CURRICULUM OF
REMOTE SENSING &
GEOGRAPHICAL INFORMATION
SYSTEM

BS/MS

(Revised 2016/2017)
<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
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<tbody>
<tr>
<td>Prof. Dr. Mukhtar Ahmed</td>
<td>Chairman</td>
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<tr>
<td>Prof. Dr. Arshad Ali</td>
<td>Executive Director</td>
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<tr>
<td>Mr. Muhammad Raza Chohan</td>
<td>Director General (Academics)</td>
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<tr>
<td>Dr. Muhammad Idrees</td>
<td>Director (Curriculum)</td>
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<tr>
<td>Syeda Sanober Rizvi</td>
<td>Deputy Director (Curriculum)</td>
</tr>
<tr>
<td>Mr. Riaz-ul-Haque</td>
<td>Assistant Director (Curriculum)</td>
</tr>
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PREFACE

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

University Grants Commission (UGC) was designated as the competent authority to develop, review and revise curricula beyond Class-XII vide Section 3, Sub-Section 2 (ii), Act of Parliament No. X of 1976 titled “Supervision of Curricula and Textbooks and Maintenance of Standard of Education”. With the repeal of UGC Act, the same function was assigned to the Higher Education Commission (HEC) under its Ordinance of 2002, Section 10, Sub-Section 1 (v).

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

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

It is hoped that this curriculum document, prepared by the respective NCRC’s, would serve the purpose of meeting our national, social and economic needs, and it would also provide the level of competency specified in Pakistan Qualification Framework to make it compatible with international educational standards. The curriculum is also placed on the website of HEC

http://hec.gov.pk/english/services/universities/RevisedCurricula/Pages/default.aspx

(Muhammad Raza Chohan)
Director General (Academics)
CURRICULUM DEVELOPMENT PROCESS

STAGE-I  
CURRI. UNDER CONSIDERATION
COLLECTION OF REC
CONS. OF CRC.
PREP. OF DRAFT BY CRC

STAGE-II  
CURRI. IN DRAFT STAGE
APPRASIAL OF 1ST DRAFT BY EXP. OF COL./UNIV
FINALIZATION OF DRAFT BY CRC
APPROVAL OF CURRI. BY V.C.C.

STAGE-III  
FINAL STAGE
PREP. OF FINAL CURRI.
INCORPORATION OF REC. OF V.C.C.
PRINTING OF CURRI.
IMPLE. OF CURRI.
ORIENTATION COURSES

STAGE-IV  
FOLLOW UP STUDY
QUESTIONNAIRE
COMMENTS
REVIEW
BACK TO STAGE-I

Abbreviations Used:
CRC. Curriculum Revision Committee
VCC. Vice Chancellor’s Committee
EXP. Experts
COL. Colleges
UNI. Universities
PREP. Preparation
REC. Recommendations
INTRODUCTION

MINUTES OF PRELIMINARY MEETING OF NCRC
(REMOTE SENSING & GEOGRAPHICAL INFORMATION SYSTEM BS/MS PROGRAMS)

The final meeting of National Curriculum Revision Committee in the subject of Remote Sensing (RS) & Geographical Information System (GIS) was held on April 17-19, 2017 at HEC Regional Centre Lahore to finalize the draft curriculum reviewed/prepared in its preliminary meeting held on December 05-07, 2016 (03 days) at NED University of Engineering and Technology, Karachi. Following attended the meeting:

<table>
<thead>
<tr>
<th>S.N</th>
<th>Name &amp; Institution</th>
<th>Position</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Dr. Badar Ghauri</td>
<td>Convener</td>
</tr>
<tr>
<td></td>
<td>Professor/ Head of Department</td>
<td></td>
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<tr>
<td></td>
<td>Department of RS &amp; GIS</td>
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<tr>
<td></td>
<td>Institute of Space Technology, Karachi.</td>
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<tr>
<td>2</td>
<td>Dr. Salman Atif</td>
<td>Secretary</td>
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<tr>
<td></td>
<td>Assistant Professor,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Institute of Geographical Information System (IGIS), National University of Science &amp; Technology, IGIS Building, Islamabad.</td>
<td></td>
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<tr>
<td>3</td>
<td>Prof. Dr. Asif Ahmed Shaikh</td>
<td>Member</td>
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<td></td>
<td>Chairman/ Professor</td>
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<tr>
<td></td>
<td>Department of Environmental Engineering,</td>
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<td></td>
<td>NED University of Engineering &amp; Technology, Karachi.</td>
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<tr>
<td>4</td>
<td>Prof. Dr. Mir Shabbar Ali</td>
<td>Member</td>
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<tr>
<td></td>
<td>Chairman/ Professor</td>
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<tr>
<td></td>
<td>Department of Urban &amp; Infrastructure Engineering,</td>
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<tr>
<td></td>
<td>NED University of Engineering &amp; Technology, Karachi.</td>
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<td>5</td>
<td>Dr. Imran Khan</td>
<td>Member</td>
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<td></td>
<td>Director General,</td>
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<td></td>
<td>Geological Survey of Pakistan,</td>
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<td></td>
<td>P.O Box No. 15, Sariab Road, Quetta.</td>
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<tr>
<td>6</td>
<td>Dr. Muhammad Shahzad Sarfraz</td>
<td>Member</td>
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<tr>
<td></td>
<td>Associate Professor,</td>
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<tr>
<td></td>
<td>Department of Computer Sciences,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>University of Gujrat, Gujrat.</td>
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</tbody>
</table>
| 7 | Dr. Sheeba Afsar  
Associate Professor  
Department of Geography,  
Department of Geology, University of Karachi. | Member |
|---|---|---|
| 8 | Muhammad Khubaib Abuzar  
Senior Assistant Professor/ GIS-RS Expert,  
Department of E&ES,  
Bahria University, Islamabad. | Member |
| 9 | Dr. Anila Kausar  
Assistant Professor,  
Department of Geography,  
University of Karachi. | Member |
| 10 | Dr. Muhammad Jamal Nasir,  
Assistant Professor,  
Department of Geography,  
University of Peshawar, Peshawar. | Member |
| 11 | Dr. Kashif Mahmood,  
Assistant Professor,  
Department of Geography,  
Government College University, Faisalabad. | Member |
| 12 | Dr. Muhammad Afzaal  
Director, Research & Development Division,  
Pakistan Meteorological Department,  
Pitrus Bukhari Road, H-8/2, Islamabad. | Member |
| 13 | Mr. Maqsood Ullah Khan  
Assistant Director(ICT)  
Directorate of Information & Communication Technology, NDMA, Prime Minister Office, Islamabad. | Member |
| 14 | Dr. Saad Malik,  
Assistant Professor,  
Department of Remote Sensing & GIS,  
Institute of Space Technology, Karachi | Member |
| 15 | Mr. Muhammad Ahmed  
Lecturer, Dept. of Urban & Infrastructure Engineering,  
NED University of Engineering & Technology,  
University Road, Karachi. | Member |
| 16 | Mr. Sanaullah  
Assistant Director,  
Survey of Pakistan,  
22nd Central Street DHA, Phase-II, Karachi | Member |
NCRC Agenda
The agenda of NCRC for the subject of RS&GiSc was as follows:

i. To revise/update the curriculum of Remote Sensing-Geographical Information System (2012) for BS & MS Programs according to indigenous needs and to bring it at par with international standards.

ii. To revise/update preface, mission, vision, preamble, and rationale of the program according to Outcome Based Education (OBE).

iii. To develop and revise Program Learning Outcomes (PLOs), Course Learning Outcomes (CLOs), list of contents and assessment criteria (formative & summative).

iv. To incorporate/suggest latest reading materials/references (local & international) for every course.

v. To revise/update course contents keeping in view the uniformity across other disciplines and avoiding overlapping.

vi. To make recommendations for promotion/development of the discipline, keeping in view the futuristic needs of the society and international trends.

The meeting started with recitation from the Holy Quran. Dr. Muhammad Idrees, Director, Academics Division, HEC, Islamabad welcomed the participants on behalf of Higher Education Commission, Pakistan. Prof. Dr. Muhammad Afzal Haque, the worthy Vice Chancellor of NED University of Engineering and Technology, Karachi honored the inauguration session. He welcomed the participants and thanked HEC, Pakistan for providing opportunity of hosting NCRC meeting at NED, UET, Karachi. He further highlighted the importance of OBE based curriculum and encouraged the committee to participate in this academic and professional activity. All the participants introduced themselves highlighting their qualification, experience and area of expertise within the discipline of RS-GIS. Keeping with the tradition, Dr. Muhammad Idrees, Director Academics Division, HEC, Islamabad offered the house to nominate the Convener and Secretary of the NCRC for smooth functioning. Dr. Badar Ghauri, Professor/ Head of Department, Department of RS & GIS, Institute of Space Technology, Karachi and Dr. Salman Atif, Assistant Professor, Institute of Geographical Information
System (IGIS), National University of Science & Technology, IGIS Building, Islamabad were selected unanimously as Convener and Secretary, respectively.

Dr. Muhammad Idrees presented the agenda and objectives of the NCRC. He highlighted the importance of this meeting and emphasized for adaptation of general rules of curriculum development and revision like scope of the subject/program, horizontal & vertical alignment, rule of flexibility and adaptability keeping in view the futuristic approach, market value/job market and societal needs. He also shared a template for revising/updating the curricula. The template was unanimously accepted to be followed. It was also agreed to add vision, mission, program learning outcomes (PLOs) and course learning outcomes (CLOs), teaching methodology and assessment segments in the curricula.

In next session the house openly discussed the nomenclature of the discipline, preface, vision, mission, objectives of the programs, Program Learning Outcomes (PLOs), methods of instruction and learning environment, assessment and operational framework keeping in mind new trends of Outcome Based Education (OBE) being adopted by various institutions. Sample Course Learning Outcomes (CLOs) were also proposed for few subjects. After long deliberation, the committee finalized the above said segments of the curriculum. Similarly, framework/scheme of studies of undergraduate 4-years program for RS-GIS was discussed keeping in view the duration of the program, number of semesters, number of weeks per semester, total number of credit hours, number of credit hours per semester, weightage of theory and practical. Furthermore, list of courses (core & elective) and semester wise breakup of courses were also discussed thoroughly and the same was unanimously finalized.

In the afternoon session, admission criteria/intake criteria was discussed and finalized. After that the list of courses was distributed among the committee members keeping in view the experience and expertise in the field for reviewing course objectives, adding learning outcomes, updating list of contents, adding teaching-learning methods and assessment, and updating bibliography/ references/ suggested books.

On second day, task assigned to the groups was displayed and discussed the addition/deletion and revising the courses. After thorough deliberations, draft curriculum of the BS (4-years) for RS-GIS was finalized.

On third day, the courses of MS program of RS-GIS was reviewed and after thorough discussion, courses were finalized. It was decided that the draft curriculum of RS-GIS would be circulated among the experts of the field (local & foreign) and the feedback of the experts will be incorporated in final meeting.
In the end, Dr. Idrees thanked the Convener, Secretary and all members of the Committee for sparing their time and for their contribution to prepare the revised draft of the curriculum. He also thanked Vice Chancellor of NED, UET for hosting this NCRC meeting and department of Urban and Infrastructure (NED, UET) for facilitation and other logistic arrangements for smooth functioning of NCRC. He further stated that their efforts will go a long way in developing workable, useful and market oriented comprehensive degree programs in RS-GIS. The Convener of the NCRC also thanked the Secretary and members for their inputs in revising/updating the curriculum to make it more practical, competitive, efficient and realistic. The committee appreciated the efforts made by the officials of HEC Regional Centre, Karachi for making arrangements to facilitate the committee and their accommodation. The meeting ended with the vote of thanks to Dr. Muhammad Idrees and his team from HEC for providing this academic and professional opportunity for national cause.

RECOMMENDATIONS BY NCRC

**Recommendations for Undergraduate Program**
1. The courses should include newer approaches on data sciences, analytics, big geo-spatial data and Internet of Things;
2. It was stressed that electives on enterprise GIS design, management and implementation should be included;
3. Web GIS as an important technology should be made part of the curriculum;
4. RS-GIS labs should be fully equipped with latest hardware and software.
5. The student final year projects should be in line with the needs of the industry. Universities are suggested to develop linkages with RS-GIS industries through ORIC;
6. Students must gain practical experience through internship.

**Recommendations for Postgraduate Program**
1. Students should take the deficiency courses in RS & GIS where, required;
2. Deficiency courses should be designed such that the basic principles and approaches in RS & GIS are implicitly introduced;
3. Students should be encouraged and supported to publish their research in reputed scientific journals.

**General Recommendations for the Discipline**
1. The program should be in line with the guidelines of NCRC;
2. The core RS &GIS courses should be identical to maximum extent. In this regard, the Universities are advised to take appropriate steps
to harmonize their programs with these guidelines. However, the electives component may vary depending on the level of expertise and resources available in individual academic institution and allied industry.

3. Faculty development should be facilitated through trainings, seminars, meetings and conferences in their subject areas.

4. In order to harness the real potential of RS-GIS at user end, proposals/guidelines be issued/circulated through Cabinet Division to all Ministries/Divisions, Attached Departments, Autonomous bodies, Corporations and Industry to provide technical support in preparation of their recruitment rules/ToRs for RS-GIS specific projects/portfolios.

Aims and Objectives:

National Curriculum Revision Committee members held intensive deliberations in two (preliminary and final) meetings on multidimensional aspects of the required curriculum. The main tasks of this group were:

1. To develop international standard Remote Sensing and GIS curriculum for undergraduate and postgraduate degree programs that could uniformly be adopted by the public and private sector institutions.

2. To impart cutting edge knowledge and practical based skills among our graduates through rigorous theory, practical work and field exercises focused on key and applied aspects of these space age technologies.

3. To develop entrepreneurial skills for launching professional career in the geospatial field.

4. To devise components for the smooth implementation of teaching and research program at HEIs of Pakistan.

As a starting point, BS (RS&GIS) four years degree program was taken up for the discussion on its nomenclature, duration, eligibility criteria, course streams and contents to be offered. This followed deliberations to revise MS RS&GIS program in terms of duration of the degree, core courses, elective courses and thesis.

After prolonged discussions BS and MS in RS&GIS degree programs were finalized.

Vision

Produce innovation oriented RS-GIS graduates who can contribute to the betterment of environment and society.
Mission
To impart the best quality RS & GIS education through advanced teaching tools providing impetus for sustainable socio-economic development of Pakistan.

PREAMBLE
With the advent of new technologies, the world has turned into a global village. In view of tremendous research taking place world over new ideas and information pours in like a stream, making it imperative to update the curricula after regular intervals, for introducing latest development and innovation in the relevant field of knowledge.

In exercise of the powers conferred under Section 3 Sub-Section 2 (ii) of Act of Parliament No. X of 1976 titled “Supervision of Curricula and Textbooks and Maintenance of Standard of Education” the erstwhile University Grants Commission was designated as competent authority to develop review and revise curricula beyond Class-XII. With the repeal of UGC Act, the same function was assigned to the Higher Education Commission under its Ordinance of 2002 Section 10 Sub-Section 1 (v).

