UNIVERSITY OF THE PUNJAB

NOTIFICATION

It is hereby notified that the Syndicate at its meeting held on 17-12-2022 has approved the recommendations of the Academic Council made at its meetings dated 11-03-2022 and 21-03-2022 respectively, regarding approval of the revised Scheme of Studies for Ph.D. in Space Sciences w.e.f. the Session, Fall 2022.

The Scheme of Studies for Ph.D. in Space Sciences is enclosed herewith, vide Annexure-'A'

Sd/-
SHAHID JAVED
Registrar

Admin. Block,
Quaid-i-Azam Campus,
Lahore.
No. D/ 408 /Acad. **Dated: 13 – 01 /2023.**

Copy of the above is forwarded to the following for information and further necessary action: -

1. Dean,
   Faculty of Sciences
2. The Chairman, Department of Space Sciences
3. Chairperson, DPCC
4. Controller of Examinations.
5. Director, IT for placement at website.
6. Secretary to the Vice-Chancellor
7. PS to the Registrar.
8. Assistant Registrar (Statutes)
9. Assistant Syllabus.

Assistant Registrar (Academic)
for Registrar

Scheme of Studies

PhD
in
Space Science

Department of Space Science
University of the Punjab, Lahore

Program Title: PhD in Space Science

Department: Space Science

Faculty: Faculty of Science

1. Mission and Vision

Our expertise in collecting and analysing data from space can lead the nation on a great journey of discovery, seeking new knowledge and understanding of our planet Earth, our Sun and solar system, and the universe out to its farthest reaches and back to its earliest moments of existence. Space science community use space observatories to conduct scientific studies of the Earth from space, sample data from other heavenly bodies in the solar system, and to peer out into our Galaxy and beyond. The space science program seeks answers to profound questions that touch us all: How and why are Earth's climate and the environment changing? How and why does the Sun vary and affect Earth and the rest of the solar system? How do planets and life originate? How does the universe work, and what are its origin and destiny? Are we alone?

Our vision using the vantage point of space to achieve with the science community and our partners a deep scientific understanding of our planet, other planets and solar system bodies, the interplanetary environment, the Sun and its effects on the solar system, and the universe beyond. In so doing, we lay the intellectual foundation of the future while meeting today's needs for scientific information to address national concerns, such as climate change and space weather. The objective is to explore Earth Science study from space to advance scientific understanding and meet societal needs; Planetary Science: an advance scientific knowledge of the origin and history of the solar system, the potential for life elsewhere, and the hazards and resources present as humans explore space; Astrophysics: to is cover the origin, structure, evolution, and destiny of the universe, and search for Earth-like planets. Fundamental research on profound

science questions using space-based observatories and related assets is the hallmark of Space Science. Astrophysics pursues answers to questions about the universe that are as old as humanity. Planetary Science both include elements important to the success of human exploration endeavors, and the former has practical utility on Earth. Earth Science is inherently beneficial to society in practical ways and requires that means be created to transfer its results for use in decision support and policy making. Research in areas is essential to the fulfillment of national and scientific priorities identified by the nations' scientific community.

Mission Statement of Space Science Department

To transform diversified space science students into technologically literate, enthusiastically science thinker and self-motivated collaborator to elevate the department to become a well-reputed high-tech centre of excellence in space science and technology.

Programs Aims and Objectives:

1- Provide postgraduates with advanced knowledge of mathematics, basic and applied sciences, spacecraft sub-systems, astrodynamics, remote sensing & geo-information systems.
2- To equip them with the talent to function in multidisciplinary teams.
3- To develop a nurture with understanding of professional and ethical responsibilities.
4- Excel in effective communication ability.
5- Recognize the need to engage in life-long learning to pursue and succeed in a graduate program.

Degrees of skills and capabilities that will reflect on the performance of Space Science are as listed below:

1- Students will be able to apply their knowledge of Space Science to scientific and related technology issues.

2- Students will be able to identify and solve practical scientific and technology problems.
3- Students will be able to recognize relevant disciplinary knowledge for a specific space application to meet the desired needs of industry and academia.
4- Students will be able to use modern tools, techniques, and skills necessary for practicing Space Science including computational tools and statistical techniques.
5- Students will be able to work in a professional science and related engineering environment, and to understand the associated ethical and economic considerations.
6- Students will have an understanding of the professional and ethical responsibilities of a scientist.
7- Students will have an understanding of the impact of science on society and environment.

2. Introduction

Space has been the new and the final frontier of the 20th century. Space exploration has resolved mysteries that were inaccessible from the ground and has opened new questions and demonstrated techniques for pursuing the answers. Satellite data are contributing to unravel the complex systems that govern the Earth's climate. The satellite exploration has created a new branch of the communications industry, which is making its own growing contributing to the information revolution. The advances in the field of Space Science, which comprise the disciplines like Remote Sensing, Satellite Communications, Meteorology, Space Environment, Meteorology, and Astronomy & Astrophysics, play a significant role in the overall development of a country. More than 6400 satellites are orbiting and watching the planet Earth Day and night for Communications, Weather Forecasting, Land-use/Land-cover studies, Television Broadcasting, Flood and Environmental Monitoring and protection purposes. Images from the Earth observation satellites are being used in mapping the regional patterns for Forest changes, Soil study and Environmental hazards. The

know-how and availability of space technology has become an index of space power like nuclear or industrial power.

The University of the Punjab has realized the importance of Space Science and decided to start and academic program in this field and consequently the Department of Astronomy was reorganized as the Department of Space Science in 1986. Initially, the Department of Space Science was established in the building of the Department of Astronomy, located opposite to the old Hailey College in Cust Road, Lahore. The Department was then shifted to the Quaid-e-Azam Campus in 1992. The Astronomical Observatory equipped with a seven inches refracting telescope and other equipment was established in 1924 as one of the best observatories in South Asia at that time. This observatory remained a center of learning for many decades and constitutes one of the teaching laboratories of the Department of Space Science.

The Department of Space Science intends to educate and train students by establishing a broad background of basic space science knowledge, leading to selected advanced studies in Remote Sensing & GIS, Tele/Satellite Communications, Astrophysics/Cosmology, Meteorology and Space Environment through learner-centered teaching and research.

