 'B')*
	B. FINANCIAL DETAILS
1	**Source of Funding:** • **BU: Fully/Partially: Fully** • **Public Sector (B1): Fully/Partially** *(provide complete details; attach MOU, agreement etc.) Fully* • **NNGO (B1): Fully/Partially** *(provide complete details; attach MOU, agreement etc.)* • **INGO (B1): Fully/Partially** *(provide complete details; attach MOU, agreement etc.)* • **UN/IGO (B1): Fully/Partially** *(provide complete details; attach MOU, agreement etc.)*
2	**Degree Duration:** **Annual or Semester System:** Annual 4 Years Semester: 8 Semesters **Total Number of Credit Hours: 135**
3	**Expected fee to be charged based on Cost & Benefits Analysis in the Light of other Universities:** - Total Tuition Fee (135 credit hours @ Rs. 8,500 per credit hour): - 135 × 8,500 = **Rs. 1,147,500** - Admission Fee (One Time): Rs. 28,000 - Misc. Charges (Rs. 12,000 per semester): Rs. 96,000 - Caution Money (Refundable): Rs. 21,000 - Degree Fee (One Time): Rs. 10,000 - Registration Fee (One Time): Rs. 5,000 - Total Program Fee: - 1,130,500 + 28,000 + 96,000 + 21,000 + 10,000 + 5,000 = **Rs. 1,307,500** - For BS Artificial Intelligence program at Bahria University Lahore Campus, we propose the allocation of 10 scholarships for the Fall 2025 intake to attract and support exceptional talent. This initiative includes 5 scholarships offering a 100% fee waiver, ensuring full financial support for top-performing students, and an additional 5 scholarships providing a 50% fee waiver throughout the duration of the degree program. This structured financial assistance is designed to promote academic excellence, drive innovation, and ensure that the best and brightest have access to cutting-edge AI education without the burden of financial constraints.

4	**Expected Number of students for 1st & 2nd Intakes:** - 1st Intake = 50 Students - 2nd Intake = 50 Students
5	**Expected Earning from first two Intakes (B5):** - **Intake Students Total Students Revenue** - 1st 50 50 11,025,000/- - 2nd 50 100 27,579,637/-
6	**Expected Earnings for the Next Five Years (B6):** *(show working)* - **Year Students Total Students Revenue** 1st 50 50 19,864,763 2nd 50 100 35,281,931 3rd 50 150 50,724,258 4th 50 200 64,516,341 5th 50 200 64,516,341 ,
7	**Total Estimated Salaries of all Additional Human Resources per annum (B7):** *(Show working)*

Year	Faculty Distribution	(Monthly)	(Monthly)	(Monthly)	Total Monthly Expense	Total Yearly Expense
1	2 PhDs, 1 MS (2 VFM's)	Rs. 750,000	–	–	Rs. 750,000	Rs. 750,000 × 12 = Rs. 9,000,000
2	3 PhDs, 2 MS (4 VFM's)	Rs. 825,000	Rs. 495,000	–	Rs. 825,000 + 495,000 = Rs. 1,320,000	Rs. 1,320,000 × 12 = Rs. 15,840,000
3	3 PhDs, 4 MS (7 VFM's)	Rs. 907,500	Rs. 544,500	Rs. 363,000	Rs. 907,500 + 544,500 + 363,000 = Rs. 1,815,000	Rs. 1,815,000 × 12 = Rs. 21,780,000
4	3 PhDs, 4 MS (10 VFM's)	Rs. 998,250	Rs. 598,950	Rs. 399,300	Rs. 998,250 + 598,950 + 399,300 = Rs. 1,996,500	Rs. 1,996,500 × 12 = Rs. 23,958,000
5	3 PhDs, 4 MS (10 VFM's)	Rs. 1,098,075	Rs. 658,845	Rs. 439,230	Rs. 1,098,075 + 658,845 + 439,230 = Rs. 2,196,150	Rs. 2,196,150 × 12 = Rs. 26,353,800