In compliance with the above provisions, the HEC undertakes revamping and refurbishing of curricula after regular intervals in a democratic manner involving universities/DAIs, research and development institutions and local Chamber of Commerce and Industry. The intellectual inputs by expatriate Pakistanis working in universities and R&D institutions of technically advanced countries are also invited to contribute and their views are incorporated where considered appropriate by the National Curriculum Revision Committee (NCRC).

RATIONALE
Considering the recent advancements in the science and technology and their impacts in the field of RS & GIS, coupled with contemporary requirements of Outcome Based Education (OBE), there is a dire need to update the curriculum of RS & GIS program.

SCOPE
The scope of the document is to provide minimum standards in the form of guidelines for the development, delivery and assessment of the RS & GIS program. The guideline areas include; Program Educational Objectives (PEOs), Program Learning Outcomes (PLOs) and Course Learning Outcomes (CLOs), scheme of studies, course outlines, credit hours distribution, assessment criterion, and recommendations.

Program Educational Objectives (PEOs)
Following are the sample program educational objectives that are expected to be exhibited by the RS & GIS graduates.

1. Demonstrate sound knowledge and skills.
2. Work, manage and illustrate effective teamwork, interpersonal skills and professional growth.
3. Undertake professional practice considering ethical, societal and environmental implications.

*Note: Institutions are expected to customize their own PEOs for their program requirements.*

**PROGRAM LEARNING OUTCOMES (PLOs)**

- RS & GIS program provides the necessary technical as well as professional skills consistent with Higher Education Commission (HEC) accreditation standards and national development needs.
- A RS & GIS graduate would be able to undertake planning, designing, operations and maintenance of urban and rural infrastructure by applying his/her knowledge in all stages of RS & GIS and inter-disciplinary projects.

**METHODS OF INSTRUCTIONS AND LEARNING ENVIRONMENT**

This shall comprise the following:-

- Classroom lectures, duly supported by audio-visual aids, demonstrations and relevant handouts.
- Assignments and tutorials requiring use of latest of reference materials and internet facility.
- Homework load for the students should be rationalized considering the credit hours of the course.
- Semester projects and class presentations.
- Laboratory experiments and design exercises.
- Final year project
- Field works such as survey camp, community services and internship
- Instructional visits to appropriate establishments, installations, construction sites, field stations, industries etc.
- Extension lectures and class room discussions by renowned professionals.
- Enhanced use of modern computing facilities in the institutions.
- The notebooks/field books/graphs and drawing sheets pertaining to the field work and practical should be completed within the allocated time and submitted to the teacher. In case of field visit, the students shall be required to write a visit report.

**ASSESSMENT**

1. Classroom attendance, class assignments, class tests, homework assignments, quizzes, viva voce, presentations etc., should be considered for the award of sessional marks.
2. Structured rubrics are encouraged to be used for the assessment of Laboratory work, class performance, Complex RS & GIS Problems, field survey, semester projects and Final Year Project (FYP).

3. The academic pursuit and achievements of a student in a semester/academic year are to be evaluated by holding semester examinations.

4. Examination of final year courses may be evaluated by external/neutral examiners, in addition to internal examiner.

5. Final year projects shall be evaluated by both external and internal examiners.

OPERATIONAL FRAMEWORK
1. Following the HEC guidelines, an operational framework is developed which includes both Geo-spatial and non-geospatial courses as detailed in summary table titled "BS REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM".

2. Every University in Pakistan covers different areas in respect of professional applications. However, objectives of Bachelor of RS & GIS courses are same. Considering this aspect that the courses suggested one and in such way that graduates from all universities are at par and at the same time be prepared to meet the national and international requirements. The curriculum designed has the room for individual universities to adjust courses as per their local requirements.

3. Number of contact hours: The contact hours for study of courses are kept for university to university, considering the variation in local requirements. The following scheme is recommended:
   1 credit hour of theory class = 1 contact hour
   1 credit hour of lab / design class / practical = 2 contact hours

4. The evaluation of the students will be made on the basis of grading system as per guidelines of the HEC.

5. Course Contents:
   Course contents of each course are being provided as guidelines to meet the requirement of uniformity.

6. Practical/Design Classes/Field Work:
   The Laboratory Experiments/Practical/Design Classes/Field Works shall be in conformance with the contents of the respective course.
Bachelor of Science (BS) in Remote Sensing (RS) & Geographical Information System (GIS) BS (RS & GIS)

Eligibility:

1. Intermediate with Science or Equivalent with Mathematics at that level.
2. All those students who have not taken mathematics course at Intermediate level will have to take “prescribed mathematics” as non-credit course.

Duration:
- Four year program spread over 8 semesters (two Semesters per Year)
- 133+ credit hour courses including final project.

Degree Requirement:
Minimum 133+ Credits are required to complete Bachelor of Science (RS&GIS) Minimum Cumulative Grade Point Average (CGPA) required is 2.0 out of maximum of 4.0 CGPA.

Evaluation:
For the uniformity in the evaluation system, NCRC recommends that the minimum CGPA required to pass a semester is 2.0 out of 4.0 at undergraduate level.

Table 1.0
Following table provides full details of core courses centered on key streams of 4 years BS (RS & GIS) Program.

Table: 1.0 Structure of 4 years BS (RS&GIS)

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<th>No.</th>
<th>Code</th>
<th>Pre-Req</th>
<th>Course Title</th>
<th>Credit hours</th>
<th>Semester</th>
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<tr>
<td>1.</td>
<td>Nil*</td>
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<td>Introduction to Remote Sensing</td>
<td>3</td>
<td>2</td>
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<tr>
<td>2.</td>
<td>Nil</td>
<td></td>
<td>Introduction to Photogrammetry</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>1</td>
<td></td>
<td>Advance Remote Sensing</td>
<td>3</td>
<td>5</td>
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<td>Stream 2: Core Geographic Information Sciences Courses</td>
<td>24/136</td>
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<tr>
<td>4.</td>
<td>Nil</td>
<td>Navigation Systems</td>
<td>3</td>
<td>4</td>
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<td>5.</td>
<td>1 &amp; 2</td>
<td>Digital Image Processing</td>
<td>3</td>
<td>4</td>
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**Stream 2: Core Geographic Information Sciences Courses**

| 1. | Nil | Introduction to Geographic Information Systems | 3 | 1 |
| 2. | IT2 | Spatial Databases | 3 | 6 |
| 3. | GC5 | Geo Statistics | 3 | 4 |
| 4. | 1 & RS1 | Spatial Data Analysis | 3 | 5 |
| 5. | 1, CC4 & IT1 | GIS Programming | 3 | 5 |
| 6. | 5 | Spatial Decision Support Systems | 3 | 6 |
| 7. | 1, RS3 | Geospatial Project Management | 3 | 7 |
| 8. | 3 | Spatial Data Infrastructure | 3 | 6 |

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<tr>
<th>Stream 3: Core Geography and Earth Sciences Courses</th>
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<tbody>
<tr>
<td>1.</td>
<td>Nil</td>
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<tr>
<td>2.</td>
<td>Nil</td>
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<td>3.</td>
<td>Nil</td>
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<td>4.</td>
<td>Nil</td>
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<td>5.</td>
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<td>6.</td>
<td>Nil</td>
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<td>7.</td>
<td>GES5</td>
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<td>8.</td>
<td>Nil</td>
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**Stream 3: Core Geography and Earth Sciences Courses**

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<th>Stream 4: Core Information Technology Courses</th>
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<tbody>
<tr>
<td>1.</td>
<td>1</td>
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<tr>
<td>2.</td>
<td>GC1</td>
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<td>3.</td>
<td>Nil</td>
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<td>4.</td>
<td>Web GIS</td>
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<td>Stream 5: Compulsory Courses</td>
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<tr>
<td>1. Nil</td>
<td>Calculus and Analytical Geometry</td>
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<tr>
<td>2. Nil</td>
<td>Pakistan Studies</td>
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<tr>
<td>3. Nil</td>
<td>Functional English</td>
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<td>4. Nil</td>
<td>Introduction to Computer</td>
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<td>5. Nil</td>
<td>Linear Algebra and Applications</td>
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<td>6. Nil</td>
<td>Islamic Studies/Ethics</td>
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<td>7. Nil</td>
<td>Communication Skills</td>
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<tr>
<td>8. Nil</td>
<td>Technical Writing and Presentation Skills</td>
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<tr>
<td>9. Nil</td>
<td>Professional Ethics* (in lieu of English-IV)</td>
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<th>Stream 6: General Courses</th>
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<tbody>
<tr>
<td>1. CC4</td>
<td>Introduction to Computer Programming</td>
</tr>
<tr>
<td>2. Nil</td>
<td>Applied Physics</td>
</tr>
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<td>3. CC1</td>
<td>Discrete Mathematics</td>
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<td>4. Nil</td>
<td>Applied Statistics</td>
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<td>5. Nil</td>
<td>Research Methods</td>
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<tr>
<th>Electives (Specialization areas)</th>
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<td><strong>Total Credit Hours for 4 years BS (RS &amp; GIS)</strong></td>
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*Please note that the number/abbreviation in pre-requisite column is the serial Number and abbreviated form of a particular stream. *If only Number is mentioned then the pre-requisite falls in the same stream.
## Scheme of Study for 4 Years BS (RS & GIS) Program

<table>
<thead>
<tr>
<th>Semester 1</th>
<th>Credits</th>
<th>Semester 2</th>
<th>Credits</th>
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<td>Introduction to Remote Sensing</td>
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<tr>
<td>Introduction to Computer</td>
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<td>Introduction to Programming</td>
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<td>Physical Geography</td>
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<td>Digital Image</td>
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<td>Data Structures and Algorithms</td>
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<td>Object Oriented Programming</td>
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<td>Climate Change</td>
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<td>Cartography</td>
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<td>Geo-statistics</td>
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<td>Introduction to Photogrammetry</td>
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<td>Introduction to Earth Sciences</td>
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<td>Surveying</td>
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<td>Navigation Systems</td>
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<td>1 &amp; 2</td>
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<td>Digital Image Processing</td>
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</table>
1. Introduction to Remote Sensing

Credit Hours: 3 (2+1)
Prerequisites: Nil

Learning Objectives:
- To provide basic concepts and principles of Remote Sensing
- To introduce remote sensing techniques as tool for data collection/mining and analysis
- To provide an overview of the application of Remote Sensing in different fields

Learning Outcomes
After studying this course, the students will be able to:-
1. Define and describe the terms of Remote Sensing
2. Understand the basic principles of Remote Sensing
3. Evaluate the applications of Remote Sensing in various disciplines

Course Outline
- History, Scope and Concept of Remote Sensing
- Elements of Remote Sensing
  - Energy Sources or Illumination
  - Electromagnetic radiation its characteristics and different parts of spectrum
  - Radiation and the Atmosphere
    - Energy interaction with atmosphere
    - Scattering and its types, Absorption
    - Atmospheric Window
  - Energy interaction with earth surface features
    - Absorption, Transmission and Reflectance, Specular and Diffuse reflectance
    - Spectral Reflectance Curves, Water, Vegetation and Soil
    - Image Characteristics
  - Recording of Energy by the Sensor
    - Platforms (Types and Orbital Characteristics)
    - Sensor types and their characteristics
    - Image resolution types
    - Swath width
- Data reception and processing
- Major components in digital image processing for radio metric correction
  - Image Rectification and registration,
  - Image Enhancement,
• Mosaicking and sub-setting

• **Interpretation and Analysis**
  • Visual Image Interpretation
  • Digital Image processing overview

• **Applications Overview**

**Lab Outline:**
1. Introduction to labs,
2. Overview of Image Processing Software (e.g. ERDAS Imagine, ENVI, Orfeo Toolbox),
3. Image Georeferencing
4. Layer stacking,
5. Image Mosaicing,
6. Extraction of AOI (Subsetting),
7. Color composites,
8. Various sensors data comparison,
9. Feature recognition,
10. Image classification
   a. Unsupervised
   b. Supervised

**Teaching Methodology**
• Lectures
• Written Assignments
• Lab work

**Assessment**

**Mid Term (40%)**
• Written (Long Questions, Short Questions, MCQs) 50%
• Presentation 20%
• Assignments 20%
• Report Writing 10%

**Final Term (60%)**
• Written (Long Questions, Short Questions, MCQs) 50%
• Presentation 20%
• Report Writing 10%
• Lab work 20%

**Recommended Books**


2. Introduction to Photogrammetry

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

Learning Objective
- To provide basic knowledge about the key elements of photogrammetry and its procedures/techniques.
- To understand stereo photogrammetry and its applications

Learning Outcomes
After studying this course, the students will be able to:-
1. Define and describe the terms photogrammetry and aerial photograph
2. Understand the basic principles of photogrammetry
3. Apply the knowledge to visually interpret the aerial photograph.
4. Compare photogrammetry and remote Sensing.
5. Evaluate the application of aerial photographs and its importance in natural Resource management

Course Outline:
- Introduction: History, overview and importance of photogrammetry
- Analog, and digital photogrammetry
- Sensor, films and filters, data acquisition methods
- Types of aerial photographs: vertical, oblique, terrestrial, convergent and trimetrogon photographs
- Flight configuration of aerial photography: forward & side lap and forward gain
- Aerial photograph’s marginal information
• Methods for calculation of scale and area: descriptive, graphical and representative friction method
• Interpretation of aerial photographs: shape, shadow, size, pattern, tone, texture and association
• Stereovision, Ray’s Diagram, Porro-Koppe’s principle, Stereoscopic analysis
• Introduction to Digital Photogrammetric Work Stations (DPWS)
• Concepts of UAVs, LIDAR and their applications
• DEM, DSM and DTM generation and their comparison,
• Ortho-photography/Ortho-image, applications: visual interpretation, identification and extraction of natural and man-made features, flood damage assessment and various types of mass-movement

Teaching Methodology
• Lecturing
• Written Assignments
• Lab work

Assessment

Mid Term (40%)
• Written (Long Questions, Short Questions, MCQs) 50%
• Presentation 20%
• Assignments/Lab work 20%

Final Term (60%)
• Written (Long Questions, Short Questions, MCQs) 50%
• Presentation 20%
• Assignments/Lab work 20%
• Term Project 10%

Lab Outline:
• Visual interpretation, Identification and Extraction of various land features
• DEM generation, Height measurement, scale & area calculations, and contouring by using Stereoscope and Photogrammetric Work Station

Reference Material:

3. Advanced Remote Sensing

Credit hours: 3 (1+2)
Prerequisites: Introduction to Remote Sensing

Course Objectives:
To equip students on the advanced development in Remote Sensing and analytical techniques.

Learning Outcomes
After studying this course, the students will be able to:
1. Understand practical skills required in advanced remote sensing
2. Learn techniques to handle analytically the remote sensing data.
3. Become proficient in the use of advanced remote sensing techniques.
4. Become effective in analyzing optical, thermal and microwave remotely sensed data sets.