3. Program Introduction (PhD in Space Science)

The PhD program provides basic research training which motivates scholars to go into high quality research and post-Doc like programs. This ultimately helps to prepare scientific/educational manpower with depth of scholarship and research competence of international level to fill senior positions in research organizations, industry, management, universities, and educational institutions. This also improves the qualification of teachers and thus provides competent teachers at all levels of education in universities, colleges, and schools.

4. Program Objectives

- Educating students to think analytically, work creatively, and become technologically literate in the fields of Space Science and contribute towards national uplift and capacity building in academics and R&D activities.
- Collaborating national and international institutions of well repute to promote research and development activities in the field of Space Science and its applications.
- Providing a supportive environment that encourages faculty and staff to continue their intellectual and professional growth.
- Promoting areas with distinctive strengths for which reputations for excellence can be recognized.

Space Science students acquire a substantial knowledge of different fields of space science making them able to a cope rapidly and thoroughly with any field of activity connected with Astrophysics & Astronomy, Meteorology, Remote Sensing & GIS, Telecommunications and Space Exploration as well as with different interdisciplinary fields of activity. Professional scientists, administrators, decision and policy makers will be benefitted from this course to finally raise the socio-economic uplift of the society

5. Admission Eligibility Criteria

- **MPhil Space Science or equivalent***

  * Equivalent: Remote Sensing, Physics, Computational Physics, Mathematics, Astrophysics, Meteorology, Climatology, Atmospheric Science, Agricultural and Soil Sciences, Environmental Sciences, Urban Planning and transportation Engineering, Computer Science, Electronics, Electrical Engineering, Electronics Engineering, Mechanical Engineering, Civil Engineering, Computer Engineering, Software Engineering, Aerospace/ Avionics/Aeronautical Engineering.

- **Seats: 15**

6. Duration of the Program

PhD	Years	Semesters	Courses	Credit Hours
Coursework	1	2	6	18
Dissertation	As per HEC criteria			

7. Scheme of Studies:

PhD program is enriched with advanced Applications of Space Science. Details are given in tables below.

PhD in Space Science

Course Title	Credit Hours	Code
SEMESTER-I		
Advanced Remote Sensing and Digital Image Processing	3 (2+1)	SPSC-801
Advanced Geospatial modeling and GIS	3 (2+1)	SPSC-802
Elective-I	3 (2+1)	
Semester's Total Credits	**9**	
SEMESTER-II		
Advanced Programming for Image Analysis	3 (2+1)	SPSC-803
Satellite Climate Data Analysis and Modeling	3 (2+1)	SPSC-804
Elective-II	3 (2+1)	
Semester's Total Credits	**9**	
DISSERTATION		
As per HEC criteria	50	

8. Award of Degree

As per Punjab University Rules & Regulations

9. NOC from Professional Councils (If Applicable)

Not Applicable

10. Faculty Strength

Degree	Area /Specialization	Total
PhD	1. Dr. Syed Amer Mahmood (Chairman/Professor); Space Science/RS 2. Dr. Syeda Adila Batool (Assistant Professor); Environmental Science 3. Dr. Muhammad Athar Javaid (Lecturer); Geodesy/Geoinformatics 4. Dr. Zia-ul-Haq (Assistant Professor); Space Science/RS 5. Dr. Asim Daud Rana (Assistant Professor); Space Science/RS 6. Dr. Khalid Mahmood (Assistant Professor); Space Science/GIS 7. Dr. Salman Tariq (Assistant Professor); Space Science/RS 8. Dr. Amer Masood (Assistant Professor); Space Science/RS 9. Dr. Ghulam Jaffer (Assistant Professor); Satellite Com. Aerospace Systems 10. Dr. Muhammad Yaseen (Assistant Professor); Geoinformatics 11. Dr. Salma Anwar (Assistant Professor); Geoinformtics 12. Dr. Jahanzeb Qureshi (Assistant Professor); Space Science/RS 13. Dr. Shahid Parvez Rana (Assistant Professor); Space Science/RS	(13)
Non-PhD	1. Mr. Javed Sami (Assistant Professor); Plasma Physics 2. Muhammad Kashif Nazir (Lecturer); Signal Processing	(02)

11. Present Student Teacher Ratio in the Department

Number of PhD Students: 05
Permanent Faculty Members: 15 (PhD = 13, Non-PhD = 02)

12. Course Outlines Separately for each course

Table: 1 Program Structure PhD Program

S. No	Course Structure	Credit Hours	Courses
01	Core Courses	09	3
02	Elective/Specialized	09	3
03	Thesis	50	-
	Total	**68**	**6**

Table 2: List of postgraduate core courses:

Course Code	Course Title	Credit
SPSC-801	Advanced Remote Sensing and Digital Image Processing	3(2+1)
SPSC-802	Advanced Geospatial modeling and GIS	3(2+1)
SPSC-803	Advanced Programming for Image Analysis	3(2+1)
SPSC-804	Applied Remote Sensing and GIS	3(2+1)

Table 3: List of postgraduate elective\specialized courses

06	Course Title	Credits Hours
SPSC-805	Exploration of Natural Resources	3(3+0)
SPSC-806	Natural Hazards and Disaster Management	3(2+1)
SPSC-807	Satellite Climate data Analysis and Modeling	3(3+0)
SPSC-808	Landuse Management and Urban Planning	3(3+0)
SPSC-809	GPS applications	3(3+0)
SPSC-810	Advanced Geostatistics	3(2+1)
SPSC-811	Climate Change and Sustainable Development Goals	3(2+1)
SPSC-812	Geoinformatics and Food security	3(2+1)
SPSC-813	Geospatial Hydrology	3(2+1)
SPSC-814	Terrain Mapping and Modeling	3(2+1)

Details of postgraduate core courses:

SPSC-801: Introduction to Remote Sensing and Digital Image Processing.

Course Structure: Lectures: 2 / Labs: 1 **Credit Hours:** 3(2 +1)

Prerequisite: Nil

Objective:

To provide basic understating about Space and Air borne Remote Sensing and digital image processing and analysis of remotely sensed data.