8	**Cost of <u>Additional</u> Laboratory Equipment/Tools (B8):** 45 PC's and 5 GPU's (Rs. 65 Million) **Phase 1:** Purchase 15 PCs and 2 GPUs, allocating roughly one-third of the Rs. 65 million budget. This phase will establish the basic infrastructure and allow early adopters to start working on foundational AI projects. **Phase 2:** Acquire another set of 15 PCs and 2 GPUs, further expanding the lab's capacity and enhancing research capabilities. **Phase 3:** Complete the setup with the remaining 15 PCs and the final GPU, ensuring all planned equipment is in place to fully support the program's academic and research objectives.
9	**Cost of Additional Classrooms (B9):** **None**
10	**Cost of Additional Books, Subscription & Memberships to on-line Sites/Repositories (B10):** (Rs. 5 Million)
11	**Off-Site rental Expenses and Cost of other Fixtures (B11):** *NO*
12	**Miscellaneous Expenses required for Starting the Program (B12):** - Advertisement: Rs 1 Million - Printing & Stationery – Rs. 0.1 Million - Admin Cost – Rs. 0.2 Million - Any other – Rs. 0.2 Million - **Total – Rs. 1.5 Million**
13	**Annual Recurring Expenditures in Subsequent Years (B13):** - Salaries: Rs. 26,353,800 - Rentals: - Subscriptions/Memberships: Rs. 1 Million - Advertisements: Rs. 0.2 Million each year - Printing & Stationery: Rs. 0.2 Million each year - Admin Cost - Any other - **Total: Rs. 27,753,800**
14	**Total Cost of the Programme (B14):** [Add B(7) to B(12)] Rs. 72,853,800/-
15	**Net Cost of the Programme (B15):** [Subtract B(1) from B(14)] Rs. 72,853,800/-
16	**Net Earnings in First Year (B16:** [Subtract B(15) from B(5)] **Rs. −52,989,037/-**

17	**Projected Annual Gross Earning in Subsequent Years (B 17):** *(show details & working; add 10% towards all expenses in subsequent years.)* - **Year** **Students** **Total Students** **Revenue** 1st 50 50 19,864,763 2nd 50 100 55,146,694 3rd 50 150 105,870,952 4th 50 200 170,387,293 So after 4 years' total revenue will be Rs. 170,387,293 from students getting admission in **BS(AI).**

18	**Projected Annual Net Earning in Subsequent Years:** *[Subtract B(13) from B(17)]* Total salaries of FM's will amount to Rs. 23,958,000 and Annual recurring expense will amount to Rs. 5.6 Million. Projected Annual Gross Earning in Subsequent Years **= 170,387,293-23,958,000-5,600,000-40,000,000 = Rs. 100,829,293/-**

Program Title: **BS Artificial Intelligence**
Duration: 4 Years
Total Credit Hours: 135

Summary of Credit Hours

Sr No	HEC UEP Category	Credit Hours
1.	General Education (Mandatory)	32
2.	Major/Disciplinary (Mandatory)	43(Computing Core) 18(Domain Core)
3.	Interdisciplinary (Mandatory)	12 (mathematics and supporting courses) 3(Elective Supporting)
4.	Electives toward specialization	21
5.	Tajweed, Quran and Hadith (Compulsory – non-credit course, only for Muslim Students)	8 Contact Hours (non-credited)
6	Internship (Mandatory)	6-8 Weeks non- credited (mandatory)
7.	Capstone Project (Mandatory)	6
8	Double Major (Optional)	-
9.	Minor (Optional)	-
	Total	**135**