Content List
- Introduction to new generation satellites (GPM, SMAP, SWOT, ICESat, Aqua/Terra, ALOS, Sentinel-2, etc)
- Major components in digital image processing
  - Spatial Filtering,
  - Principle component Analysis,
  - Image Fusion,
  - Image Classification techniques (object based, knowledge based, support vector machine, neural network)
  - Generating DEM, DTM & DSM
- Integrated Remote sensing and GIS Modeling
• Synthetic aperture radar (SAR)
  • Interferometry,
  • Image spectrometry,
  • Feature Extraction from hyper-spectral data,
  • Image Residuals,
  • Spectral Fingerprints,
  • Absorption-band Parameters,
  • Spectral Derivative Ratio,
  • Classification Algorithms for hyper-spectral Data,
  • Radar remote sensing,
  • Speckle noise and suppression,
  • Texture analysis,
  • Data Fusion,

• Basic concepts of satellite altimetry and gravimetry
• Applications of new generation satellite sensors (SAR, InSAR, Altimetry, Gravimetry)

Lab:
• Image Enhancement and Image Fusion
• Image Classification: object based, knowledge based, support vector machine, neural network
• Indices Development: NDVI, NDWI, NDSI, Leaf Area Index in ERDAS Imagine, ENVI, MATLAB, etc.
• Application in natural resource management

Teaching Methodology
• Lectures
• Lab sessions
• Term Projects

Assessment
Mid Term (40%)
• Written (Long Questions, Short Questions, MCQs) 60%
• Term Project Completion 20%
• Term Project Presentation 20%

Final Term (60%)
• Written (Long Questions, Short Questions, MCQs) 100%

Reference Material:


4. **Navigation systems**

Credit hours: 3 (2+1)
Prerequisites: Introduction to GIS

**Course Objectives:**
Introduces students to the basic of global satellite navigation systems in a manner where they will be able to add significant components of the said in their practical applications of GIS. These practical applications may include surveying, mobile applications with real-time navigation and integration in web mapping applications etc.

**Learning Outcomes**
Upon successful completion of this course, the student will demonstrate the ability to:

1. Identify various global satellite navigation systems and their operational principles;
2. Understand the functioning and operational details of GNSS and similar systems;
3. Analyze the shortcomings of such systems in real-life scenarios;
4. Adapt to variations in various navigation systems based devices and their operational mechanisms.

Content List
- Introduction to Navigation science,
- Available and Future Navigation Systems,
- Basic Mathematical Concept for Navigation Systems,
- Space Segment,
- Control Segment,
- User Segment,
- Point to point transmission,
- Point to area transmission,
- Differential GPS and Kinematics,
- Diffusion and interference,
- Application of Navigation system,
- GPS Error sources and Accuracy Assessment,
- Data transfer from and to a GPS receiver.

Practical:
- 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

Teaching Methodology
- Lectures
- Written Assignments
- Field Assignments
- Report Writing

Assessment

Mid Term (40%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 10%
- Report Writing 10%
- Lab work 10%

Final Term (60%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
Assignments 20%
Term Project 10%
Lab work 10%

**Recommended Books**

5. **DIGITAL IMAGE PROCESSING**

Credit hours: 3 (2+1)
Prerequisites: (Advance Remote Sensing)

**Course Objectives:**
- To provide basic understanding of digital image processing of remotely sensed data.
- To apply the image processing techniques of feature detection for generating useful knowledge.

**Learning Outcomes**
After studying this course, the students will be able to:-
1. Understand different modalities and current techniques in image acquisition
2. Describe how digital images are represented and stored efficiently depending on the desired quality, color depth, dynamics (time-varying data).
3. Use the mathematical principles of digital image enhancement (contrast, gradients, noise).
4. Analyze the constraints in image processing when dealing with larger data sets (efficient storage and compression schemes).
5. Apply the knowledge primarily obtained by studying examples and cases in the field of biomedical imaging to other engineering disciplines.

**Content List**
- Data Sources and acquisition
- Characteristics of grey-level digital images
- Types of Image data Formats
- Pre-processing (Image stacking, Sub-setting & Geomatric and Atmospheric Corrections)
- Image Rectification and Registration
Re-sampling
Image transformation (Geometric and Affine)
Batch Processing
Image Mosaicking and Color Balancing
Image Enhancement (Grey level transformations, Histogram equalization,)
Image Filtering (Pan-sharpening, Fourier descriptors, Linear and non-linear filtering operations, Image and Separable convolutions, Sub-sampling and interpolation as convolution operations)
Image Indices (NDVI, NDWI, NDSI, Leaf Area Index, etc)
Image Classification (Types, Algorithms and Spatial modeler techniques)
Signatures selection, feature space and evaluation
Principal component analysis
Morphological operations
Accuracy Assessment and Field Verification

Practical:
Intro to lab and software
Hands on training on Spatial modeler in ERDAS Imagine
Atmospheric correction of multi-spectral and hyper-spectral data sets
Image Management (Import/Export & Display)
Image Enhancement Techniques (Histogram equalization, filtering)
Spectral and spatial digitizing
Mosaicking and color balancing
Rectification, Registration and Re-sampling
Image processing techniques
Signature selection
Accuracy Assessment and Field Verification
Individual/Group project with field work

Teaching Methodology
Lecturing
Written assignments
Lab based assignments
Final project

Assessment

Mid Term (40%)
Written (Long Questions, Short Questions, MCQs) 50%
Written assignment 25%
Lab based assignments 25%
• Term project 10%

Final Term (60%)
• Written (Long Questions, Short Questions, MCQs) 50%
• Written assignment 20%
• Lab based assignments 20%
• Final project 10%

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<td>Spatial Data Infrastructure</td>
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</table>
1. **Introduction to Geographic Information Systems**

Credit hours: 3 (2+1)
Prerequisites: Nil

**Course Objectives:**
The course is designed to understand the fundamental understanding and application of GIS

**Learning Outcomes**
After studying this course, the students will be able to:-
1. Understand the fundamental theory of Geographic Information Systems (GIS)
2. Understand the basic concepts of Geo-Spatial data acquisition and development
3. Use the GIS tools to conduct spatial analyses
4. Develop maps that are fit-for-purpose and effectively convey the information they are intended to.

**Content List**
- Introduction to Geographical Information System.
- Fundamental theory of Geographic Information Science.
- History and evolution of GIS.
- Components of GIS.
- Concepts of Geo-Spatial data (its acquisition and development)
- Concept of Geo-Workspace environment
- Geo-referencing & Geocoding
- Data structures and models. (Raster & Vector)
- Levels of Measurements in GIS.
- Vector Data entry operator in GIS
- Concepts of Spatial layering in GIS.
- Concept of four M’s (Mapping, Modeling, Management & Monitoring)
- Fundamental operations in GIS.
- Application of GIS

**Practical:**
- Introduction to Open Source and Commercial Software
- Coordinate Systems
- Introduction to Geo-workspace
- Geo-referencing
- Plot a geographic grid of graph paper (manual).
- Handheld GPS based survey.
- Incorporation of spreadsheet data with GIS
- Creating shape file and spatial database files
• Digitization [preparation of Land-use Map]
• Generating Maps in form of PDF/Jpeg etc.

Teaching Methodology
• Lecturing – *Basic Concepts*
• Filed Survey – *Data Collections*
• Computer lab sessions – *Demonstration of GIS software*
• Term Projects – *Application*

Assessment

**Mid Term (40%)**
• Written (Long Questions, Short Questions, MCQs) 40%
• Term Project Completion 20%
• Term Project Presentation 20%
• Lab Exercises 20%

**Final Term (60%)**
• Written (Long Questions, Short Questions, MCQs) 80%
• Practical Examination 20%

Recommended Books

2. Spatial Database Systems

Credit Hours: 3 (2 + 1)
Prerequisites: Introduction to GIS

Course Objectives:
To introduce a thorough understanding and capabilities of Spatial databases

Learning Outcomes:
After this course’s completion, the students should be able to:

1. Understand basic spatial database concepts,
2. Distinguish Spatial data models and geodatabases
3. Implement Spatial data retrieval techniques and SQL in the GIS environment
4. Compare various spatial data management and Open GIS Standards

Contents List:
- Introduction to Spatial Database
- Basic Open GIS Standards for Spatial Database
- Relational Database in Spatial domain
- Object Relational Database
- Spatial Query and Spatial Operators
- Basics of Geodatabase
- Basic spatial and geometry tests
- Table operations
- Topology in Spatial Database
- Spatial Indexing

Practical:
Introduction to lab and software
Linking with GIS software
Development of geo-databases and spatial databases
Topological testing
Spatial Queries and Spatial Operators
Assignments on application of spatial queries

Teaching Methodology
- Lectures
- Written Assignments
- Guest Speaker
- Field Visits
- Report Writing
Assessment

Mid Term (40%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Lab Exam 50%

Final Term (60%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Lab Exam 50%

Recommended Books:
4. Oracle press release 2010, Oracle Spatial 11g user guide and reference
5. OGC release 2011, Open GIS Implementation Specification for Geographic information – Simple feature access Part 2: SQL option

3. Geo-statistics

Credit hours: 3 (3+0)
Prerequisites: (None)

Course Objectives:
To help students understand the use and application of geo-statistics in GIS and remote sensing

Learning Outcomes
After studying this course, the students will be able to:

1. Understand the concepts underlying geo-statistical analysis;
2. Differentiate different geo-statistical analysis techniques;
3. Understand and analyze the outcomes of geo-statistical analysis;
4. Use of the suitable geo-statistical models;
5. Employ geo-statistical analysis for planning and decision making.

Content List
- Statistic
- Data analysis and transformation
• Sets and Probability
• Concept of Random Variables
• Possibilities
• Probabilities and expectations
• Directional semi-variograms
• Sampling Theory
• Estimation Theory
• Testing Hypothesis: One sample Tests, Two Sample Tests
• Regression and Correlation
• Analysis of Variance
• The Chi-Square Distribution
• Quantile-quantile plot
• Spatial autocorrelation and directional influences
• Cross validation

**Practical:**
Exercise related to:
• Statistics, data analysis and transformation.
• Directional semi-variograms.
• Quantile-quantile plot

**Teaching Methodology**
• Lecturing
• Written assignments
• Lab based assignments
• Final project

**Assessment**

**Mid Term (40%)**
• Written (Long Questions, Short Questions, MCQs) 50%
• Written assignment 20%
• Lab based assignments 20%
• Final project 10%

**Final Term (60%)**
• Written (Long Questions, Short Questions, MCQs) 50%
• Written assignment 20%
• Lab based assignments 20%
• Final project 10%

**Recommended Books**
4. **Spatial Data Analysis**

**Credit Hours:** 3 (2 + 1)

**Prerequisites:** Spatial Data Systems

**Course Objectives:**
To develop spatial analytical skills in practical scenarios within the geographic information systems.

**Learning Outcomes:**
After studying this course, the students will be able to:

1. Identify the main functional components of GIS
2. Understand the various types of Spatial analyses
3. Implement standardized data input and management
4. Simulate real world using various analytical techniques.

**Contents List:**
- Introduction to spatial data types
- Potentials of spatial data
- Modeling and storing field data
- Cluster analysis
- Boundary Analysis
- Spatial Analyses
- Point pattern analysis
- Spatial Autocorrelation
- Buffering, proximity and neighborhood functions
- Spatial interpolation, type, Methods / algorithms, Derived measures on surfaces
- Polylines and network Analyses
- Area objects and types of area objects
- Geometric properties of areas
- Map overlay
- Vector and raster overlay operations
- Ordinary Least Squares & Geographically Weighted Regression Techniques
- Problems in simple Boolean polygon overlay
- Multivariate data and multidimensional space
- New approaches to spatial analysis
- Surface modeling, DTM/DEM/DSM
- Multi-criteria and Multi-attribute Decision Making
- Uncertainties in spatial modeling.

**Practical:**
Assignment on Spatial Analysis for various applications
Geo-coding
Point analysis exercise
Interpolation of point data and surface modeling
Network analysis exercise
Aerial analysis exercise
Buffer analysis exercise
Multivariate analysis
Assignment on advanced spatial analysis
Suitability analysis
Risk Modeling, Assignment on uncertainties in spatial modeling

**Teaching Methodology:**
Lectures
Lab work
Assignments
Term Project

**Assessment:**

Mid Term (40%)
- Written (Long Questions, Short Questions, MCQs) 40%
- Quizzes 30%
- Lab Exam 30%

Final Term (60%)
- Written (Long Questions, Short Questions, MCQs) 40%
- Lab Exam 20%
- Term Project Completion 20%
- Term Project Presentation 20%
Recommended Books:

5. GIS Programming

Credit Hours: 3 ( 2 + 1)

Prerequisites: Data Structures and Algorithms

Course Objectives:
To provide a foundation for customized geospatial applications using various programming platforms.

Learning Outcomes:
Students completing this course should be able to:
1. Understand the basic working environments of Python
2. Apply geoprocessing techniques using Arcpy code.
3. Implement automated tasks using Arcpy code.
4. Understand and implement the use of cursors.
5. Create usable ArcObjects code for typical GIS programming tasks in .NET.
Contents List:
- Intro to course
- Fundamentals of geo-processing
- Fundamentals of Python
- Usage of variables and special data types
- 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
- Writing results to disk, various formats and switches
- Advanced topics and further directions
- Num.py for numerical modeling
- Architecture of ArcObjects
- Main Arc Objects classes, classes and interfaces (IFeatureLayer, IFeatureClass, IFeature, IFeatureCursor, etc.) other useful modules

Practical:
- Introduction to Lab
- Looping statements
- Getting and setting object parameters
- Creating features and feature classes
- Editing layer’s display properties
- Changing/editing and summarizing attribute data
- Exploring the geo-processor object,
- Projects

Teaching Methodology:
Lectures
Lab work
Assignments

Assessment
Mid Term (40%)
Written (Long Questions, Short Questions, MCQs) 50%
Lab exam 50%

Final Term (60%)
Written (Long Questions, Short Questions, MCQs) 50%
Lab Exam 50%

Recommended Books:

6. Spatial Decision Support Systems
Credit hours: 3 (2+1)
Prerequisites: Geo-Spatial Database Systems

Course Objectives:
To provide the students with an understanding, use and development of decision support systems to address complex spatial problems.

Learning Outcomes
After studying this course, the students will be able to:-
1. Define and differentiate conventional and spatial decision support systems.
2. Understand the components of SDSS.
3. Compare various technologies that are important in developing new SDSS, including programming languages, development environments, and spatial libraries.
4. Apply the methods for tailoring SDSS into work environment.