Course Outline: Key concepts, Physical Basis (EM Spectrum, Energy Interaction, Spectral Reflectance Curves) Image Characteristics, Sensor and Platforms, Visual Image Interpretation, Introduction to Photogrammetry (Analytical and Digital), Introduction to Thermal, Hyperspectral and Active Remote Sensing, Sensor and Platform Types, Working Mechanism, Image Geometry and interferometry, Data Sources and Procurement, Image Pre-processing, Image Arithmetic, Image Classification Techniques, Accuracy Assessment and Ground/Field Verification, Stereoscopic Analysis and DEM generation, Use of Remote Sensing for various Earth Resources and Environmental applications.

Lab Outline: Intro to lab and software, Image Management (Import/Export & Display), Sources and Characteristics of Remote Sensing Image Data, Interpreting Images, Enhancement Techniques, Spectral and spatial digitizing (image masking), Atmospheric Correction, Mosaicing and color balancing, Rectification and Registration and Re-sampling, Band Ratio, Pan-sharpening, Vegetation Indices, Difference images, Image filters, Signature selection, Supervised and Unsupervised classifications, Accuracy Assessment.

Reference Material

1. Lillesand, T. M. and Kiefer, R. W. (2007). Remote Sensing and Image Interpretation, 6th edition. (John Wiley and Sons), ISBN: 9780470052457
2. Mather, P M (2011). Computer Processing of Remotely Sensed Images, 4th Ed. (John Wiley and Sons), ISBN: 9780470742389

3. Campbell, James B. (2011) Introduction to Remote Sensing, 5th Ed., (The Guilford Press) ISBN: 9781609181765.
4. Edward M. Mikhail, James S. Bethel, J. Chris McGlone (2001) Introduction to modern photogrammetry 1st Ed. Wiley, ISBN: 9780471309246
5. Schowengerdt, R A (2007) Remote Sensing, Models and Methods for Image Processing (Academic Press) ISBN: 978-0-12-369407-2
6. Richards, John A., Remote sensing digital image analysis—An Introduction. Vol. 5, Springer, 2013
7. John R. Jensen, Introductory Digital Image Processing: A Remote Sensing Perspective, 2016
8. Floyd F. Sabins, Jr., James M. Ellis, Remote Sensing: Principles, Interpretation, and Applications,2020
9. Ali Nadir Arslan, Zuhal Akyurek, Remote Sensing of Snow and Its Applications, 2021

Teaching Strategies		Participatory lectures, cases, presentations etc.			
Assessment Criteria	**Marks %**	**Session**	**Mid**	**Final**	**Total %**
		25	**35**	**40**	**100**
Recommendations		All assignments must be completed and presented on time.			
Teaching-learning strategies		Class Lecture method, which includes seminars, discussions, assignments, and projects. (Audio-visual tools are used where necessary)			
Assignments-Types and Number with calendar		According to the choice of respective teacher.			
Assessment and Examinations		According to the University's Semester Rules.			

- Class Attendance will be strictly observed as per the University Rules.
- Students are advised to keep the course outlines in record in their own interest for future reference and studies abroad.

Governing Rules

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SPSC-802: Advanced Geospatial Modeling and GIS

Course Structure: Lectures: 2 / Labs: 1 **Credit Hours:** 3(2+1)

Prerequisite: Nil

Objectives:

Providing an understanding of Geographical Information Systems (GIS) spatial analysis, visualization of data and applications

Course Outline: Introduction to GIS principles, concepts and applications, History and evolution of GIS, Data structures and models, Data sources, Data acquisition, capturing, and conversion techniques, Earth model, Map projections and coordinate systems, Visualization of

spatial data, Map layouts, Spatial data queries and analysis, Network and overlay analysis, GIS applications, spatial modeling

Lab Outline: Hands-on experience using latest GIS software in understanding and applying GIS concepts introduced in this course.

Reference Material:

1. Bolstad, P. (2007), "GIS Fundamentals", 3rd Edition, Atlas Books. ISBN: 978-0-9717647-2-9
2. Chang, K. T. (2010), "Introduction to Geographical Information Systems" Higher Education, McGraw Hill
3. Clarke, K. (2010), "Getting started with Geographic Information System", 5th Edition, Prentice Hall, New York. ISBN –10: 0131494988
4. Heywood, I., Cornelius, S. and Carver, S. (2006), "An introduction to Geographic Information System", 3rd Edition, Prentice Hall. ISBN-10: 0131293176
5. 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
6. Longley, P.A., Goodchild, M.F., Maguire, D.J., and David, W.R. (2011), "Geographic Information Systems and Sciences", 3rd Edition, John Wiley & Sons.
7. Ormsby, T., Napoleon, E., Burke, R., Groessl, C., and Bowden, L. (2010), "Getting to Know ArcGIS Desktop: Basics of ArcView, ArcEditor, and ArcInfo", 2nd Edition, ESRI Press. ISBN: 9781589482609
8. Martin Wegmann, **,Jakob Schwalb-WillmannStefan Dech, An Introduc**tion to Spatial Data Analysis: Remote Sensing and GIS, (2020) Edition, Illustrated, ISBN 9781784272128.
9. Lex Comber, **,Chris Brunsdon** Geographical Data Science and Spatial Data Analysis: 2020
10. Martin Wegmann, **,Jakob Schwalb-WillmannStefan Dech**, An Introduction to Spatial Data Analysis: 2020

Teaching Strategies		Participatory lectures, cases, presentations etc.			
Assessment Criteria	**Marks %**	**Session**	**Mid**	**Final**	**Total %**
		25	**35**	**40**	**100**
Recommendations		All assignments must be completed and presented on time.			
Teaching-learning strategies		Class Lecture method, which includes seminars, discussions, assignments, and projects. (Audio-visual tools are used where necessary)			
Assignments-Types and Number with calendar		According to the choice of respective teacher.			
Assessment and Examinations		According to the University's Semester Rules.			

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SPSC-803 Advanced Programming for Image Analysis

Course Structure: Lectures: 1 / Labs: 2 **Credit Hours:** 3(1+2)

Prerequisite: Nil

Course Objective

Introduce students in geosciences and related disciplines to the fundamentals of Digital image processing with a view to extracting thematic and quantitative information from raw image data; and prepare and train the students on the use of GIS software to process raw image data, extract geo-information from it, analyze to generate new information and present the results in aesthetic maps, tables or graphics.