Semester-wise Revised Roadmap of BSAI

Semester 1

Sr. No.	Proposed Road map aligned with HEC new UG Policy					
	Pre-requisite Course Code	Course Code	Course Title	Credit Hours	HEC Category	17 UN SDGs alignment (please mention relevant SDG No.
1.	None	GSC 114	Applied Physics	2	General Education	4, 9
2.	None	GSL 113	Applied Physics Lab	1	General Education	4, 9
3.	None	CSC 114	Introduction to Information & Communication Technology	2	General Education	4, 9
4.	None	CSL 114	Introduction to Information & Communication Technology Lab	1	General Education	4, 9
5.	None	CSC 113	Computer Programming	3	Major/Disciplinary (Computing Core)	4, 8, 9
6.	None	CSL 113	Computer Programming Lab	1	Major/Disciplinary (Computing Core)	4, 8, 9
7.	None	GSC 221	Discrete Mathematics	3	General Education	4
8.	None	ISL 101	Islamic Studies	2	General Education	4
9.	None	CSC 308	Professional Practices and Ethics	2	General Education	4, 8, 9
10	None	ISL 107	Tajweed	1 Contact Hour	Non-Credit course Tajweed, Quran and Hadith (Compulsory*)	
Total Credit Hours				17		

*Only for Muslim students

Semester 2

Sr. No.	Proposed Road map aligned with HEC new UG Policy					
	Pre-requisite Course Code	Course Code	Course Title	Credit Hours	HEC Category	17 UN SDGs alignment (please mention relevant SDG No.
1.	None	CEN 122	Digital Design	2	Major/Disciplinary (Computing Core)	4, 8, 9
2.	None	CEL 122	Digital Design Lab	1	Major/Disciplinary (Computing Core)	4, 8, 9
3.	CSC 113	CSC 210	Object Oriented Programming	3	Major/Disciplinary (Computing Core)	4, 9
4.	CSC 113	CSL 210	Object Oriented Programming Lab	1	Major/Disciplinary (Computing Core)	4, 9
5.	None	GSC 122	Probability and Statistics	3	Interdisciplinary (Mathematics & Supporting Courses)	4
6.	None	GSC 110	Applied Calculus and Analytical Geometry	3	General Education	4
7.	None	ENG 101	Functional English	3	General Education	4
8.	None	PAK 103	Pakistan Studies & Global Perspective	2	General Education	4, 10, 16
9.	ISL 107	ISL 108	Understanding Quran-I	1 Contact Hour	Non-Credit course Tajweed, Quran and Hadith (Compulsory*)	4, 10, 16
			Total Credit Hours	18		

*Only for Muslim students

Semester 3

Sr. No.	Proposed Road map aligned with HEC new UG Policy					
	Pre-requisite Course Code	Course Code	Course Title	Credit Hours	HEC Category	17 UN SDGs alignment (please mention relevant SDG No.
1.	CEN 120	CEN 323	Computer Organization& Assembly Language	2	Major/Disciplinary (Computing Core)	4, 9

2.	CEN 120	CEL 323	Computer Organization& Assembly Language Lab	1	Major/Disciplinary (Computing Core)	4, 9
3.	CSC 113	CSC 221	Data Structures and Algorithms	3	Major/Disciplinary (Computing Core)	4
4.	CSC 113	CSL 221	Data Structures and Algorithms Lab	1	Major/Disciplinary (Computing Core)	4
5.	CSC 113	AIC 202	Programming for Artificial Intelligence	2	Major/Disciplinary (Domain Core)	4, 9
6.	CSC 113	AIL 202	Programming for Artificial Intelligence Lab	1	Major/Disciplinary (Domain Core)	4, 9
7.	None	GSC 121	Linear Algebra	3	Interdisciplinary (Mathematics & Supporting Courses)	4
8.	None	ENG134	Communication Skills	2	General Education	4
9.	None	HSS 219	Civic and Community Engagement	2	General Education	4, 5, 16
10.	ISL 108	ISL 109	Understanding Quran-II	1 Contact Hour	Non-Credit course Tajweed, Quran and Hadith (Compulsory*)	4, 10, 16

*Only for Muslim students

Semester 4

Sr. No.	**Proposed Road map aligned with HEC new UG Policy**					
	Pre-requisite Course Code	Course Code	Course Title	Credit Hours	HEC Category	17 UN SDGs alignment (please mention relevant SDG No.
1.	None	CEN 222	Data Communication and Networking	3	Major/Disciplinary (Computing Core)	4, 9