Content List
- Introduction to Spatial Decision Making (Need, Process, Evolution and Trends)
- Components of Traditional DSS
- Components of SDSS
- Methods and Techniques to Support Spatial Decisions
• Modeling Techniques (Generic Models and Application-Specific Models)
• GIS Software Used in SDSS
• SDSS Software Components
• Design and Development of SDSS from Scratch
• Enabling Technologies for the Development of Desktop
• Web-Based SDSS Development and Architecture
• SDSS Application Domains
• SDSS Challenges (Technical, Technological, Social, Policy, and Organizational and Educational)
• Future Trends and Directions

Practical:
• Collaborative Decision -Making Software Packages, INDEX®
• Populating a data warehouse using different loading facilities
• Running different queries for extraction of results
• ArcGIS Server-based SDSS and Map Server-based SDSS
• Heuristic modeling using Marxan
• Populating and using an OLAP tool

Teaching Methodology
• Lecturing
• Written Assignments
• Guest Speaker
• Report Writing

Assessment
Mid Term (40%)
• Written (Long Questions, Short Questions, MCQs) 50%
• Presentation 20%
• Assignments 20%
• Lab Assignments 10%

Final Term (60%)
• Written (Long Questions, Short Questions, MCQs) 50%
• Presentation 20%
• Assignments 20%
• Term Projects 10%

Recommended Books
5. S. Ramanathan and DeGroote, John (2011); Spatial Decision Support Systems; CRC Press, 487 pages

7. Geospatial Project Management

Credit Hours: 3
Course Structure: Lectures: 3 / Labs: 0
Prerequisites: Introduction to RS & GIS

Objectives:
i. Familiarize with important aspects of managing projects

Learning Outcomes:

After completion of this course the students will be able to:
1. Identify and analyze the issues involved in organizing, planning, monitoring and controlling a geospatial project.
2. Initiate a small-scale geospatial technology project by developing project plans and financial budgets, assembling project costs and benefits, developing investment appraisal methods and using authorization, monitoring and control processes.
3. Discuss the role, significance and impact of people in a project management setting, and evaluate and implement strategies for managing people in geospatial technology projects.
4. Review current geospatial technology project management methodologies and appraise their effectiveness and efficacy for managing different types of geospatial projects.

Course Outline:
Introduction and overview of Geospatial project management.
Geospatial Program Development: Role of planning and management in developing a successful geospatial technology based projects.
Geospatial Program Organizational Structure: Governance and Coordination: Role of planning and development, organizational structures, leadership and governance, and communications in successful geospatial projects.
**Human Resources:** Role of project leadership, team building, capacity building (including opportunities for geospatial certification) and multi-organizational agreements (i.e. collaborations) in contributing to successful geospatial programs.

**Funding, Financial Management, and Collaboration:** The financial aspects, such as funding, financial management, monitoring, and reporting, and risk management that contribute to successful geospatial programs and the completion of projects on time and on budget.

**Geospatial Program Legal Issues:** The ways in which legal and ethical issues influence the geospatial sector.

**Management of Geospatial Program Technical Elements:** Role of technical design (system configuration, data, applications) and the development and maintenance of these technical components in contributing to successful geospatial programs.

**Geospatial Office Operations, Service Delivery and User Support:** Role of the operational environment in helping to shape and sustain successful geospatial programs.

**Geospatial Projects and Project Management:** The ways in which all of the aforementioned components can be combined to successfully manage geospatial projects.

Also current and emerging trends, including the consequences of choosing proprietary vs. open source software solutions, geospatial standards, spatial data infrastructures, web-based geoprocessing service architectures, and volunteered geographic information, and how they are likely to influence future geospatial projects.

**Teaching Methodology**
- Lectures
- Written Assignments
- Presentation
- Brainstorming for creativity

**Assessment**

**Mid Term (40%)**
- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Report writing 10%

**Final Term (60%)**
- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Report writing 10%
Reference Material:

8. Spatial data infrastructure

Credit hours: 3 (3+0)
Prerequisites:

Course Objectives:
Spatial data infrastructures are meant for data holding and dissemination amongst a wider range of audience. In light of this the course objectives are to introduce students to the basic need and necessity of SDIs, their data holding nature, metadata standards and protocols, system architecture and deployment for public.

Learning Outcomes
After studying this course, the learners will be able to:-
1. Understand the basic working principles of SDI
2. Create and deploy working prototypes of SDI
3. Describe the working principles of an SDI and its component elements

Content List
- Introduction, Need for SDI
- Components of SDI
- Clearinghouse
- Clearing house architecture National Geospatial Clearinghouse
- Metadata
- Metadata concepts and functionality
- Structure of Metadata
- Functionality of Metadata
- System Architecture
- Attribute Data Standardization
- System Architecture for SDI Interoperability
• Interoperability and standards
• Client Server Architecture
• Spatial Data Quality
• Data Quality Information (DQI)
• Accuracy, Precision, Bias and Error Modeling
• Data Modeling for SDI
• Data Modeling, Abstraction of Real World
• Types of abstraction, Problems of information sharing (Heterogeneities),
• Distributed database concept
• GIS Internet Services and SDI Technologies
• System Architecture
• Available Services
• Technologies that support internet GIS services
• Commercial tools for internet GIS
• Standardization by ISO and OGC

Teaching Methodology
• Lecturing
• Written Assignments
• Guest Speaker
• Field Visits
• Report Writing

Assessment

Mid Term (40%)
• Written (Long Questions, Short Questions, MCQs) 50%
• Presentation 20%
• Assignments 20%
• Report Writing 10%

Final Term (60%)
• Written (Long Questions, Short Questions, MCQs) 50%
• Presentation 20%
• Assignments 20%
• Report Writing 10%

Recommended Books
1. P. Williamson, Abbas Rajabifard, Developing Spatial Data Infrastructures: From Concept to Reality, Taylor & Francis, 2003

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1. Physical Geography

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

Learning Objectives:

To create an understanding about the characteristics of four spheres of the earth, and the processes which are bringing changes in these spheres.

Learning Outcomes
After studying this course, the students will be able to: -
1. Define and describe the four spheres of the earth
2. Understand and apprehend the physical processes occurring on the earth.
3. Evaluate the importance of physical Geography in natural resource management

Credit Hours: 2+1 (3)

Learning objectives:
Course outline:
- Introduction: Definition, scope, and major branches
- Lithosphere
  - Plate tectonics, mountain building forces
  - Internal structure of earth
  - Rocks–origin, formation and types: Igneous, Sedimentary and Metamorphic Rocks
  - Geomorphic processes: Terrestrial and extra-terrestrial processes
  - An overview of the Geomorphic agents and there Landforms

- Atmosphere
  - Composition and structure of Atmosphere
  - Atmospheric temperature and pressure,
  - Global circulation and wind systems
  - Cyclones and other Atmospheric disturbances
  - Atmospheric moisture and precipitation
  - Air masses and fronts

- Hydrosphere
  - Hydrological cycle
  - Ocean composition, morphology
  - Temperature, salinity and other characteristics of ocean water
  - Movements of the ocean water; waves, currents and tides

- Biosphere
  - Eco-systems
  - Formation and types of soils

Lab. Work:
- Study and identification of landforms using Satellite imageries and Topographic Sheets.
- Observation and recording of weather data from a weather station.
- Isotherms, isobars, climographs, meteorological instruments, study of weather maps.
- Construction of maps and diagrams, identification of rocks and minerals, methods of showing relief: contours (pattern, cross section).

Field visits:
- Visit to national park/biosphere reserves, Soil Survey of Pakistan, Geological Survey of Pakistan, (any one of them)

Teaching Methodology
- Lecturing
- Written Assignments
- Field Visits
Assessment

Mid Term (40%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Report Writing 10%

Final Term (60%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Report Writing 10%

Books Recommended:
2. **Human Geography**

Credit hours: 3 (3-0) 2+1 (3)

Prerequisites: Nil

**Course Objectives:**
1. To introduce the basic concepts in Human Geography
2. To familiarize with the recent trends in the field of Human Geography

**Learning Outcomes:**
After studying this course, the students will be able to:-
1. Define human geography concepts of realms and regions, culture integration, population distribution etc.
2. Recognize and interpret the relationships among patterns and processes at different scales of analysis.
3. Interpret man-environmental relationship and its consequences.
4. Characterize and analyze changing interconnections among places.
5. Evaluate the working of themes of human geography to understand the real world phenomenon.

This course covers the following topics:

**Course Details**

**Introduction:**
Definition, Domains, Scope and Applications of Human Geography

**Man Environment Relationship:**
Determinism, Possibilism and Perception, Environmental Problems

**Population Growth/Change:**

**Population Distribution:**
Types, Measurements, Factors and World Pattern of Population Distribution
Urbanization:
Causes, Overview of urbanization along with future prospects, Mobility determinants, Push and Pull factors, Types of Migration, Push and Pull Factor, Consequence

Language and religion:
Classification of languages, world pattern of languages, classification of principle religion, race: major racial groups and their distribution,

Settlements:
Classification of settlements (central place theory), urban and rural settlements (forms, functions and classification),

Political systems: national political systems (nations, states and nation-states), geographic characterization of states (size, shape, location, cores and capitals), classification of boundaries, international political system: the United Nations and its agencies, regional alliances, laws of the sea and maritime boundaries.

Economic Activities:
Primary economic activities, Secondary economic activities Tertiary economic activities Quaternary & Quinary economic activities

International trade,
Major trade partners and organization, world trade pattern,

Energy resources:
Renewable and non-renewable resources (thermal power, hide power, solar power, wind power, nuclear power),

Economic development: world pattern of economic development, measures of economic development, poverty problem.

Lab.
Construction of maps and diagrams to show world distribution of population, religions, languages and races, age sex pyramids of different countries, calculation of rates and ratios related to population.

Construction of maps and diagrams to show economic activities, world distribution of major crops, fishing grounds, major minerals, major industrial goods, trade pattern.

Teaching Methodology
• Lecturing
• Written Assignments
• Field Visits

Assessment

Mid Term (40%)
• Written (Long Questions, Short Questions, MCQs) 50%
• Presentation 20%
• Assignments 20%
• Report Writing 10%

Final Term (60%)
• Written (Long Questions, Short Questions, MCQs) 50%
• Presentation 20%
• Assignments 20%
• Report Writing 10%

Recommended Books:
3. **Introduction to Earth Sciences**

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

**Objectives:**  
To introduce the concepts of Geosciences, the earth’s properties and its dynamic processes.

**Learning Outcomes:**  
After studying this course, the students will be able to:-  
1. Apprehend with the physical properties and the origin of the landforms of the Earth’s surface.  
2. Familiarize with earth resources, managing the environment and natural hazards.  
3. Understand the economic potential of different metallogenic zones of Pakistan.

**Course Outline:**  
- Formation of the Earth and Solar System  
- Structure and Composition of Earth;  
- Geomorphology and Mountain Building Processes,  
- Geological Hazards, Volcanoes, Earthquakes, Tsunamis, Floods, Landslides, Mass-movements,  
- Geological Time Scale;  
- Sequence stratigraphy  
- Evolution of Life and the Atmosphere,  
- Glaciation and glacial landforms  
- Global Change in the Earth System,  
- Clastic sedimentology,  
- Mineralogy and geochemistry,  
- Geological and geophysical surveys  
- Exploration and Exploitation of Natural Resources,  
- Aquifer types and groundwater systems  
- Petroleum Basins of Pakistan.

**Lab/Field Outline:**  
Identification of rocks and minerals in hand specimens, Identification of different rock units and geological structures in field, preparation of geological maps, and field visit to different geological sections and land for and hazard prone areas
Teaching Methodology

- Lectures
- Filed Survey
- Labs/Field
- Field Report

Assessment

Mid Term (40%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Field Report 20%
- Presentation 20%
- Labwork 10%

Final Term (60%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Field Report 20%
- Presentation 20%
- Labwork 10%

Reference Material:

4. **SURVEYING**

Credit hours: 3 (1+2)

Prerequisites: **NIL**

**Course Objectives:**
- To introduce the basic concepts of surveying
- To implement different field techniques of surveying

**Learning Outcomes:**
After studying this course, the students will be able to:-
1. Define surveying, its components, types and classification
2. Understand the procedure of surveying and functioning of different instruments used in surveying
3. Solve technical problems through practical applications
4. Contribute to the analysis, planning, and provision of site planning documents

**Course Contents**

**Introduction to Basic Concepts:** Definition, Scope, future prospects, surveying classification, Operations in Surveying: Triangulation, Trilateration, Traverse, establishment of ground control, mosaic, diagonal scale, surveying safety, units of measurement in surveying, zero-dimension in relation to different map scales, Theory of errors in observations, precision & accuracy, least square adjustments

**Functions of Surveying Instruments:** Tripod, Level vial, Circular level, Leveling heads, Plumb bob, Optical plumbing assembly, Telescopes, Total station, GPS, Distance measurement: Horizontal and vertical, Chain, Taping and its errors: Horizontal taping, Slope taping, Taping corrections, Taping procedure

**Practical:**
1. **Plane Table(PT) Surveying**
   General description, instruments, procedure, methods of plane tabling, advantages and disadvantages of Plane-Table (PT) surveying, errors in plane table surveying two point & three point problems. PT traversing, point location, plotting detail using PT, contouring & compilation
2. **Compass Survey**
   General description, bearing, compass traverses (open and close). Calculation of angles, bearing from the true north, adjustment of errors, compass sketch surveys, finding the direction of Qibla using compass, problems on whole circle bearing and quadrantal bearing.

3. **Leveling**
   General description, kinds of levels and adjustments in levels. Contours by Clinometers-Tangent scale clinometers used with plane table laying out of contours-leveling, procedure of leveling, methods of calculating reduced levels, profiles, longitudinal leveling, cross sectional leveling-accuracy required in leveling operation. High Precise (HP) Leveling.

4. **Application of Theodolite /Total Station**
   Transit theodolite, Vernier theodolites, modern theodolites, micrometer theodolites, direct measurement of horizontal angles, measurement of vertical angles, deflection angle measurement, measuring horizontal distance by Stadia Method. Topographic data capturing through Total Station and its processing for mapping in Micro-Survey-Cad, AutoCad & ArcGIS.

**Teaching Methodology**
- Lecturing
- Written Assignments
- Field Survey
- Survey sheets making

**Assessment**

**Mid Term (40%)**
- Written (Long Questions, Short Questions, MCQs) 40%
- Presentation 15%
- Assignments 20%
- Field work 25%

**Final Term (60%)**
- Written (Long Questions, Short Questions, MCQs) 40%
- Presentation 15%
- Assignments 20%
- Field work 25%

**Suggested Books**

5. **GEODESY**

Credit hours: 3 (2+1)
Prerequisites: Surveying & Physical Geography

**Course Objectives:**
- To provide basic understanding of geodetic science as it pertains to the practice of Geomatics.
- To develop skills and concepts related to the geodetic parameters behind any GIS project.
- To understand the shape of earth.

**Learning Outcomes**
After studying this course, the students will be able to:-
1. Explain theoretical concepts of GPS survey methods and data processing
2. Convert point coordinates between different geodetic reference systems
3. Evaluate the discrepancies between different horizontal and vertical datums as it pertains to the practice of land surveying.
4. Apply trigonometric computations on spherical and spheroidal earth models
5. Apply best practices for GPS surveys.

**Content List**
- Introduction: Definitions, scope, evolution, current trends and future prospects of geodesy
- Earth’s shape & size, ellipsoid, its gravitational field and geoid
- Units of measurement
- Elementary geometry of the ellipsoid and spheroid
- Types of geodesy, geometric, gravimetric, satellite and space geodesy
- Traditional survey positional techniques
- Triangulation, traverse and trilateration
- Various types of heights, ellipsoidal heights, orthometric heights, geoidal separation
- Types of latitude, horizontal and vertical datum, datum and map projection, transformation parameters, WGS 84 and Everest ellipsoids
- Deflection of the vertical, radius of curvature, radius of curvature along prime vertical and meridional plane
- Geodetic to Geocentric Coordinate Conversions and vice versa
• Planning a GPS survey, data collection and data formats

**Practical:**
Exercise related to:
• Datum and coordinate systems
• Use of GPS in the field
• Manipulating GPS data
• Change of projections and datums

**Teaching Methodology**
• Lecturing
• Written assignments
• Lab based assignments
• Final project

**Assessment**

**Mid Term (40%)**
• Written (Long Questions, Short Questions, MCQs) 50%
• Written assignment 25%
• Lab based assignments 25%
• Term project 10%

**Final Term (60%)**
• Written (Long Questions, Short Questions, MCQs) 50%
• Written assignment 20%
• Lab based assignments 20%
• Final project 10%

**Recommended Books**
6. **Cartography**

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

**Objectives:**
- Providing basic knowledge of portraying spatial features from reality by using cartographic techniques.
- Providing training in coordinates and projection systems and map classification techniques.