Course Outline:

Introduction to digital image processing, Fundamentals of computers and image processing systems, Fundamentals of image analysis and digital format, Fundamentals of image rectification and registration, Image enhancement techniques, Python, R, Matlab, C, IDL basic understanding

and use of these languages in all image processing requirements like geometric correction, atmospheric correction, mosaicking, stacking, classification, vegetation indices, change detection, image fusion, and accuracy assessment. Introduction to Python Basics, Handling GIS data in Python, API Development, vegetation mapping, time series analysis, image fusion, atmospheric correction, image classification (supervised and unsupervised), object-based classification, change detection etc, Machine Learning and Deep Learning based on Python scripts.

Lab Outline:

Optical and Microwave Image Analysis by using Python, R, MATLAB, and IDL.

Reference Material:

1. John C. Russ, F. Brent Neal (2015). The Image Processing Handbook, 7th Edition (CRC Press), ISBN 9781498740265.
2. Mather, P M (2004). Computer Processing of Remotely Sensed Images, 3rd Ed. (John Wiley and Sons), ISBN 0-470-84919-3
3. Christopher Bishop (2006). Pattern Recognition and Machine Learning (Springer), ISBN 978-0-387-31073-2
4. Mark Lutz (2013), Learning Python, 5th Edition (O'Reilly Media), ISBN 978-1-4493-5573-9
5. Gonzalez, R. C., Woods, R. E., & Eddins, S. L. (2009). Digital image processing using MATLAB (2nd Ed.). Gates mark Publishing
6. Marques, O. (2011). Practical image and video processing using MATLAB. Wiley.
7. Sandipan Dey, Hands-On Image Processing with Python, 2018
8. K. C. Santosh, Ravindra S. Hegadi, Recent Trends in Image Processing and Pattern Recognition:2019
9. Ashwin Pajankar, Python 3 Image Processing: 2019
10. Neeta Nain, ,Santosh Kumar VipparthiBalasubramanian Raman, Computer Vision and Image Processing: 2020
11. Sandipan Dey, Image Processing Master class with Python:2021

Teaching Strategies		Participatory lectures, cases, presentations etc.			
Assessment Criteria	**Marks %**	**Session**	**Mid**	**Final**	**Total %**
		25	**35**	**40**	**100**
Recommendations		All assignments must be completed and presented on time.			
Teaching-learning strategies		Class Lecture method, which includes seminars, discussions, assignments, and projects. (Audio-visual tools are used where necessary)			
Assignments-Types and Number with calendar		According to the choice of respective teacher.			
Assessment and Examinations		According to the University's Semester Rules.			

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SPSC-804: Applied Remote Sensing and GIS

Course Structure: Lectures: 2 / Labs: 1 **Credit Hours:** 3(2+1)

Course Objectives

To expose students to a broad range of practical applications of Remote Sensing and GIS.

Course Outlines: Various applications of Remote Sensing and GIS, Ocean Remote Sensing, Remote Sensing of Hydrology, Remote Sensing of Cryosphere, Remote Sensing of Geology, Remote Sensing of Agriculture, Remote Sensing of Forest, Mapping for Disaster management, Environmental Monitoring, Application of Remote Sensing and GIS for Land use/ Land cover.

Reference Material:

1. John R. Jensen (2006) Remote Sensing of the Environment: An Earth Resource Perspective, 2nd Edition, Pearson Prentice Hall, New Jersey, USA.
2. Gareth Rees, (2006) Remote sensing of snow and ice, CRC Press, Florida, USA.

3. Yangbo Chen, (2004) GIS and remote sensing in hydrology, water resources and environment, IAHS publisher, Oxford shire, UK.
4. Shyam Singh Yadav, **,Robert J. ReddenJerry L. Hatfiel**d, Food Security and Climate Change, 2019
5. Siamak Khorram, **,Cynthia F. van der WieleFrank H. Koch, Principles of Applied Remote Sensing, 2016**
6. Santra, Abhisek, **Mitra, Shreyashi Santra Remote Sensing Techniques and GIS Applications in Earth and Environme**ntal Studies, 2016
7. Kazuya Kaku · An Introduction to Applying Satellite Remote Sensing to Disaster Management,2019
8. MOHD NAZIP SURATMAN, ,Zulkiflee Abd LatifGabriel De Oliveira, Forest Degradation Around the World, 2020
9. Dr. SS. Asadi & Dr. M. Sujatha, Evaluation Of Terrain And Environmental Characteristics Of Reservoir Using Geospatial Technology,2021

Teaching Strategies		Participatory lectures, cases, presentations etc.			
Assessment Criteria	**Marks %**	**Session**	**Mid**	**Final**	**Total %**
		25	**35**	**40**	**100**
Recommendations		All assignments must be completed and presented on time.			
Teaching-learning strategies		Class Lecture method, which includes seminars, discussions, assignments, and projects. (Audio-visual tools are used where necessary)			
Assignments-Types and Number with calendar		According to the choice of respective teacher.			
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Detail of Postgraduate Elective\Minor Courses:

SPSC-805: Exploration of Natural Resources

Course Structure: Lectures: 3 / Labs: 0 **Credit Hours:** 3(3+0)

Prerequisite: Nil

Course Objective

- To understand the basic and advance concepts of Natural resources
- To use remote sensing and GIS techniques for exploration of natural resources

Course Outline: Natural resources introduction, types, Overview of soil, water, plants, and animals as renewable natural resources in ecosystem, Agricultural systems, transition systems, forestry systems, aquaculture and fisheries, watersheds, biological and physical factors control hydrology, soil formation, nutrient transport, agroecological dynamics, and component interactions of agroforestry systems, Agroforestry systems in temperate and tropical regions, Sustainable development in agriculture, protected areas, ecotourism and forestry, Survey of the ecology and management of forest, and wildlife resources in intensive agriculture. Conservation and management practices for private agricultural lands, Concepts of integrated resource management, Measurement and interpretation of aerial photos in resource management, Exploration techniques using Geographic Information Systems (GIS) including digitizing, development and query of attribute tables, georeferencing, use of multiple GIS layers in simple spatial analyses. GPS as a data collection tool for GIS, Theory, practice of natural resource policy, Integrative wildlife and forest policies.