2.	None	CEL 222	Data Communication and Networking Lab	1	Major/Disciplinary (Computing Core)	4, 9
3.	CSC 210	AIC 201	Artificial Intelligence	3	Major/Disciplinary (Computing Core)	4, 9
4.	CSC 210	AIL 201	Artificial Intelligence Lab	1	Major/Disciplinary (Computing Core)	4, 9
5.	None	CSC 220	Database Management Systems	3	Major/Disciplinary (Computing Core)	4, 8
6.	None	CSL 220	Database Management Systems Lab	1	Major/Disciplinary (Computing Core)	4, 8
7.	None	HSS 423	Entrepreneurship	2	General Education	4, 8, 9, 17
8.			Social Sciences Elective	3	General Education	
9.	None	PAK 109	Ideology & Constitution of Pakistan	2	General Education	4, 10, 16
10.	ISL 109	ISL 110	Understanding Quran-III	1 Contact Hour	Non-Credit course Tajweed, Quran and Hadith (Compulsory*)	4, 10, 16
			Total Credit Hours	19		

*Only for Muslim students

Semester 5

Sr. No.	**Proposed Road map aligned with HEC new UG Policy**					
	Pre-requisite Course Code	Course Code	Course Title	Credit Hours	HEC Category	17 UN SDGs alignment (please mention relevant SDG No.
1.	AIC 201	AIC 203	Knowledge Representation & Reasoning	3	Major/Disciplinary (Domain Core)	4, 9

2.	AIC 201	AIC 301	Machine Learning	2	Major/Disciplinary (Domain Core)	3, 4, 9
3.	AIC 201	AIL 301	Machine Learning Lab	1	Major/Disciplinary (Domain Core)	3, 4, 9
4.	GSC 110	GSC 211	Multivariable Calculus	3	Interdisciplinary (Mathematics & Supporting Courses)	4
5.	CSC 221	CSC 321	Design and Analysis of Algorithms	3	Major/Disciplinary (Computing Core)	4, 9
6.			Domain Elective 1	(2+1)	Domain Elective	
7.			Domain Elective 2	(3+0 or 2+1)	Domain Elective	
8.	ISL 110	ISL 111	Understanding Quran-IV	1 Contact Hour	Non-Credit course Tajweed, Quran and Hadith (Compulsory*)	4, 10, 16
Total Credit Hours				18		

*Only for Muslim students

Semester 6

Sr. No.	**Proposed Road map aligned with HEC new UG Policy**					
	Pre-requisite Course Code	Course Code	Course Title	Credit Hours	HEC Category	17 UN SDGs alignment (please mention relevant SDG No.
1.	AIC 301	AIC 401	Deep Learning	2	Major/Disciplinary (Domain Core)	3, 4, 9
2.	AIC 301	AIL 401	Deep Learning Lab	1	Major/Disciplinary (Domain Core)	3, 4, 9

3.	CSC 221	CSC 320	Operating Systems	3	Major/Disciplinary (Computing Core)	4, 8
4.	CSC 221	CSL 320	Operating Systems Lab	1	Major/Disciplinary (Computing Core)	4, 8
5.	CSC 320	AIC 302	Parallel & Distributed Computing	2	Major/Disciplinary (Domain Core)	4, 9
6.	CSC 320	AIL 302	Parallel & Distributed Computing Lab	1	Major/Disciplinary (Domain Core)	4, 9
7.			Domain Elective 3	(2+1)	Domain Elective	
8.			Elective 4	(3+0 or 2+1)	Domain Elective	
9.	ISL 111	ISL 112	Understanding Quran-V	1 Contact Hour	Non-Credit course Tajweed, Quran and Hadith (Compulsory*)	4, 10, 16
Total Credit Hours				**16**		

*Only for Muslim students

Semester 7

Sr. No.	**Proposed Road map aligned with HEC new UG Policy**					
	Pre-requisite Course Code	Course Code	Course Title	Credit Hours	HEC Category	17 UN SDGs alignment (please mention relevant SDG No.
1.	None	FYP 400	Final Year Project	3	Capstone Project	4
2.	None	SEN 220	Software Engineering	3	Major/Disciplinary (Computing Core)	4, 8, 9
3.	None	AIC 304	Computer Vision	2	Major/Disciplinary (Domain Core)	3, 4, 9