**Course Outline:**
Introduction to Cartography and its history, Nature of Cartography, Map Types (Choropleth, Proportional Symbol, Dot, Isarithmic, Cartograms Flow, and Graduate Color Maps), Symbols, Lettering, Scale and direction, Map Projections, Datum and Coordinate Systems, Generalization, Land Use/Land Cover Schemas: standards for land cover/land use classification schemes Survey of Pakistan, Food and Agriculture Organization (FAO), United States Geological Survey (USGS), Coordination of Information on the Environment (CORINE). Thematic Maps, Descriptive Statistics, Class Intervals, Map Compilation, Map Design, Cartography and Ethics, Map Production, Project.

**Lab Outline:**
Map reading, Assignment on Types of Maps, Understanding of Survey of Pakistan (SOP) symbology and Development of Symbol Charts, Development of Graphical Map Projections, Development of at least two map projections each from conical, cylindrical, and plane projection, Large to small scale map conversion, Data classification and Thematic Mapping, Map composite development, Assignment on misleading cartography, Visit to SOP, seminar

**Reference Material:**
7. Advanced Cartography

**Course Structure:** Lectures: 1 / Labs: 2

**Prerequisites:** Cartography

**Credit Hours:** 3(1+2)

**Objectives:**

- Provides digital training in coordinates and projection systems and map classification techniques.
- Provides advance knowledge of portraying spatial features from reality by using cartographic techniques.

**Learning Outcomes**

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

1. Define and describe the terms digital Cartography and its concepts
2. Understand the basic principles of digital Cartography
3. Apply the Knowledge to create digital maps in formats reflecting the purpose, content and function of input data
4. Evaluate the digital cartographic methods for exploring, critiquing, confirming and presenting geographical relationships

**Course Outline:**

- Introduction to digital cartography,
- Overview of Elements of cartographic design
- Typography and Lettering the Map
  - Maplex Label Engine
- Symbolization and visualization (Color use guidelines)
- Arcscan and 3D Analyst:
  - Viewing DEM (SRTM) Data in 3D
- Classic Cartography Techniques
- Data for Digital Cartography
- Georeferencing, digitization and data base
- Advance of Thematic Mapping
  1. Choropleth Mapping
  2. Proportional Symbol Mapping
  3. Dot Density Map
  4. sarithmetic Maps (Spatial Analyst)
  5. Pie Diagram
  6. Raster Data and Supervised Classification
• Proximity Analysis: Buffering
• Mapping Flow Data: Airline Traffic
• Digital Cartography and Satellite Data
• Satellite Data Downloading
• Tracking Analyst
• Analyzing hurricanes using Tracking Analyst
• Cartographic Design: Special Topics
• Distributed GIS, internet mapping for education,
• Commercial web mapping programs
• Internet mapping,

**Lab.**
Exercise related to:
1. Maplex Label Engine
2. Arcscan and 3D Analyst:
3. Viewing DEM (SRTM) Data in 3D
4. Data for Digital Cartography
5. Georeferencing, Digitization and Database Development
6. Advances in Thematic Mapping
   • 1. Choropleth Mapping
   • 2. Proportional Symbol Mapping
   • 3. Dot Density Map
   • 4. Isarithmic Maps (Spatial Analyst)
   • 5. Pie Diagram
   • 6. Graduated Symbols
   • 7. Raster Data and Supervised Classification
7. Proximity Analysis: Buffering
9. Digital Cartography and Satellite Data
10. Tracking Analyst
11. Web mapping

**Teaching Methodology**
• Lecturing
• Labs
• Assignments
• Quiz
Assessment

Mid Term (40%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Quiz 10%

Final Term (60%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Research Project 20%
- Quiz 10%

Suggested Readings:
8. Natural Resources

Credit hours: 3(2+1)

Prerequisites:
- Introduction to Remote Sensing
- Introduction to Geographic Information Science

Objectives:
1. Provide concepts of different types of natural resources,
2. Introduce different analytical and modeling techniques for natural resource assessment
3. Apply remote sensing and GIS techniques for natural resource management
Learning Outcomes:
After completion of this course, the students will be able to:
- Understand the basics of natural resources, their importance with management perspective.
- Comprehend different techniques of remote sensing and GIS for management of natural resources.

Course Outline:
- Introduction to natural resources (Land, water and biodiversity)
- Historical/current issues, practices, natural resource inventory, monitoring and analysis,
- Basic ecological principles,
- Watershed Hydrology, hydrological cycle and processes
- Different types of soils and properties (soil-water movement and Infiltration)
- Surface and groundwater characteristics and interaction
- Forest Inventorying and Carbon Budget,
- Energy Resources,
- Spatial analysis tools for natural resources management,
- Soil and water erosion (processes and assessment),
- Land and water resource management (Surface and Ground Water)
- Surface and groundwater quality assessment,
- Mountain, coastal ecology,
- Energy resources management using geo-spatial techniques,
- Wildlife ecology and Habitat Assessment,
- Remote Sensing for mineral exploration, land cover monitoring (snow and glacier, natural vegetation, rangeland, etc)
- Geo-spatial modeling techniques in natural resource management (watershed, land, surface and groundwater)

Lab/Field:
Exercise related to:
- Prepare inventory of natural resources (Forestry, rangeland, wetlands, and water resources),
- Image classification techniques,
- Features extraction using different indices,
- Watershed delineation and modeling,
- Statistical data analysis

Teaching Methodology
- Lecturing
- Written assignments
- Lab based assignments
- Final project
Assessment

Mid Term (40%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Written assignment 20%
- Assignments 20%
- Final project 10%

Final Term (60%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Written assignment 20%
- Assignments 20%
- Final project 10%

Reference Material:
9. Climate Change

Credit hours: 3 (2+1)
Prerequisites: Basic programming skill, Gridded data analysis and display skills

Course Objectives:
After studying this course, the student will be able to:
1. Understand the basic concepts related to Climate system
2. Explain the various factors that shape climate
3. Describe the risks and uncertainties in Climate Change
4. Use of Remote Sensing/GIS techniques in Climate Change assessment

Learning Outcomes
After studying this course, the student will learn:
1. How climate system works
2. What factors cause climate to change at different time-scales
3. How much climate has changed in past
4. How scientists use models, observations and theory to generate future climate scenarios
5. How satellite and RS/GIS technologies are revealing the global signals of climate change
6. What are the possible impacts of climate change on water and agriculture on national and regional level?

Content List
- Review of general climatology
- Climatic elements
- World climate classification, Climate of Asia, Climate of the sub-continent
- The Earth's atmosphere and surface radioactive transfers (energy balance) and Green House Effect
- Ocean Circulations (Energy transport from equator to poles)
- Hydrological Cycle
- Global Warming
- Climate Change and climate variability
- Natural & Anthropogenic causes of Climate Change
- Climatological statistics Mean, mode, median, anomalies and trends
- Introduction to time series analysis
- Climate change assessment
- Basic concepts of climate modeling
- Impact of climate change on water, agriculture & weather pattern

Practical:
To be decided by the instructor/Institute
Teaching Methodology

- Lecturing – Basic Concepts
- Field Survey – Data Collections
- Computer lab sessions – Demonstration for use of RS/GIS
- Term Projects – Application

Assessment

Mid Term (40%)
- Written (Long Questions, Short Questions, MCQs) 60%
- Term Project Completion 20%
- Term Project Presentation 20%

Final Term (60%)
- Written (Long Questions, Short Questions, MCQs) 100%

Recommended Books

Stream 4: Core Information Technology Courses

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<td></td>
<td>Web GIS</td>
<td>3</td>
</tr>
</tbody>
</table>

1. **Object Oriented Programming**

Credit hours: 3 (2 + 1)
Prerequisites: Introduction to Computer Programming

**Course Objectives:**
The course will develop the understanding of object-based programming, object oriented design and problem solving skills using object oriented techniques.

**Learning Outcomes**
After studying this course, the students will be able to:-
- Comprehend the application of advanced computer programming
- Compose object-orientated solutions for problem solving
- Evaluate and apply the concepts of inheritance and polymorphism among classes
- Develop the advanced concepts of multithreading and exception handling
- Manipulate classes provided in the programming API and incorporate them into computing solutions

**Content List**
- Understanding of Object-oriented programming
- Features of Object-oriented programming languages
- Classes and Inheritance, Abstract classes, Interfaces and Inner classes
- Objects as wrappers, Containers and collections
- Dynamic versus Static typing
- Event handling, Exception handling, Recursion, Stream-based file I/O, Packages
- Testing of Object-oriented programs
Packaging & Deployment
Case studies (ranging from simple to real-world complexity)

Practical:
- Define Classes, and Inheritance using C++
- Develop module based programs like calculator and games etc.

Teaching Methodology
- Lecturing
- Labs
- Assignments
- Quizzes

Assessment

Mid Term (40%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Quiz 10%

Final Term (60%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Quiz 10%

Recommended Books
3. C++ How to Program by Deitel & Deitel, Latest Edition
4. Let us C++ by Yashavant Kanetkar, 8th Edition

Data Structures & Algorithms

Credit Hours: 3 (2 + 1)
Prerequisites: Introduction to Programming, Object Oriented Programming

Course Objectives:
To teach the students how to select and design data structures and algorithms that are appropriate for problems that they might encounter. This course is also about showing the correctness of algorithms and
studying their computational complexities. This course offers the students a mixture of theoretical knowledge and practical experience.

Course Outcomes:
The students should be able to:
- Analyze the asymptotic performance of algorithms.
- Write rigorous correctness proofs for algorithms.
- Demonstrate a familiarity with major algorithms and data structures.
- Apply important algorithmic design paradigms and methods of analysis.
- Synthesize efficient algorithms in common engineering design situations

Contents List
- Properties of Data
- Asymptotic Analysis
- Algorithm Analysis
- Arrays.
- Dynamic memory allocation.
- Implementation of stacks.
- Implementation of Queues & priority Queues.
- Linked lists (single, double, circular) and Arrays.
- Binary Trees.
- N-Trees.
- Implementation of Searching Algorithms.
- Calculating the complexity of algorithms.
- Improving the efficiency of algorithms.
- Sorting Algorithms.
- Searching Algorithms.
- Vectors.
- Roles and Implementation of trees in databases.
- Indexing.
- Algorithm Design

Practical
- Introduce Dev-C++ IDE
- Concepts of stacks and queues
- Understanding to Recursion
- Data Structure
- To study and implement a singly linked list
- C++ Program Basic Structure
- A Circular Doubly Linked List (with a dummy header node)
- An Application of Singly and Doubly Linked Lists
- Read and Write Records To and From File
Teaching Methodology:

Lectures
Lab work
Assignments

Assessment

Mid Term (40%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Lab exam 50%

Final Term (60%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Lab Exam 50%

Text Book


Recommended Books


3. Database Management Systems

Credit hours: 3 (2+1)
Prerequisites: (Intro to Computers and Programming)

Course Objectives:
The course aims to introduce basic database concepts, different data models, data storage and retrieval and design techniques. The course primarily focuses on relational data model and DBMS concepts.
Learning Outcomes
After studying this course, the students will be able to:-
1. Define the modern database systems and their working
2. Understand the relational databases and its advantages over traditional systems
3. Apply the data storage and retrieval techniques
4. Demonstrate the knowledge of database administration

Content List
• Basic Database Concepts
• Data Model and Relational Algebra
• Entity Relationship Modeling
• Structured Query Language
• Rational Database Management Systems
• Database Design
• Functional Dependencies
• Normal Forms
• Transaction Processing and Optimization
• Concurrency Control and Recovery Techniques
• Database Recovery Techniques
• Database Security and Authorization

Practical:
• Exploring DBMS Environment
• Creating Databases and Tables
• Executing Selection Queries
• Executing Updation Queries
• Table Joins
• Views and Populating Data using Views
• Creating and Executing Stored Procedures
• Roles and Permissions
• User Defined Functions
• Importing and Exporting Data
• Creating and Restoring Backup

Teaching Methodology
• Lecturing
• Written Assignments
• Guest Speaker
• Report Writing

Assessment
Mid Term (40%)
• Written (Long Questions, Short Questions, MCQs) 50%
• Presentation 20%
Assignments 20%
Lab Tests 10%

Final Term (60%)
• Written (Long Questions, Short Questions, MCQs) 50%
• Presentation 20%
• Assignments 20%
• Term Project 10%

Recommended Books

4. Web GIS
Credit hours: 3 (2+1)
Prerequisites: Introduction to Computer Programming, Introduction to GIS, Spatial Database Systems

Course Objectives:
The course introduces students to Web GIS technologies. Students will acquire skills in Web architecture and Web application structure required for the delivery of online GIS mapping solutions. They will develop hands-on web pages/websites in conjunction with standard website creation languages.

Learning Outcomes
After studying this course, the students will be able to:-
1. Acquire skills how to make different types of Web Maps.
2. Integrate Spatial Databases with Web Applications
3. Publish maps online using Open Source Software (Carto DB, fusion Tables, Geoserver, etc).
4. Read data from various data sources
5. Process Spatial data with FOSS (Free and Open Source Software)
6. Draw and query maps on the server using Web Map Service
7. Put layers together with a web mapping API
8. Learn how to Explore open data, VGI, and crowd sourcing
Content List
• Components of Web GIS
• GIS Server, Web Server and Database Server
• GIS / Web Server Architecture
• Cloud Computing process in relation to Web GIS
• Databases and SQL
• Web GIS Servers
• Web Editors used by Industry professionals for Webpage design
• HTML, PHP, CSS and JavaScript code
• HTML with GUI
• CSS and JavaScript into web pages for GIS
• Templates as an alternative solution to creating a foundation for web-based GIS maps
• APIs for web mapping
• Map servers and their applications
• Analytics on web maps

Practical:
• Introduction to key concepts in Web mapping
• System architecture for web mapping
• Understanding Free and Open Source Software and its use in web mapping
• WMS Services
• System architecture for web mapping
• Elements of a web map
• Collaborative web maps
• Spatial data processing with FOSS libraries
• Drawing and querying maps on the server using Web Map Service
• Map APIs
• Web based data editing
• Drawing vector layers on the client side
• Working with vector KML
• Working with GeoJSON
• Symbolizing vector layers in OpenLayers
• Adding interactive GeoJSON layers in OpenLayers
• GIS analysis on the web

Teaching Methodology
• Lecturing
• Written Assignments
• Guest Speaker
• Field Visits
• Report Writing
Assessment

Mid Term (40%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Lab Exams 10%

Final Term (60%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Project 10%

Recommended Books

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<tr>
<th>Stream 5: Compulsory Courses</th>
<th>25/136</th>
<th>Semester</th>
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<td>Calculus and Analytical Geometry</td>
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<td>Linear Algebra and Applications</td>
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<td>Islamic Studies/Ethics</td>
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<td>Communication Skills</td>
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<td>8.</td>
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<td>Technical Writing and Presentation Skills</td>
</tr>
<tr>
<td>9.</td>
<td>Nil</td>
<td>Professional Ethics* (in lieu of English-IV)</td>
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</table>
1. **Calculus & Analytic Geometry**

**Course Structure:** Lectures: 3 / Labs: 0  
**Credit Hours:** 3  
**Prerequisites:** None

**Course Outline:**
Complex Numbers, DeMoivre’s Theorem and its Applications, Simple Cartesian Curves, Functions and Graphs, Symmetrical Properties, Curve Tracing, Limit and Continuity, Differentiation of Functions. Derivative as Slope of Tangent to a Curve and as Rate of Change, Application to Tangent and Normal, Linearization, Maxima/Minima and Point of Inflexion, Taylor and Maclaurin Expansions and their convergence. Definite Integral as Limit of a Sum, Application to Area, Arc Length, Volume and Surface of Revolution. Reference Frames, Coordinate systems

**Reference Material:**

2. **Pakistan Studies**

**Course Structure:** Lectures: 2 / Labs: 0  
**Credit Hours:** 2  
**Prerequisites:** None

**Objectives:**
To take an analytical view in the history and development of Muslim society and culture in the sub-continent, emergence of Pakistan and its constitutional development. To develop an appreciation of the issues and challenges currently being faced in Pakistan. The strengths of its people and strategies to deal with the impediments to progress. International relations of Pakistan.