Reference Material:

1. Barry Pound, Sieglinde Snapp, Cynthia McDougall, Ann Braun, (2003) Managing natural resources for sustainable livelihoods: uniting science and participation, IDRC, Ottawa, Ontario, Canada.
2. Bertie J. Weddell, (2002) Conserving living natural resources: in the context of a changing world, Cambridge University Press, Cambridge, UK.
3. Finn Helles, Per Holten-Andersen, Lars Wichmann, (2001) Multiple Use of Forests and Other Natural Resources, Springer, New York, USA.

4. L. Alexander Norsworthy, (2000) Rural development, natural resources, and the environment: lessons of experience in Eastern Europe and Central Asia, World Bank Publications, Washington DC, USA.
5. David L. Verbyla, (1995) Satellite remote sensing of natural resources, CRC Press, Florida, USA.
6. Bianco, Nauja, Reducing risks and increasing environmental security in Arctic Waters:2020
7. Anastasia Strati, The Protection of the Underwater Cultural Heritage: An Emerging Objectice:2021
8. Sughosh Madhav, Pardeep Singh, Groundwater Geochemistry: Pollution and Remediation Methods:2021

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<tr><td colspan="2">Teaching Strategies</td><td colspan="4">Participatory lectures, cases, presentations etc.</td></tr>
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SPSC-806: Natural Hazards and Disaster Management

Course Structure: Lectures: 3 **Credit Hours:** 3(3+0)

Objectives: While natural hazards cannot be prevented, their human impacts can be greatly reduced through advance action that mitigates risks and reduces vulnerability. This course focuses primarily on the understanding of hazards, disasters, vulnerability assessment and the potential use of GIT for natural disaster management in all the three phases, i.e. pre-disaster, disaster, and post-disaster with examples from globe and particularly Pakistan.

Course Outline: Overview of elements of Hazard and Disaster Management, Broad Identification of Natural hazard types and characteristics, Overview Natural Hazard Assessment and Zonation (magnitude, frequency and location relations versus types of hazards), Element at risk mapping - Vulnerability Assessment, Damage assessment, loss analysis, Risk Assessment Techniques, Hazard Mitigation Strategies & Selection, Types of Disasters and Risk Assessment

Course Outcomes: By the end of this course students will be able to achieve and demonstrate, the ability to

1. Understand the Disaster Management Cycle.
2. Understand the characteristics of disasters.
3. Apply GIS & RS in disaster risk reduction.

Reference Material:

1. ADPC (2005), Disaster Risk Management in Asia-A Primer, Asian Disaster Preparedness Centre, Bangkok, Thailand
2. N.C. Mahanti, S.K. Samal, P. Datta and N.K. Nag (2006), Disaster Management, Narosa Publishing House (pvt) Ltd
3. H. N. Srivastava, Management of Natural Disasters in Developing Countries,2006
4. Sinha, C. Prabhas, Disaster Mitigation
5. Judy L. Baker, Climate Change, Disaster Risk, and the Urban Poor,2012
6. S. Syngellakis, Management of Natural Disasters, 2016

7. George Haddow, ,Jane A. BullockKim Haddow, Global Warming, Natural Hazards, and Emergency Management, 2017
8. Anna Lukasiewicz, Claudia Baldwin, Natural Hazards and Disaster Justice, 2021

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SPSC-807: Satellite Climate Data Analysis & Modeling

Course Structure: Lectures: 3 / Labs: 1 **Credit Hours:** 3(2+1)

Prerequisite: Nil

Course Objective

- Access relevant climate data sources (e.g. on-line)
- Comprehend basic statistical concepts as applied to climate data
- Assess how decisions in data analysis can influence outcomes
- Use, develop and apply statistical based modeling techniques to analyze climate data
- Apply modeling techniques to simulate climate at various scales

Course Outline: Empirical data and conceptual models fundamentally underpin our understanding of how the world works. Critically, they provide a basis for which science can test the validity of a particular hypothesis in seeking to improve our understanding of a system. This is particularly true in the case of the global climate system, a complex, non-linear, system comprised of many interlinking and related components, for which the classic laboratory based experimental approach is simply not possible. This module provides a basic introduction to processes of accessing, analysing and modelling data; with a specific emphasis on large climate data sets. In order to develop practical skills and knowledge, students will be trained in the use and application of relevant techniques and software packages for processing and viewing climate data. These skills will be further developed through the use and application of various modelling techniques typically applied in climate analysis. While the module will focus on the analysis and modelling of climate data, the techniques employed are readily transferable to other data types in many other analysis settings.

Lab Outline:

Familiarization with RegCM, PRECIS; learning GrADs and NCL; Principal Component Analysis by using Matlab etc; Familiarization with gridded data; Understanding Re-analysis data.

Reference Material:

1. Earth's Climate: Past and Future, 3rd Edition, William F. Rudiman;
2. Toward a New Climate Agreement / Cherry, Hovi & McEvoy, 2014.
3. Finn Helles, Per Holten-Andersen, Lars Wichmann, (2001) Multiple Use of Forests and Other Natural Resources, Springer, New York, USA.
4. L. Alexander Norsworthy, (2000) Rural development, natural resources, and the environment: lessons of experience in Eastern Europe and Central Asia, World Bank Publications, Washington DC, USA.
5. David L. Verbyla, (1995) Satellite remote sensing of natural resources, CRC Press, Florida, USA.
6. Moses Eterigho Emetere, Esther Titilayo Akinlabi, Introduction to Environmental Data Analysis and Modeling, 2020

7. Alfonso Fernandez, ,Michel BaraerBryan G. Mark, Connecting Mountain Hydroclimate,2021
8. Anthony Arendt, ,Summer RupperSujay V. Kumar, Collaborative Research to Address Changes in the Climate,2021

Teaching Strategies		Participatory lectures, cases, presentations etc.			
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SPSC-808: Land Use Management and Urban Planning

Course Structure: Lectures: 3 / Labs: 0 **Credit Hours:** 3(3+0)