4.	None	AIL 304	Computer Vision Lab	1	Major/Disciplinary (Domain Core)	3, 4, 9
5.	HSS 120	ENG 123	Expository Writing	3	Interdisciplinary (Mathematics & Supporting Courses)	4
6.			Elective 5	(2+1)	Domain Elective	
7.	ISL 112	ISL 113	Seerah-I	1 Contact Hour	Non-Credit course Tajweed, Quran and Hadith (Compulsory*)	4, 10, 16
Total Credit Hours				15		

*Only for Muslim students

Semester 8

Sr. No.	Proposed Road map aligned with HEC new UG Policy					
	Pre-requisite Course Code	Course Code	Course Title	Credit Hours	HEC Category	17 UN SDGs alignment (please mention relevant SDG No.
1.	None	FYP 400	Final Year Project	3	Capstone Project	9
2.	CEN 222	CSC 407	Information Security	3	Major/Disciplinary (Computing Core)	4, 8, 9
3.			Elective Supporting	3	Interdisciplinary (Elective Supporting Courses)	
4.			Domain Elective 6	(2+1)	Domain Elective	
5.			Domain Elective 7	(3+0 or 2+1)	Domain Elective	
6.	ISL 113	ISL 114	Seerah-II	1 Contact Hour	Non-Credit course Tajweed, Quran and Hadith (Compulsory*)	4, 10, 16
			Total Credit Hours	15		

*Only for Muslim students

List of Elective Courses

Sr. No.	Proposed Road map aligned with HEC new UG Policy					
	Pre-requisite Course Code	Course Code	Course Title	Credit Hours	HEC Category	17 UN SDGs alignment (please mention relevant SDG No.
1	GSC 122	AIC 305	Advance Statistics	3	Domain Elective	4
2	None	CSC 315	Theory of Automata	3	Domain Elective	4
3	None	CSC 452	Data Mining	3	Domain Elective	3, 4, 9
4	None	AIC 306	Speech Processing	3	Domain Elective	4, 9
5	None	AIC 402	Reinforcement Learning	3	Domain Elective	4, 9, 11
6	None	AIC 403	Fuzzy Systems	2	Domain Elective	4, 9, 11
7	None	AIC 307	Evolutionary Computing	3	Domain Elective	4, 9
8	None	AIC 308	Agent-Based Modeling	3	Domain Elective	4, 9
9	None	CEN 459	Robotics	2+1	Domain Elective	4, 9, 11
10	None	ITC 412	Introduction to Cyber Security	2+1	Domain Elective	4, 8, 9
11	None	AIC 442	Natural Language Processing	2+1	Domain Elective	4, 9
12	None	AIC 410	Virtual and Augmented Reality	2+1	Domain Elective	4, 9
13	None	AIC 411	HCI & Computer Graphics	2+1	Domain Elective	4, 9
14	None	AIC 310	Swarm Intelligence	2+1	Domain Elective	4, 9, 11
15	None	CSC 400	Quantum Computing	2+1	Domain Elective	4, 8, 9
16	None	AIC 377	Game Artificial Intelligence	2+1	Domain Elective	4, 9
17	CSC 221 GSC 121	CSC-XXX	Quantum Computing for Artificial Intelligence	3+1	Domain Elective	
18	AIC 201	CSC-XXX	Explainable Artificial Intelligence	3+0	Domain Elective	

19	None	CSC-XXX	Cloud and Devops Engineering	3+0	Domain Elective	
20	None	CSC-XXX	AI Ethics and Society	3+0	Domain Elective	

List of Social Sciences Courses

Sr. No.	**Proposed Road map aligned with HEC new UG Policy**					
	Pre-requisite Course Code	Course Code	Course Title	Credit Hours	HEC Category	17 UN SDGs alignment (please mention relevant SDG No.
1.	None	HSS 107	Introduction to Psychology	3	General Education (Social Sciences)	3, 4
2.	None	HSS 115	Introduction to Media studies	3	General Education (Social Sciences)	4
3.	None	BES 103	Critical Thinking	3	General Education (Social Sciences)	3, 4