**Course Outline:**
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 Ahmad Khan; Muslim League; Nehru; AllamaIqbal: Independence Movement; Lahore Resolution; Creation of Pakistan and transfer of power. Pakistan culture and society, Constitutional and Administrative issues, Pakistan and its geo-political dimension, Pakistan and International Affairs, Pakistan and the challenges ahead.

Reference Material:
The Emergence of Pakistan, by Chaudary M. Ali
The Making of Pakistan, by K.K. Aziz

3. Functional English
Course Structure: Lectures: 3 / Labs: 0 Credit Hours: 3
Objectives:
Basic understanding of language skills including grammar and comprehension

Course Outline:

Reference Material:
English for Modern Business By Ketteley and Thompson
Write Better,Speak Better, By Readers Digest

4. Introduction to Computer:
Introduction to Computer hardware and Software organization, Operating System concepts, DOS, LINUX/UNIX Operating Systems, Introduction to Windows, Environment, Local Area Networks and Internet, Computer Security.


RECOMMENDED BOOKS:

5. Linear Algebra and Applications

Course Structure: Lectures: 3 / Labs: 0
Credit Hours: 3
Prerequisites: None

Course Outline:

Reference Material:
1. Linear Algebra by David C Lay, 3rd Ed., Amazon, 2002
2. Linear Algebra: A Modern Introduction -- by David Poole, Amazon, 2003
4. Schaum's Easy Outline of Linear Algebra by Seymour Lipschutz, Marc Lipson, 2002
6. Islamic Studies/Ethics

Course Structure: Lectures: 2 / Labs: 0

Credit Hours: 2

Objectives:
To impart an understanding of the fundamental principles and teachings of Islam through study of selected verses of the Quran and Prophetic Sayings. Important facets of the Prophet’s life and salient, features of Islamic Civilization. To provide appreciation of other prominent religions, systems of ethics and cultures to prepare students to survive in international and multicultural work place.

Course Outline:
Fundamentals of Islam. (Aqaid, Ibadat, Islamic Dawah etc.); Ethical values of Islam; Seerah of the Holy Prophet (PBUH); Islamic Civilization and its effects on humanity. Study of other prominent world religions and ethical systems in comparison with Islamic viewpoint. Multicultural societies.

Reference Material:
1. Islam in the Light of a First Testament and Traditions by Shaukat Umari
2. What Everyone Knows About Islam by Zunaire Hanif
3. Introduction to Islam by Hamidullah

7. Communication Skills

Course Structure: Lectures: 3 / Labs: 0

Credit Hours: 3

Prerequisites: Functional English

Objectives:

Course Outline:
Introduction to Oral Communication and its Application: Communicating at Work, Communication in Process, Communication in Organization, Oral Presentation and Oral Reports, Presentation: Face to Face Information Gathering, Communicating non verbally, Types of Non-Verbal Communication, Developing good listening habits, Listening Barriers, Active listening Techniques, Oral Communication/Planning Business Communications, Short Talks and Presentation Types of Short Presentation/Modes of Delivering the Speech, Guidelines for presenting the speech, Oral Communication / Delivering Business Presentations, The Long Presentation & the Purpose of Presentations: Analyzing your audience, Parts of presentations, Verbal Visual supporting Materials, Conducting successful interviews, meetings and conferences, Types of Interviews, Leading Group and holding Successful conferences,
Techniques for participation in a meeting, Small group communication and Decision making, Use and values of small groups in effective organization, Basic problem solving procedure, Employment communication, Responsibilities of the interviewee, Responsibilities of the interviewer, Participation and leadership in small groups, Effective group participation, Effective group leadership, Old communication/methods of dictating techniques, Communication and telephone, Communicating effectively in international business, Non-Verbal communication in international business, Training needs in international business, Criteria for communicating effectively

Reference Material:

Business communication principles and applications by C.Glen Pearce, rossfli Steven P. Golden
Communication for result by Cheryl Hamilton, Cordell Parker, Doyle D. Smith.

8. Technical Writing and Presentation Skills

Course Structure: Lectures: 3 / Labs: 0 Credit Hours: 3

Objectives:
To develop good Technical writing, language usage and reading skills. To appreciate the importance of communication and to develop understanding of communication concepts, principles, theories and problems. To develop good oral communication and presentation skills.

Course Outline:
Principles of writing good English, understanding the composition process: writing clearly; words, sentence and paragraphs. Comprehension and expression. Use of grammar and punctuation. Process of writing, observing, audience analyzing, collecting, composing, drafting and revising, persuasive writing, reading skills, listening skills and comprehension, skills for taking notes in class, skills for exams. Business communications; planning messages, writing concise but with impact. Letter formats, mechanics of business, letter writing, letters, memo and applications, summaries, proposals, writing resumes, styles and formats, oral communications, verbal and non-verbal communication, conducting meetings, small group communication, taking minutes. Presentation skills; presentation strategies, defining the objective, scope and audience of the presentation, material gathering material organization strategies, time management, opening and concluding, use of audio-visual aids, delivery and presentation.
Reference Material:

*Business English* by Vawdrey, Stoddard and Bell

9.  Professional Ethics

Course Structure: Lectures: 3 / Labs: 0  
Credit Hours: 3

Objectives:
This course intends to give insight about data standards used in GIS and RS, common security issues of geographic data, and professional ethics involved in exchange of data and interoperability. The course emphasizes the importance of standardization as a real challenge and comparable to the most important development project in the spatial industry. The course will try to deal with the numerous economic, legal, and regulatory factors of importance to both the public and private sectors.

Course Outline:
Ethical Issues in GIS / RS / Electronic Information, ISO Standards  
Accuracy, Precision, Error and Uncertainty, Managing Spatial Data Errors  
Ethics in GIS Development, Interoperability of GIS Data, Ethics of GIS  
Data Security, National Spatial Data Infrastructure.

Reference Material:

**Journals:**
1. Annals of the Association of American Geographers
2. Cartographica
3. International Journal of Geographic Information Science
4. Cartography and Geographic Information Systems
5. Gender, Place and Culture
6. Transactions in GIS
7. Journal of the American Planning Association
8. Journal of URISA
9. Geographical Review

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<tr>
<td>5.</td>
<td>Nil</td>
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</tbody>
</table>

**5. 1. Introduction to Computer Programming**

**Course Structure:** Lectures: 2 / Labs: 1

**Credit Hours:** 3

**Objectives:**
The course is designed:
1. To familiarize students with the basic programming
2. To develop programming logic and understanding
3. Emphasizes on problem analysis and program development
4. Basic concepts of functions, statement and pointers.

**Course Outline:**
Fundamental programming concepts and constructs, purposes of programming and software development translation of solution (algorithms) to programs, data types, control structures i.e. conditional statements and Iterative/Loops statements , Implementation of procedure/functions, Handling of arrays, Handling of pointers, Objects and Classes, Streams and Files.
Lab Outline:
Coding, executing and debugging of simple programs, Implementation of
Constructs: if, then, switch, etc., Implementation of loops: for, while,
Implementations of simple functions and overloading functions,
Implementations of Arrays (1D, 2D), pointers (dynamic memory
allocation), Implementation of linked list, Implementation of Filing.

Reference Material:
2. Harvey M. Deitel and Paul J. Deitel 2012, Inc ,C++ How to Program
8th Edition
Brooks/Cole Publishing.
4. Lesley Anne Robertson, Simple Program Design: A step-by-step
approach, 4/e, ISBN: 0-619-16046-2 © 2004

2. Applied Physics

Course Structure: Lectures: 3 /
Credit Hours: Labs: 0

Course Outline:
Review of Vector Motion: position, velocity, and acceleration
vectors. Applications of laws of motion: Projectile Motion, motion in
resistive media, rocket motion, motion of charged particles in electrical and
magnetic fields, Rotational motion: constant angular acceleration, uniform
circular motion, torque, linear and angular momentum and their
conservation, System of Particles: center of mass, two-body collisions in
two-dimensions, moment of inertia of objects, Wave Motion: mathematical
concepts of simple and damped harmonic motion, analytical treatments of
superposition of waves, concepts and applications of diffraction and
polarization of light and sound waves.

Reference Material:
1. University Physics by Freedman and Young (10th or higher editions),
2. College Physics by Resnick, Halliday and Krane (6th and higher
edition).

3. Discrete Mathematics

Course Structure: Lectures: 3 / Labs: 0 Credit Hours: 3

Objectives:
This course aims to develop understanding and appreciation of the finite
nature inherent problems and structures through study of combinatorial

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reasoning, abstract algebra, iterative procedures, predicate calculus, tree and graph structures.

**Course Outline:**
Sets, Combinatorics, Sequences, Formal logic, Prepositional and predicate calculus, Methods of Proof, Mathematical Induction and Recursion, loop invariants, Relations and functions, Pigeon whole principle, Trees and Graphs, Optimization and matching.

**Reference Material:**
2. Discrete Mathematical Structures by Rosen, 2004

**4. Applied Statistics**

**Course Structure:** Lectures: 3 / Labs:0 Credit Hours: 3

**Course Outline:**
Introduction to Statistics, Descriptive Statistics, Statistics in decision making, Graphical representation of Data Stem-and Lead plot, Box-Cox plots, Histograms and Ogive, measures of central tendencies, dispersion for grouped and ungrouped Data, Moments of frequency distribution; examples with real life, use of Elementary statistical packages for explanatory Data analysis. Counting techniques, definition of probability with classical and relative frequency and subjective approaches, sample space, events, laws of probability. Conditional probability and Bayesian theorem with application to Random variable (Discrete and continuous) Binomial, Poisson, Geometric, Negative Binomial Distributions; Exponential Gamma and Normal distributions.

**Reference Material:**
5. *Introduction to Statistics* by Walpole, 2000

5. **Research Methods**

**Course Structure:** Lectures: 3 / Labs: 0

**Credit Hours:** 3

**Prerequisites:** None

**Course Contents:**
Research Design and Data Sources: Types of research and research designs, Primary data and its sources, Secondary data and its sources.
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 Material:**
1. Ranjit Kumar, Research Methodology, Sage Publications.
5. C. William Emory, Business Research Methods, IRWIN.
Elective Courses
On the recommendation of the BS (RS &GIS) program coordinator, students can choose electives either from the following list or any other undergraduate courses offerings of their respective institution. The following section provides brief details of some of the key elective of the 4 years BS (RS &GIS) program that may be chosen by the undergraduate students.

1: Spatial Data Modeling
Course Structure: Lectures: 2 / Labs: 1 Credit Hours: 3
Prerequisites: Spatial data visualization

Objectives:
This course attempts to provide an introduction to GIS data models and data structures. The subject continues with a systematic overview of spatial data models (e.g. raster and vector) and the structures used to implement these, together with methods of spatial feature addressing, geometry of objects, topology, object hierarchies and aggregations, the modeling of fuzzy objects and the uncertainty aspects of spatial data.

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 Material:
2: Spatial Data Infrastructure

**Course Structure:** Lectures: 2 / Labs: 1

**Credit Hours:** 3

**Objectives:**
This course attempts to provide an understanding to the data structures, processes and its standards which are involved in data sharing. Subject includes the applications and architecture of Spatial Data Infrastructure.

**Course Outline:**
Need and main components of SDI, Clearing house architecture
National Geospatial Clearinghouse, Metadata concepts, its structures and functionality, System Architecture for SDI Interoperability, Client Server Architecture, Data Quality Information (DQI) Accuracy, Precision, Bias Error Modelling, Data Modelling.
Abstraction of real world, Types of abstraction, Problems of information sharing (Heterogeneities), Distributed database concept, GIS Internet Services and SDI Technologies, Available Services, Technologies that support internet GIS services. Commercial tools for Internet GIS, legal aspects of SDI.

**Lab Outline:**
Comparison of working SDI’s, Development of Metadata according to Standards, Development of Architecture of SDI, Data Standardization, Data transformations and translations, Web Publishing & development.

**Reference Material:**

3: Land Information System

**Course Structure:** Lectures: 2 / Labs: 1

**Credit Hours:** 3

**Objectives:**
This course attempts to give students a broad understanding of land tenure and the cadastre concept, how it has evolved historically and its role in documenting land rights. The course covers cadastral systems in
the world as a means of understanding fundamental principles and design criteria underlying these systems. The final part of the course deals with the design of cadastre-based LIS.

Course Outline:
Introduction to Land characteristics, Land information system, Cadastre, Land information management, LIS Taxonomy, classification of land information, Land Registration, Comparison of land registration and cadastre, Benefits of land registration for individuals and role of land registration for Government, Land Tenure Systems, Concept and definition, Forms of land tenure operational forms of land tenure, English, Anglo-American, Continental, Western European Concept and rights, Customary land tenure Islamic land tenure, Land Registration concept, process, Public registration, Principles of registration, Deeds Registration, Title Registration, Features of Land Registration system, Private conveyancing, Positive and Negative Systems, Boundaries, Fiscal cadastre Multipurpose Cadastre, Institutional arrangement and technical matters, Procedures for introducing a land administration system.

Lab Outline: Studying and understanding the existing LIS examples, Development of work flow diagrams for the procedures, Comparison of existing land information systems, Cadastral mapping through existing analogue maps/satellite imageries, Cadastral map editing, and updating, Development of database for land registration, Process verification and development of Registries, Titles, Integration of Revenue mapping and statistical analysis, Integration of cadastral system with other utility information system, LIS Project Development.

Reference Material:

4: Introduction to Computer Systems (ICS)

Course Structure: Lectures: 2 / Labs: 1

Credit Hours: 3

Objectives:
This course focuses on a breadth-first coverage of Information Technology discipline, introducing computing environments, general application software, basic computing hardware, operating systems, office working
tools, Internet and computer usage concepts; Software engineering process, Social and ethical issues of computing.