Prerequisite: Nil

Course Objective

- A broad understanding of Land Use and Land Cover (LULC) applications with the help of remotely sensed data

- The fundamental principles and mapping design criteria for LULC as well as change detection techniques as a means of understanding allied systems besides role of a prevalent land tenure system

Course Outline: Land Use and Land Cover (LULC) significance; LULC Database Construction methods; Remotely sensed data for LULC characterization; United States Geological Survey (USGS) LULC classification system, James Anderson USGS LULC Classification scheme criteria using RS Data, European CORINE Land Cover (CLC) Mapping, Vegetation, Agricultural and Forest resource mapping: Soil Line, Improved Vegetation Indices, Atmospherically resistant Indices, Comparison of Vegetation Indices; Change Detection techniques and methods, environmental factors and complexities; Urban Land Use Classification: Urban Growth/Sprawl using RS & GIS, Data Resolutions Required for Urban Applications, Critical Environmental Area Assessment, LULC change value estimation using RS & GIS; Human-environment interactions in LULC change; LULC conversion and modification; Land division, land law and Land Tenure System; LULC and Sustainable environment planning; Environmental Impact Assessment (EIA) procedures and various models;, Landscape ecology; Catchment area monitoring, Mapping of hydrosphere, Snow Cover and Glaciers; Conservation Management Systems; Land Use Planning Process; Land information management.

Reference Material:

1. John R. Jensen, (2007), Remote Sensing of the Environment, Second Edition, Pearson Prentice Hall
2. Mather, P (2004). Computer processing of remotely sensed images. Third Edition, J Wiley. ISBN 0-470-849193.
3. John R. Jensen, (1996), Introductory digital image processing: a remote sensing perspective, Prentice Hall,
4. Yangbo Chen, (2004) GIS and remote sensing in hydrology, water resources and environment, IAHS publisher, Oxford shire, UK.
5. Jane Silberstein M.A., ,Chris Maser ,Land-Use Planning for Sustainable Development 2013

6. Edoardo Marcucci, ,Valerio GattaLaetitia Dablanc, Urban Freight, land use planning and public administration:2019
7. Walter Leal Filho, ,Andréia Faraoni Freitas SettiUlisses Miranda Azeiteiro, Sustainability in Natural Resources Management and Land Planning:2021
8. George D. Bathrellos, Hariklia D. Skilodimou, Land Use Planning for Natural Hazards: 2021

Teaching Strategies		Participatory lectures, cases, presentations etc.			
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SPSC-809: GPS Applications

Course Structure: Lectures: 2 / Labs: 1 **Credit Hours:** 3(2+1)

Course Objective

- An in-depth overview of the Global Positioning System
- Growth of the GPS concept along with the applications

- Basic GPS components including satellites, ground stations, antennas and receivers

Course Outline: Introduction to GPS systems, GPS overview and modernization programs, Satellite Navigation, Reference coordinate system, Satellite orbits, GPS system Segments, GPS satellite signal characteristics, Satellite signal acquisition, Tracking and data demodulation, Interference, multipath and scintillation, Performance of stand-alone GPS, Differential GPS, Integrating of GPS with Sensors and Network Assistance, GALILEO, Other satellite Navigation Systems, GNSS markets and applications, Marine Navigation, Air Navigation, Land Navigation, GNSS in surveying, mapping and GIS, Military applications, Aviation, shipboard, Space applications

Lab Outline: Working of GPS, Working GPS in ArcGIS, GNSS, Mapping and GIS

Reference Material:

1. Elliott D. Kaplan, Christopher J. Hegarty (2006) Understanding GPS: Principles and Applications 2nd edition, Artch house, INC, ISBN: 1-58053-894-0
2. Guochang Xu (2003) GPS: Theory, Algorithms and Applications, Springer-Verlag Berlin Heidelberg New York, ISBN: 3-540-67812-3
3. Bill Clarke (2007), GPS aviation applications, McGraw-Hill publications, ISBN: 9780070116337
4. Kristof Beiglböck (2011) Programming GPS and Open Street Map Applications with Java, CRC Press, ISBN: 978-1-4665-0718-0
5. Satheesh Gopi (2005), Global Positioning System: Principles And Applications, Tata McGraw-Hill publications, ISBN: 0-07-058599-7
6. Elliott D. Kaplan, Christopher J. Hegarty, Understanding GPS: Principles and Applications,2006
7. Rustam B. Rustamov, A.M. Hashimov, Multifunctional Operation and Application of GPS,2018
8. Dewang Chen, Ruijun Cheng, Intelligent Processing Algorithms and Applications for GPS:2019
9. Shabbir Syed-Abdul, ,Luis Fernandez LuquePei-Yun Sabrina Hsueh, Data Analytics and Applications of the Wearable Sensors in Healthcare:2020
10. Yu Lu,BDS/GPS Dual-Mode Software Receiver: 2021

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SPSC-810: Advanced Geo-statistics

Course Structure: Lectures: 3 / Labs: 0 **Credit Hours:** 3(3+0)

Course Objectives

Statistical concepts and reasoning relevant to environmental sciences to provide experience in the proper use of statistical methods for the analysis of Remote Sensing and GIS applications

Course Outlines: Main concepts in statistical science, Exploratory data analysis, Probability distributions, Statistical inference, Linear modeling, Multivariate methods, Time series analysis, the practical content involves supervised hands-on experience using statistical software to analyze and interpret data

Course content:

R programming language for geo-statistical analyses

Geographically-weighted regression kriging

Geostatistics for precision agriculture

Reference Material:

1. Oliver Schabenberger, Carol A. Gotway, (2005) Statistical methods for spatial data analysis, CRC Press, Florida, USA.
2. Glen Cowan, (1998) Statistical data analysis, Oxford University Press, New York, USA.
3. Ram Gnanadesikan, (1997) Methods for statistical data analysis of multivariate observations, Wiley, New York, USA.
4. Richard Webster, **,Margaret A. Oliver** Geostatistics for Environmental Scientists, 2007
5. D.D. Sarma, Geostatistics with Applications in Earth Sciences, 2010.
6. Hans Wackernagel, Multivariate Geostatistics: An Introduction with Applications, 2013
7. Y. Z. Ma, Quantitative Geosciences: Data Analytics, Geostatistics, Reservoir,2019
8. Partha Pratim Adhikary, **,Pravat Kumar ShitPriyabrata Santra**, Geostatistics and Geospatial Technologies for Groundwater Resources,2021