List of Elective Supporting Courses

Sr. No.	**Proposed Road map aligned with HEC new UG Policy**					
	Pre-requisite Course Code	Course Code	Course Title	Credit Hours	HEC Category	17 UN SDGs alignment (please mention relevant SDG No.
1.	None	MKT 110	Principles of Marketing	3	Interdisciplinary (Elective Supporting)	4, 8
2.	None	FIN 201	Fundamentals of Finance	3	Interdisciplinary (Elective Supporting)	4, 8
3.	None	MGT 111	Principles of Management	3	Interdisciplinary (Elective Supporting)	4, 8
4.	None	MGT 242	Organizational Theory and Behavior	3	Interdisciplinary (Elective Supporting)	4, 8

Appendage 3805

Revision of Curriculum – MS Mathematics

Program Mission:

To provide high quality education in pure and applied mathematics, fostering advanced analytical, computational, and research skills. The program aims to prepare scholars for graduate studies and diverse careers by promoting innovation, effective collaboration, and the application of mathematical methods to solve complex, real-world problems across disciplines.

Program Educational Objectives

a. Advanced mathematical concepts and approaches will be taught to address challenging problems in academia, industry, and other professional settings.
b. Teach graduates to undertake independent research, improve mathematical knowledge, and apply mathematical approaches to new and multidisciplinary sectors.
c. Guide them with strong analytical, problem solving, and communication skills, enabling them to effectively collaborate and contribute to professional and academic teams.

Program Learning Objectives

a. Demonstrate advanced knowledge of mathematical concepts, theories and techniques across diverse areas with a capacity to integrate and apply this knowledge in both theoretical and practical contexts.
b. Utilize advanced mathematical methods to formulate, analyze, and solve complex problems.
c. Conduct independent research, critically evaluate mathematical literature and employ modern mathematical tools through original research.
d. Effectively communicate complex mathematical concepts, findings, and research results, both orally and in writing, to diverse audiences, demonstrating clarity and precision in conveying abstract ideas.

Summary of Credit Hours

Sr. No.	HEC Curriculum Categorize	Credit Hours/Contact Hours	
		Existing Road Map	Proposed New Road Map
1.	Major/Disciplinary	12	12
2.	Electives Courses	12	12
3.	Thesis	06	06
	Total	30	30

Semester wise Roadmap MS Mathematics

Semester 1

Existing Roadmap			Proposed Roadmap			
Course Code	**Course Title**	**Credit Hours**	**Course Code**	**Course Title**	**Credit Hours**	**17 UN SDGs alignment**
	Core I	03		Core I	03	4
	Core II	03		Core II	03	4
	Core III	03		Core III	03	4

Semester 2

Existing Roadmap			Proposed Roadmap			
Course Code	**Course Title**	**Credit Hours**	**Course Code**	**Course Title**	**Credit Hours**	**17 UN SDGs alignment**
ESC 501	Research Methodology	03	ESC 701	Research Methodology	03	4
	Core IV	03		Core IV	03	4
	Elective I	03		Elective I	03	4

Semester 3

Existing Roadmap			Proposed Roadmap			
Course Code	Course Title	Credit Hours	Course Code	Course Title	Credit Hours	17 UN SDGs alignment
THS 799	MS Thesis	03	THS 799	MS Thesis	03	
	Elective II	03		Elective II	03	4
				Elective III	03	4

Semester 4

Existing Roadmap			Proposed Roadmap			
Course Code	Course Title	Credit Hours	Course Code	Course Title	Credit Hours	17 UN SDGs alignment
THS 799	MS Thesis	03	THS 799	MS Thesis	03	
	Elective III	03				