**Course Outline:**
Number Systems, Binary numbers, Boolean logic, History computer system, basic machine organization, Von Neumann Architecture, Algorithm definition and data structure design, and implementation, Programming paradigms and languages, Graphical programming, Overview of Software Engineering, Operating system, Compiler, Computer networks and Internet, Computer graphics, AI, Social and legal issues.

**Lab Outline:**
Computation of Number Systems: Binary, Octal, Hexa, Decimal number Systems, Implementation of Boolean functions, and basic machine organization e.g. motherboard, memory, I/O Cards, Input/Output Devices, Networking Devices, Concepts of Flow Charts, Environment of different Operating Systems; Linux, Unix, DOS, MS Windows, Introduction to Office Tools (MS Word, MS Excel, MS Access etc), Internet browsers and exposure to web based programming.

**Reference Material:**
5. Sherer, *Computer Science: An overview of Computer Science*,

5: Technical and Business Writing (Elective)

**Course Structure:** Lectures: 3 / Labs: 0

**Credit Hours:** 3

**Objectives:**
To develop efficient literature survey, analysis, report writing and document designing skills.

**Course Outline:**
Overview of technical reporting, use of library and information gathering, administering questionnaires, reviewing the gathered information.
Technical exposition; topical arrangement, exemplification, definition, classification and division, casual analysis, effective exposition, technical narration, description and argumentation, persuasive strategy. Organizing information and generation solution: brainstorming, organizing material, construction of the formal outline, outlining conventions, electronic communication, generation solutions. Polishing style: paragraphs, listening sentence structure, clarity, length and order, pomposity, empty words, pompous vocabulary, document design: document structure, preamble, summaries, abstracts, table of contents, footnotes, glossaries, cross-referencing, plagiarism, citation and bibliography, glossaries, index, appendices, typesetting systems, creating the professional report; elements, mechanical elements and graphical elements. Reports: Proposals, progress reports, Leaflets, brochures, handbooks, magazines articles, research papers, feasibility reports, project reports, technical research reports, manuals and documentation, thesis. Electronic documents, Linear verses hierarchical structure documents.

Reference Material:
Research Method: Guidance for Postgraduates, Greenfield, T. Arnold

6: Multivariable Calculus

Course Structure: Lectures: 3 / Labs: 0
Credit Hours: 3
Prerequisites: Calculus

Course Outline:

Reference Material:
Calculus and Analytical Geometry by Swokowski, Olinick and Pence.

7: Introduction to Economics

Course Structure: Lectures: 3 / Labs:0
Credit Hours: 3

Course Outline:
- Supply, demand and product markets: demand, utility and consumer behavior and business organizations. Theory of production and
marginal products, analysis of costs, competitive markets, monopoly and imperfect competition

- Production Function and Distribution: Factors of Production, Pricing of factors of production.
- National Economy facts: National income Accounting, Measurement, Income and Spending, Money, Monetary and Fiscal Policy, International Linkages
- Aggregate Demand, Supply and Growth, Consumption and Saving, Inflation, Unemployment, Budget Deficit and International Adjustment.
- Economics Applications in Agriculture, Industry, Demography, Business and Trade.

Reference Material:

- Saeed, AmjadKhawaja (latest edition) Economy of Pakistan
- Malik, Sohail (latest edition) Economy of Pakistan
- Waseer, Habibullah (latest edition)
- Pakistan Economic Survey (various issues)

8. Introduction to Geology

Course Structure: Lectures: 2 / Labs: 1

Credit Hours: 3
Prerequisites: Physical and Human Geography

Objectives:
This course attempts to familiarize students with Science of Geology, to discuss in detail the theory of Plate Tectonics and mountain building. To discuss in brief the economic potential of different rock units with special reference to Geology of Pakistan.

Course Outline:
Overview of Earth, Geological Framework of Earth, Structure and Composition of Earth; Deformation and Mountain Building Processes, Rock Cycle Volcanoes, Geological Hazards; Earthquakes, Tsunamis, Floods,
Landslides, Mass-movements, Geological Time Scale; Cenozoic, Mesozoic, Paleozoic, Fossils and Evolution, Global Change in the Earth System, Economic Geology; Exploration and Exploitation of Natural Resources, Petroleum Basins of Pakistan.

Lab Outline:
Identification of rocks and minerals in hand specimen, Identification of different rock units and geological structures in field, Preparation of Geological maps, Petrographic studies of rocks and minerals and Field visit to different Mining areas

Reference Material:
3. Tom W Argles, David A Rothery, Angela L. Coe (2011) Geological Field Techniques (4th Edition), Hodder and ...

9. Introduction to Ecology

Course Structure: Lectures: 2 / Labs: 1

Credit Hours: 3

Objectives:
An introduction to ecology at the population, community and ecosystems levels. This course is designed to present an introduction to current theories and practices in ecology. It covers fundamental ecological principles with special reference to levels of organization, population and community properties, structural adaptation, functional adjustments, and other factors affecting the distribution of organisms.
Course Outline:
Introduction, Natural history, Temperature relations, Water relations, Energy and nutrient relations; Population genetics and natural selection, Population distribution and abundance, Population dynamics, Population growth, Life histories; factors governing species distribution and interactions, community description and classification; community stability, factors determining community structure and diversity, emergent properties of communities; Competition, Interactions – Exploitation, Mutualism, Species Abundance and Diversity, Food Webs, Biogeography; Community Metrics, Diversity and Stability, Succession and Biogeography, ecosystem energetics; island biogeographic theory; Trophic Structure; Primary Production and Energy Flow, Nutrient Cycling, Succession and Stability, Landscape Ecology, Global Ecology, Global Change

Lab Outline:
Lab Introduction, Spreadsheets, Demography, Population Size Estimation, Forest Ecosystem, Spatial Patterns, Predation and Functional Response

Reference Material:

10. Introduction to Atmospheric Sciences

Course Structure: Lectures: 2 / Lab: 1

Credit Hours: 3

Objectives:
Purpose of the course is to:
Familiarize the students with the basic concepts related to Atmospheric Sciences. Train the students regarding use and understanding of atmospheric sciences in Remote Sensing and GIS.

Course Outline:
Composition and structure of the atmosphere. Evolution and present state of earth's climate. Emphasis on physical processes determining the

**Lab Outline:**
To be decided by the instructor/institute

**Reference Material:**

11. **Environmental Management**

**Course Structure:** Lectures: 2 / Lab: 1

**Credit Hours:** 3

**Prerequisites:** Nil

**Objectives:**
To introduce advanced tools, techniques and applications of GIS for environmental management. Strengthen the capacity of students for decision support for developing environmental information management system (EMIS) and its applications.

**Course Outline:**
GIS and related applications with particular focus on advance spatial analysis and their use in solving environmental problems. Review of existing GIS applications in environmental planning, such as monitoring and implementation of environmental issues, housing and socioeconomic analysis, utilities, facilities and infrastructure planning and transportation management etc. Role of GIS in Environmental Management Information System (EMIS) for efficient urban management; mapping policies, sensitively mapping and its applications. Case studies for environmental management covering different aspects.
Lab Outline:
To be decided by the instructor/institute

Reference Material:
7. Sullivan & Unwin, Geographic Information Analysis. 2003
11. Managing Our Urban Future, A Lecture by Prof. Ian Masser, Division of Urban Planning and Management, ITC, Netherlands, 1999 (Printed booklet)

12. Coastal Zone Management

Course Structure: Lectures: 2 / Lab: 1

Credit Hours: 3

Objectives:
he course is mainly focused on applications of remote sensing for coastal zone management, especially about the importance of coastal resources, conservation principles and management.
Course Outline:
Coastal Processes: Oceanic circulation, upwelling and sinking, Current measurement, Surface waves, Water motion in waves, reflection, diffraction and refraction, wave generated currents: Tides, Tidal forces and sediment drift, Bathymetry, Coastal waters: Estuaries, Wetlands and Lagoons, Living and non-living resources, Coastal aquifers. Brackish water aquaculture. Coastal habitats (coral reefs, mangroves, change detection). Coastal hazards (Cyclones, storm surges, Coastal erosion, Sea level rise and possible effects, Non-point and point pollution, Oil pollution, and Phytoplankton blooms). Morphology of Sea, morphological divisions of Sea and biological environment, biological productivity of ocean environment, food chain of the Sea. Remote Sensing applications for coastal erosion and accretion, salinity intrusion, navigation, estuarine studies and coastal zone management. Use of Optical, Hyperspectral and Microwave satellites [e.g: ERS (European Remote Satellite), MOS (Marine Observation Satellite), OCM (Ocean Colour Monitor), CZCS (Coastal Zone Color Scanner), SeaWiFS (Sea-viewing Wide-Field of View Sensor) etc.) for coastal and ocean resource monitoring and management. Chlorophyll production index: various sensors used for coastal application, physical oceanographic parameter estimation, sea surface temperature significant wave height, wind speed and direction, coastal Bathymetry, sea level rise. Wetland mapping, site location for marine culture, sea surface temperature (SST) studies to forecast fish population, Mangroves, coral reefs and other pollution assessment - case studies.

Lab Outline:
To be decided by the instructor

Reference Material:
2. Parimal Sharma, 2009, Coastal Zone Management, Global India Publications
13. Geospatial System Analysis & Design  Credit Hours: 3

Course Structure: Lectures: 2 / Labs: 1

Objective:
- Understanding of basics concept of Object Oriented Approach
- Modeling System using Object Oriented Approach
- Develop skills to analysis System
- Develop skills to design a System

Course Outline:

Reference Material:

14. Geospatial Applications in Urban Planning

Course Structure: Lectures: 2 / Lab: 1  Credit Hours: 3

Objectives:
Focusing on information requirements across urban sectors, some analytical requirements and explores how GIS and RS tools can be applied in problem solving with deepen understanding of the application of GIS and RS in urban management

Course Outline:
Principles of GIS applied to problems in urban design and planning, landscape architecture, and environmental and resource studies. Practical problem-solving approaches using contemporary desktop mapping packages and vector and raster GIS systems. Siting, environmental evaluation and inventories, and modeling Using aerial photographs and satellite image data in urban planning. Urban change analysis, land-use
and land cover classification, and environmental planning applications. Scale and resolution considerations. Development of proficiency through laboratory exercises and use of image-processing software.

Lab Outline:
To build confidence for independent work in their future research work, real world problem solving assignments / project will be conducted by the students. Excursion to local urban management authorities will be arranged to understand their requirements and expected solutions.

Reference Material:
2. Easa, Said and Chan, Yupo (Eds); Urban Planning and Development Applications of GIS; 2000 / 304 pp.

15. Land Information System

Course Structure: Lectures: 2 / Lab: 1
Credit Hours: 3

Objectives:
This course attempts to give students a broad understanding of land tenure and the Cadastre concept, how it has evolved historically and its role in documenting land rights. The course covers cadastral systems in the world as a means of understanding fundamental principles and design criteria underlying these systems. The final part of the course deals with the design of Cadastre-based LIS.

Course Outline:
Introduction to Land characteristics, LIS, Cadastre, Land information management, LIS Taxonomy, classification of land information, Land
Registration, Comparison of land registration and Cadastre, Benefits of land registration for individuals and role of land registration for Government, Land Tenure Systems, Concept and definition, Forms of land tenure operational forms of land tenure, English, Anglo-American, Continental, Western European Concept and rights, Customary land tenure Islamic land tenure, Land Registration concept, process, Public registration, Principles of registration, Deeds Registration, Title Registration, Features of Land Registration system, Positive and Negative Systems, Boundaries, Fiscal Cadastre Multipurpose Cadastre, Institutional arrangement and technical matters, Procedures for introducing a land administration system.

Lab Outline:
Studying and understanding the existing LIS examples, Development of work flow diagrams for the procedures, Comparison of existing land information systems, Cadastral mapping through existing analogue maps/satellite imageries, Cadastral map editing, and updating, Development of database for land registration, Process verification and development of Registries, Titles, Integration of Revenue mapping and statistical analysis, Integration of cadastral system with other utility information system, LIS Project Development

Reference Material:

16. GIS for Disaster Management

Course Structure: Lectures: 2 / Lab: 1
Credit Hours: 3
Objectives:
Disaster risk information is spatial in nature and Geographic Information Systems (GIS) play an important role in disaster risk assessment and management. For this, there is a significant need to create awareness among the disaster management professionals regarding the importance of GIS usage. The course reveals how spatial data is used during pre- and post-disaster management such as during early warning, hazard, vulnerability and risk assessment, damage assessment, as well as in the design of risk reduction measures.
Course Outline:
Basic concepts and terminologies of disaster management, Handling spatial information Post-Disaster Impact and Damage Analysis, The use of satellite imagery for disaster relief and recovery, Impact analysis and preliminary damage assessment, Building damage assessment, Pre-Disaster Risk Assessment, Hazard Assessment, Elements at risk and vulnerability assessment, Types and methods of risk assessment, risk evaluation, cost-benefit analysis, Risk Information for Risk Reduction Planning, Risk evaluation, Visualization of risk information, Risk information and spatial planning, Disaster risk zoning, Flood Mapping, Disease mapping and prediction, Land degradation and Monitoring, Food security and environmental monitoring, Monitoring urban sprawl, GIS and disaster management cycle, GIS and Emergency Shelters, GIS and distribution of Relief, Challenges of using GIS in disaster management, GPS and its applications in Disaster management, risk assessment maps, GIS models in disaster management; assembling spatial information for disaster management and analysis, GIS and fire monitoring.

Lab Outline:
To be decided by the instructor/Institute.

Reference Material:
3. Hideki Kaji, Yujiro Ogawa, Hitoshi Taniguchi, Yoko Mushiake, (eds), GIS for Disaster Management, Proceedings of the 9th International Research and Training seminar on Regional Development Planning for Disaster Prevention, 12 December 1996
4. Nagoya, Japan, United Nation Centre for Regional Development (UNCRD) Proceeding Series No. 18
17. Land Use Surveying

Course Structure: Lectures: 2 / Lab: 1
Credit Hours: 3

Objectives:
It will focus on the acquisition of theory and practical field skills reinforcement designed by civil engineers as well as those in civil technology.

Course Outline:
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, leveling and its types, bench marks, leveling staff, sources of errors in leveling and accuracies, angular measurements, reading systems of optical theodolites, measuring angles and adjustments, indirect distance measurements, contouring plans by level and staff, section and cross-sections, precise and reciprocal leveling, traverse survey, triangulation and trilateration, GPS survey.

Lab Outline:
Instrumental surveys will be included for measuring the distance, angles and heights. Major emphasis will be towards theodolite and leveling surveys.