SPSC-811: Climate Change and Sustainable Development Goals

Course Structure: Lectures: 3 / Labs: 0 **Credit Hours:** 3(3+0)

Course Objective

Environmental Dynamics and Climate Change course places particular emphasis on recent global and regional environmental and climatic change, the scientific basis and limitations of models and data collection techniques. Discuss the climate change. Formulate knowledge on Climate variability. Describe the large-scale climatic phenomena and their applications to address various sustainable goals

Course Contents:

History and structure of international response to the threat of global climate change, Evidence of economic impacts of climate change and economics of stabilizing greenhouse gases, Design, implementation and cooperation on economic mechanisms to fight warming, Energy, Forests, Biofuels and Agriculture, energy efficiency and reducing consumption, the Smart Grid, distributed generation, Clean Coal, nuclear power and geoengineering, Monitoring global warming and changing environmental conditions, Regional and local implication of global warming and changing conditions. Climate Change and Sustainable Development introduction, Energy Recovery from Waste, Solar Energy, Wind Energy, Land Use and Climate Change, Bio-energy, Clean Development Mechanism, Climate Change, Agriculture and Food Security, Climate Change and Adaptation in Water Sector, Climate Prediction and Early Warning System Community and Climate Adaptation, Climate Change Vulnerability and Adaptation, Climate Change and Water Resources, Renewable Energy Design Systems, Clean Coal Technologies, Science of Climate Change and Environment Co-Benefit, Energy Resources and Technologies, Energy Environment and Climate Change: Issues and Strategies, Community and Climate Adaptation. Sustainable development goals (SGDs)

Reference Material:

1. Hartman, physical climatology (Hartmann, 1994)
2. Gill, atmosphere-ocean dynamics (Gill, 1982)
3. Dijkstra, nonlinear physical oceanography (Dijkstra, 2000)
4. Houghton J. (2009), Global Warning: The Complete Briefing, Fourth Edition, Cambridge University Press.
5. Pittock, A. B. (2009), Climate Change: The Science, Impacts and Solutions, Second Edition.
6. Oldfield F. (2005), Environmental Change, First Edition, Cambridge University Press.
7. McGuffie K. and Henderson-Sellers A., (2005),A climate modelling primer,Third Edition, WILEY.
8. David G. Anderson, ,Kirk MaaschDaniel H. Sandweiss, Climate Change and Cultural Dynamics:2011
9. RB Singh, ,Udo SchickhoffSuraj Mal, Climate Change, Glacier Response, and Vegetation Dynamics in the Himalaya, 2016

10. Sergey Chalov, ,Valentin GolosovRui Li, Climate Change Impacts on Hydrological Processes and Sediment Dynamics:2019
11. Pinki Mondal, Sonali Shukla McDermid, Global Vegetation and Land Surface Dynamics in a Changing climate:2021
12. Pedro Giovâni Da Silva, ,Jani HeinoJuliano André Bogoni, Metacommunity Spatio-Temporal Dynamics: Conservation and Management Implications:2021
13. Dean Spears, Air: Pollution, Climate Change and India's Choice Between Policy and Pretence:2019
14. Robert Henson, The Thinking Person's Guide to Climate Change:2019
15. Catherine Barr, Steve Williams, The Story of Climate Change:2021
16. Juha I. Uitto, ,Jyotsna PuriRob D. van den Berg, Evaluating Climate Change Action for Sustainable Development, 2017
17. Dalia Streimikiene, ,Asta MikalauskieneRemigijus Ciegis, Sustainable Development, Leadership, and Innovations,2019
18. Dalia Štreimikienė, :Asta Mikalauskiene, Climate Change and Sustainable Development Mitigation and Adaptation,2021

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SPSC-812 Geoinformatics and food security

Course Structure: Lectures: 2 / Labs: 1 **Credit Hours:** 3(2+1)

Prerequisite: Nil

Objectives:

- To understand methods of digital image processing and carryout hands on exercises on RS datasets for agricultural applications.
- Overall understanding of Remote Sensing and GIS tools and their applications in Food security and Agriculture monitoring.
- Integrate Geo-spatial analysis and modeling in their academic research and develop a comprehensive view for application in Agriculture field.

Course Outline:

Revision of concept in food security and agriculture such as agronomy including factors affecting productivity; Applications of Remote Sensing and GIS in Agriculture, Use of Multitemporal and Hyper temporal satellite remote sensing data in conjunction with GIS technologies; Image processing tools and techniques including identification of crops and their patterns, mapping and monitoring crops, Crop Area estimation, Crop condition assessment and Crop yield estimation, agro-meteorological modeling; Land use and Land cover mapping of Agricultural system, Remote Sensing and GIS based classifications of soils; Evapotranspiration monitoring through Remote sensing and GIS.

Lab Outline: GIS Data Integration, Agriculture Monitoring Mapping, Multi-temporal and Hyper-temporal satellite Data, Area Calculation in GIS, Soil Classification

Reference Material:

1. Remote Sensing and Environment Grimson L. John, (2003) GIS for water resources and watershed management, CRC Press, London, UK. ISB No. 0415286077
2. Remote Sensing and Image Interpretation By (author) Thomas Lillesand, By (author) Ralph W. Kiefer, By (author) Jonathan W. Chipman
3. Remote Sensing of Vegetation By (author) Hamlyn G. Jones, By (author) Robin A. Vaughan

4. GIS Applications in Agriculture: Nutrient Management for Energy Efficiency Volume by Edited by David E. Clay, Edited by John F. Shanahan
5. Souleye Wade, Earth Observations and Geospatial Science in Service of Sustainable Development:2019
6. Kathy Lewis, Douglas Warner, Sustainable Agriculture for Climate Change Adaptation 2020
7. Yong He, Pengcheng Nie, Qin Zhang, Agricultural Internet of Things: Technologies and Applications:2021.