List of Core Courses

Existing Roadmap				Proposed Roadmap				
	Course Code	Course Title	Credit Hours		Course Code	Course Title	Credit Hours	17 UN SDGs alignment
1	MAT 710	Advanced Partial Differential Equations	03	1	MAT 710	Advanced Partial Differential Equations	03	4
2	MAT 711	Advanced Functional Analysis	03	2	MAT 711	Advanced Functional Analysis	03	4
3	MAT 713	Advanced Group Theory	03	3	MAT 713	Advanced Group Theory	03	4
4	MAT 739	Mathematical Techniques for Boundary Value Problems	03	4	MAT 739	Mathematical Techniques for Boundary Value Problems	03	4
5	MAT 726	Advanced Integral Equations and Applications	03	5	MAT 726	Advanced Integral Equations and Applications	03	4
6	MAT 728	ODEs and Computational Linear Algebra	03	6	MAT 728	ODEs and Computational Linear Algebra	03	4
				7	MAT 737	Fluid Dynamics	03	4, 9
7	MAT 729	Advanced Mathematical Physics	03					
8	MAT 727	Riemannian Geometry	03					

Note: Every student will have to study four core courses.

University Requirement Course

	Course Code	**Course Title**	**Credit Hours**		**Course Code**	**Course Title**	**Credit Hours**	**17 UN SDGs alignment (please mention relevant SDG No.**
1	ESC 701	Research Methodology	03	1	ESC 701	Research Methodology	03	4

List of Electives Courses

Existing Roadmap				Proposed Roadmap				
	Course Code	Course Title	Credit Hours		Course Code	Course Title	Credit Hours	17 UN SDGs alignment
1	ISC 711	Number Theory	03	1	ISC 711	Number Theory	03	4
2	MAT 712	Numerical Solution of Partial differential Equations	03	2	MAT 712	Numerical Solution of Partial differential Equations	03	4
3	MAT 714	Non-Newtonian Fluid	03	3	MAT 714	Non-Newtonian Fluid	03	4, 9
4	MAT 715	Perturbation Methods	03	4	MAT 715	Perturbation Methods	03	4
5	MAT 716	Finite Element Method	03	5	MAT 716	Finite Element Method	03	4
6	MAT 717	Near Rings	03	6	MAT 717	Near Rings	03	4
7	MAT 718	Fuzzy Logic/Fuzzy Algebra	03	7	MAT 718	Fuzzy Logic/Fuzzy Algebra	03	4
8	MAT 719	Advanced Ring Theory	03	8	MAT 719	Advanced Ring Theory	03	4
9	MAT 720	Topological Algebras	03	9	MAT 720	Topological Algebras	03	4
10	MAT 721	Commutative Semigroup Rings	03	10	MAT 721	Commutative Semigroup Rings	03	4
11	MAT 722	General Relativity	03	11	MAT 722	General Relativity	03	4
12	MAT 723	Advanced Analytical Dynamics	03	12	MAT 723	Advanced Analytical Dynamics	03	4
13	MAT 724	Heat and Mass Transfer	03	13	MAT 724	Heat and Mass Transfer	03	4, 9

14	MAT 730	Numerical Optimization	03	14	MAT 730	Numerical Optimization	03	4, 11
15	MAT 731	Advanced Cryptography	03	15	MAT 731	Advanced Cryptography	03	4, 9, 11
16	MAT 732	Probability Models and Applications	03	16	MAT 732	Probability Models and Applications	03	4, 11
17	MAT 733	Advanced Modern Algebra with Applications	03	17	MAT 733	Advanced Modern Algebra with Applications	03	4
18	MAT 734	Spectral Methods in Fluid Dynamics	03	18	MAT 734	Spectral Methods in Fluid Dynamics	03	4
19	MAT 735	Simple Linear Regression Models	03	19	MAT 735	Simple Linear Regression Models	03	4, 11
20	MAT 736	Lattice Boltzmann Method	03	20	MAT 736	Lattice Boltzmann Method	03	4
21	MAT 738	Lie Group Methods for Differential Equations	03	21	MAT 738	Lie Group Methods for Differential Equations	03	4
22	MAT 737	Fluid Dynamics	03					
				22	MAT 727	Riemannian Geometry	03	4
				23	MAT 729	Advanced Mathematical Physics	03	4