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SPSC-813: Geo Spatial Analysis for Hydrology

Course Structure: Lectures: 2 / Labs: 1 **Credit Hours:** 3(2+1)

Prerequisite: Nil

Course Objective

- Overall understanding of Remote Sensing and GIS tools and their applications in Hydrology and Water Resources.
- Familiarizing the students with available GIS software and GIS based Hydrological modeling tools
- Watershed management and planning by using remotely sensed data integrated with the GIS
- Integrating Geo-spatial analysis and modeling for application in water sector.

Course Outline: Revision of concept in water resources; Applications of Remote Sensing and GIS in surface hydrology; Understanding the dynamics of drainage system in GIS environment such as basin extraction using DEM, fill, flow accumulation, flow direction, flow length, sink, snap pour points, stream link, stream order, watershed, and catchment delineation; Evapotranspiration estimation through Remote sensing and GIS; Floods Monitoring using Remote Sensing& GIS, Forecasting and Flood Damage Assessment through Satellite Data; GIS based sub-surface hydrological modeling using GIS such as groundwater flow, Groundwater development and management, Darcy Flow, Darcy Velocity; Exploration of groundwater by Geospatial methods.

Lab Outline: DEM Generation, Spatial Interpolation, Hydrological Tools in ArcGIS, Ground Water Tools in ArcGIS

Reference Material:

1. Grimson L. John, (2003) GIS for water resources and watershed management, CRC Press, London, UK. ISB No. 0415286077
2. Yangbo Chen, (2004) GIS and remote sensing in hydrology, water resources and environment, IAHS, Oxfordshire, UK. ISB No. 1-901502-72-4

3. Martin G. Mansell, (2003) Rural and urban hydrology, Thomas Telford, London, UK. ISB No. 0727732307
4. Reginald W. Herschy, Rhodes Whitmore Fairbridge, (1998) Encyclopedia of hydrology and water resources, Springer, New York, USA. ISB No. 1-4020-4513-1
5. Vijay P. Singh, Mauro Fiorentino, (1995) Geographical information systems in hydrology, Springer, New York, USA. ISB No. 0-7923-4226-7
6. Antonio Pepe, Qing Zhao, Geospatial Analyses of Earth Observation:2019
7. Hassane Jarar Oulidi, ,Abdelhamid FadilNour Eddine Semane, Geospatial Technology: Application in Water Resources Management:2019
8. Nicolas Malloy Essential Modeling Techniques for Geospatial Analysis Using ArcGIS:2020
9. Tenedório, José António, ,Estanqueiro, RossanaHenriques, Cristina Delgado, Methods and Applications of Geospatial Technology:2021

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SPSC-814: Terrain Mapping and Modeling

Course Structure: Lectures: 2 / Labs: 1 **Credit Hours:** 3(2+1)

Course Objective

- To understand the concept of terrain mapping and modeling through aerial photos and satellite images.
- To understand the concept of interpolation in the Digital Terrain Model (DTM) generation, DEM
- To understand the utilization of DTM and Digital elevation Modeling in the hydrological, erosion, tectonics and geomorphological applications.

Course Contents: Concept of Terrain Mapping and Modeling, Importance and need for Digital Terrain Models (DTM), Elements of Digital Terrain Modeling, Contours, Grids, Triangulated Irregular Network (TIN), Comparison of Grid based and Triangulation based DTMs, Data Models in DTM, DTM Generation: Cartographic Data Sources, Photogrammetric Data Capture, Airborne LIDAR, Terrestrial Laser Scanning System, Radar based System, DTM Data Structures, Data Structure in Grid Data, Data Structure for TINs, Node based Structure, Triangle based Data Structure, Edge based Data Structure, DTM Manipulation: Surface Classification, Interpolation Methods, Kriging, DTM Generalization and Quality Control, DTM Interpretation, DTM visualization; Greyscale Image, Shaded Relief, DTM and Ortho-photos, DTM Applications; Drainage Modeling, Determine Flow Direction and Accumulation, Watershed Delineation, Topographic Wetness Index, Erosion, Fire Risk Modeling, Avalanche Risk Management, Geomorphological applications.

Lab outline: Terrain Mapping and Modeling, Digital Terrain Models (DTM), DTM Manipulation, Cartographic Data Sources, Watershed Delineation, neotectonic mapping

Reference Material:

1. Nesar El Sheimy, CaterinaValeo and Ayman Habib (2005) Digital Terrain Modeling, Artech House, London, UK. ISBN: 1-58053-921-1

2. Zhilin Li, ,Christopher ZhuChris Gold, Digital Terrain Modeling: Principles and Methodology,2004
3. Zhilin Li, Christopher Zhu and Chris Gold (2005) Digital Terrain Modeling: Principles and Methodology, CRC Press, Taylor and Francis, London, UK. ISBN: 0-415-32462-9
4. Robert Joseph Peckham, Gyozo Jordan, Digital Terrain Modelling: Development and Applications in a Policy Support Environment,2007
5. Igor V. Florinsky (2011) Digital Terrain Analysis in Soil Sciences and Geology, Academic Press, Waltham MA, USA. ISBN: 978-0-12-385036-2
6. Zhilin Li, Jun Chen and Emmanuel Baltsavisa (2008) Advances in Photogrammetry, Remote Sensing and Spatial Information Science, CRC press, Taylor and Francis, London, UK. ISBN: 978-0-415-47805-2
7. Joel M. Caplan, Leslie W. Kennedy, Risk Terrain Modeling: Crime Prediction and Risk Reduction, 2016
8. John P. Wilson, Environmental Applications of Digital Terrain Modeling, 2018
9. Li-Yang Xiong, Guo-An Tang, Loess Landform Inheritance: Modeling and Discovery:2019
10. Kim M. Lersch, Jayajit Chakraborty, Geographies of Behavioural Health, Crime, and Disorder: 2020
11. Guy Jean-Pierre Schumann, Paul Bates, The Need for a High-Accuracy, Open-Access Global Digital: 2020
12. Fischer, G., Nachtergaele, F.O., van Velthuizen, H.T., Chiozza, F., Franceschini, G., Henry, M., Muchoney, D., Tramberend, S. · Global Agro-Ecological Zones v4 – Model documentation: 2021

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