Reference Material:
MS in Remote Sensing (RS) & Geo-Information Sciences (GISc) MS (RS & GISc)

Eligibility:

- 4 years BS (Remote Sensing & GIS) degree or Minimum of 16 years of education with Engineering / Science background
- Other disciplines graduates will have to enroll in prerequisite/deficiency courses as proposed by the individual university and as per HEC prescribed guidelines (Table 2)

Duration and Structure:

- 2 years spread over 4 semesters (Two semesters per year)
- 30 credit hours including thesis

Table: 1 Program Structure

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Courses Structure</th>
<th>Credit Hours</th>
<th>Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Core Courses</td>
<td>12</td>
<td>4</td>
</tr>
<tr>
<td>02</td>
<td>Elective/Specialized</td>
<td>12</td>
<td>4</td>
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<td>04</td>
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Table: 02 MS RS & GIS Deficiency Courses

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Introduction to Remote Sensing &amp; Digital Image Processing</td>
</tr>
<tr>
<td>02</td>
<td>Introduction to Geographical Information Science</td>
</tr>
<tr>
<td>03</td>
<td>Introduction to Database and Programming</td>
</tr>
<tr>
<td>04</td>
<td>Introduction to Mathematics / Statistics</td>
</tr>
</tbody>
</table>

Course structure 2-1 credit hour 3

Pre-requisites: None

Course outline:
This course will cover basic principles of satellite remote sensing, EM radiations and their interaction with atmosphere. It will describe various optical and microwave satellite systems and their onboard sensors. The characteristics and behavior of different earth features/objects with respect to different EM radiations will be highlighted and their role in data interpretation would be discussed. Application of different satellite images of varying spatial and spectral resolution would be discussed. The 2nd segment of the course will deal with Image processing. It will cover different image processing functions and tools for extraction of desired information in a usable form. While providing a conceptual understanding of all the image processing functions and tools to transform raw images to value added products, an ample opportunity of hands on sessions on popular off-the-shelf software packages will be provided to perform all these functions.

Objectives:
The objectives of the course are:

1. To provide basic concepts and principles of satellite remote sensing and its applications
2. To give understanding on various on-board sensor data and their applications
3. To give conceptual understanding of different image processing functions and tools and tasks

Learning outcomes:
1. An understanding on remote sensing principles, satellites and their orbits, data acquisition, onboard sensors and their characteristics.
2. Knowledge of various data processing techniques for different applications.
3. An understanding of analysis and interpretation of remote sensing data.

Skills outcomes:
By taking this course the students will be:
1. Able to process satellite data and apply different Digital Image Processing (DIP) algorithms for different tasks using off the shelf software packages.
2. Able to conceive and conduct a remote sensing based study/project.
3. Able to select and use appropriate remote sensing datasets for different applications

**Course Assessment #:**
1. Home Assignments
2. Class Interaction
3. Final Term Exam

# *To be dependent upon the course and instructor’s choice*

**Course Syllabus**

1. **Fundamentals of Remote Sensing**
   a. History of remote sensing
   b. Electromagnetic radiation
   c. Interaction of EM with the atmosphere
   d. Spectral response at various targets
   e. Radiometric and geometric Errors
   f. Basic principles of Photogrammetry
2. **Sensors**
   a. Types of Sensors
   b. Characteristics of optical sensors
   c. Resolution
   a. Earth imaging by satellite
   b. Data parameters
   c. Low Resolution Satellite - NOAA, Aqua, Terra, Meteosat
   d. Medium Resolution satellites - Landsat, SPOT, ASTER
   e. High Resolution Satellites - IKONOS, QuickBird, etc.
4. **Image Rectification and Restoration**
   a. Datum, Projection and Coordinate System
   b. Geometric Correction
   c. Data Mosaicing
5. **Image Interpretation**
   a. Introduction
   b. Interpretation elements
6. **Image Enhancements**
   a. Introduction to digital image processing (DIP)
   b. Perception of colors
   c. Visualization of image data
   d. Colour composites
e. Filter operations (noise removal, edge enhancement)
f. Contrast Manipulation
g. Spatial Feature Manipulation (Spatial filtering, convolution, edge enhancement, Fourier analysis)
h. Multi-Image Manipulation (Spectral ratioing and differencing, Density slicing, NDVI, HSI)
i. Data Merging

7. **Image Classification**
   a. Principles of image classification
   b. Unsupervised Classification
   c. Supervised Classification

8. **The Output Stage**
   a. Maps and their cartographic representation

9. **Remote Sensing data applications**
   a. Landuse/landcover
   b. Urban planning
   c. Geology/geomorphology
   d. Coastal zone
   e. Hydrology/water resources
   f. Thermal infrared data applications

10. **Microwave Remote Sensing**
    a. Principles of microwave remote sensing
    b. Microwave sensors and platforms

**Lab Outline**
1. Introduction to labs and exploring Image processing software
2. Demonstrations on various sensor data products
3. Image Management (Import/Export & Display including Single band image interpretation, False color predictions, False color composite images Interpretation)
4. Rectification, Registration
5. Image Interpretation/analysis
6. Image Enhancement Techniques
   i. Contrast Manipulation (level slicing, contrast stretching)
   ii. Spatial Feature Manipulation (Spatial filtering, edge enhancement)
   iii. Multi-image manipulations (band ratioing and differencing, NDVI, HIS color space transformations)
7. Image Mosaicing, Color balancing, Data merging
8. Signature selection, Supervised, unsupervised and hybrid classification, ISODATA, MDM, MLC
9. Map Composition
10. Thermal Infrared Image interpretation
References


2. ‘Introduction to Geographical Information Science and spatial analysis’

Course structure 2-1 credit hour 3

Pre-requisites: None

Course outline:
Geographic Information Systems or GIS is a collection of computer hardware, software, and geographic data for capturing, managing, analyzing, and displaying all forms of geographically referenced information. Geographic Information Systems (GIS) are becoming important tools in any discipline that deals with spatial information. This course introduces the diverse ways in which the concepts and theories that form the basis of modern GIS are implemented and applied. It explores the origins of GIS, its conceptual and theoretical foundations as well as important issues related to applications of GIS. This Masters level Introduction to GIS course will serve as a basic for those who want
to use GIS to support various applications and intend to concentrate their studies in the GIS specialization. Course objectives are implemented through readings, lectures and laboratory sessions that will give students "hands-on" exposure to different GIS Software packages. It will also give an overview of the history of GIS, cartography, data sources and their management techniques, vector and raster data models, database development and spatial analysis and queries etc.

Objectives:

The objectives of this course will be to:

1. introduce the concepts and theories that form the foundations of modern geographical information systems (GIS)
2. provide the students with a thorough grounding in the generic underpinnings of geographic information system concepts, design, and a working knowledge
3. provide students with a generic process of solving geographic problems using GIS and to develop skills in conceptualizing geographic problems and in developing strategies to solve the problems

Learning outcomes:

1. An understanding of concepts and theories that underpin modern GIS
2. An understanding of the analytical capabilities of GIS
3. An understanding of the issues relating to the real world spatial problems

Skills outcomes:

By taking this course the students will be:

1. Able to demonstrate a detailed knowledge of the concepts and theories of modern GIS and corresponding GIS platforms in terms of feature, functionalities and available tools and will be able to analyze and solve geospatial problems.
2. Familiar with data sources and techniques for applying GIS in different monitoring and management activities.

Course Assessment #:

1. Home Assignments
2. Class Interaction
3. Final Term Exam

# to be dependent upon instructor's choice
Course Syllabus

1. Introduction
   a. GIS - Components and characteristics
   b. Historical Background
      i. Origin
      ii. Evolution
      iii. Stages
   c. GIS Approaches
      i. Earlier Approach
      ii. Current Trends
      iii. Future Innovations and advancements
   d. GIS Operations

2. Coordinate Systems
   a. Shape of the Earth
   b. Geodesy, Datum & Spheroids
   c. Geographic Coordinate System
   d. Projected Coordinate System
      i. Map Projections
      ii. Projection Transformations
      iii. Working with Coordinate Systems in GIS

3. Geometric Transformation
   a. Geometric Transformation
   b. Root Mean Square (RMS) Error
   c. Resampling of Pixel Values

4. Data Acquisition & Capturing Techniques
   a. Data Sources
      i. Primary
      ii. Secondary
   b. Manipulation and customization of existing historical/statistical data
   c. Metadata
   d. Conversion of Existing Data

5. Data Visualization and Cartography
   a. Cartography Concepts
   b. Symbolization
   c. Types of Maps
   d. Map Elements
   e. Map Designing & Compilation
   f. Map Designing Issues

6. GIS Application Platforms
   a. Software Technologies
      i. Characteristics & Applications
      ii. Comparison
   b. Hardware Technologies

7. Spatial Data Development and Manipulation
   a. Techniques
b. Manipulation & Editing

c. Precision

d. Location errors

e. Error Rectification Techniques

f. Spatial data accuracy standards

g. Topological errors

h. Topological editing

i. Non-topological editing

j. Spatial adjustments

k. Other editing operations

8. Attribute Data Input and Management

a. Attribute Data in GIS

b. The Relational Model

c. Attribute Data Entry

d. Manipulation of Fields and Attribute Data

9. Geo-relational Vector Data Model

a. Geo-relational data model

b. Representation of Simple Features

c. Topology

d. Non-topological Vector Data

e. Data Formats

f. Data Models for Composite Features

10. Object–based Vector Data Model

a. Object-based Data Model

b. The Geodatabase Data Model

c. Relationships

d. Interface

e. Topology Rules

f. Advantages of the Geodatabase Data Model

g. Data Formats

11. Raster Data Model

a. Elements of the Raster Data Model

b. Types of Raster Data

c. Raster Data Structure

d. Image Compression

e. Data Conversion

f. Integration of Raster and Vector Data

g. Data Formats

12. Querying Spatial Data

a. Data Exploration

b. Attribute Data Query

c. Spatial Data Query

d. Raster Data Query

e. SQL Queries, Mathematical Expressions & operators

f. Geographic Visualization
13. **Satellite based Navigation**
   a. GPS
   b. GPS Components & Segments
   c. DGPS
   d. Accuracies comparison
   e. Integration with GIS

**Lab Outline**
1. Exploring GIS Softwares
2. Spatial Data Visualization
3. Cartographic Operations
4. Layout Designing
5. Spatial data Management
6. Geodatabase Development
7. Digitization Techniques
8. Editing Techniques
9. Geo-processing Operations
10. Topology Development
11. Topological Editing
12. Data Transformation / Conversion
13. Spatial Data Queries
14. Georeferencing
15. Projection Transformation

**References**


3. ‘Introduction to GIS Database and Programming’

Course structure 2-1  credit hour 03

Pre-requisites: None

Course Outline:
Databases form the most basic and valuable part of today’s Management Information Systems (MIS), Decision Support Systems (DSS) and Transaction Processing Systems (TPS). This course explores the concepts of database systems and their working. Approach of traditional and modern database systems, their pros/cons over each other and the way they interact to the outside world. Concepts of DBMS and RDBMS and requirement of their integration in today’s user friendly as well as real time applications for accurate mapping and reporting are discussed. Conceptual and Practical knowledge concerning present database systems such as data manipulation, data definition, entity relationship, normalization, database management, security enforcement etc. are explored. This course also introduces the basic concepts of computer programming and extracting data from databases through user defined computer programs.

Objectives:
The objectives of this course are
1. To introduce the concepts of modern database systems and their applications in different disciplines and spheres of life
2. To introduce the basic concepts of computer programming

Learning outcomes:
1. An understanding of the modern database systems and their working
2. An understanding of the relational databases and its advantages over traditional systems
3. Knowledge of database administration
4. An understanding of basic concepts of computer programming
5. Knowledge of the database applications and the role of computer programming to develop them.
Skills outcomes:
On successful completion of the course students will be able to
1. Demonstrate practical knowledge of the RDBMS
2. Be able to work on databases and can query and program them.
3. Be able to develop basic computer programs

Course Assessment #:
1. Home Assignments
2. Class Interaction
3. Final Term Exam

# to be dependent upon instructor's choice

Course Syllabus

Part I - Database Systems
1. Introduction to databases
   a. Traditional file based system
      i. File based approach
      ii. Limitations of file based approach
   b. Database approach
      i. The database management system
      ii. Components of the DBMS environment
   c. History of DBMS
   d. Advantages and disadvantages of DBMS
2. Database Environment
   a. The three level architecture
      i. External level
      ii. Conceptual level
      iii. Internal level
   b. Database languages
      i. The data definition language (DDL)
      ii. The data manipulation language (DML)
      iii. Fourth-generation languages (4GL)
   c. Data models and conceptual modeling
      i. Object based data models
      ii. Record based data models
      iii. Physical data models
      iv. Conceptual modeling
3. The Relational Model
   a. Brief history of the relational model
   b. Terminology
      i. Relational data structure
ii. Mathematical relations
iii. Database relations
iv. Properties of relations
v. Relational keys
c. Relational Integrity
   i. Nulls
   ii. Entity integrity
   iii. Referential integrity
d. Views
   i. Terminology
   ii. Purpose of views
   iii. Updating views

4. Data Manipulation
   a. Introduction to SQL
      i. Objectives of SQL
      ii. History of SQL
      iii. Importance of SQL
   b. Writing SQL Commands
      i. Simple queries
      ii. Sorting results
      iii. Using the SQL Aggregate functions
      iv. Grouping results
      v. Combining result tables
      vi. Database updates

5. Data Definition
   a. Data definition
      i. Creating a database
      ii. Creating a table
      iii. Changing a table
      iv. Removing a table
      v. Creating an index
      vi. Removing an index
   b. Views
      i. Creating a view
      ii. Removing a view
      iii. Restrictions on views
      iv. Advantages and disadvantages of views

6. Entity-Relationship Modeling
   a. Entity Types
   b. Relationship Types
   c. Attributes
   d. Strong and Weak entity types
   e. Attributes on Relationships
      i. One to One Relationships
      ii. One to Many Relationships
      iii. Many to Many Relationships
7. **Normalization**
   a. The purpose of Normalization
   b. Data Redundancy
   c. Functional Dependencies
   d. The process of Normalization
   e. First Normal Form (1NF)
   f. Second Normal Form (2NF)
   g. Third Normal Form (3NF)
   h. Boyce-Codd Normal Form (BCNF)
   i. Fourth Normal Form (4NF)

**Part II - Computer Programming and Problem Solving**

1. **Computer Programming/Languages**
   a. Why Programming?
   b. History
   c. Programming languages
      i. Low level languages
      ii. High level languages
      iii. Visual languages

2. **Application Types**
   a. Console based applications
   b. Forms based applications

3. **Programming Paradigms**
   a. Sequential programming
   b. Procedural programming
   c. Object Oriented programming

4. **Programming Environment**
   a. Integrated development environment (IDE)
   b. Writing code
   c. Compilation
   d. Project Building
   e. Output Execution
   f. Output Deployment

5. **Variables and Expressions**
   a. Syntax
   b. Variables
   c. Expressions

6. **Data Types**
   a. Integer data type
   b. Float data type
   c. Double data type
   d. Byte data type
   e. Character data type
   f. String data type
   g. Boolean data type
7. **Control Structures**
   a. If statement
   b. If-else statement
   c. Switch case statement
   d. For statement
   e. While statement
   f. Do while statement
   g. Break statement
   h. Continue statement
   i. Return statement
   j. Goto statement

8. **Connecting to Databases**
   a. Programming for databases
   b. Fetching data
   c. Modifying data

**Lab Outline**
1. Exploring DBMS Environment
2. Creating Databases and tables
3. Executing Selection Queries
4. Executing Updation Queries
5. Creating and running views
6. Creating and Executing Stored procedures
7. Roles and permissions
8. User defined functions
9. Importing and exporting data
10. Creating and restoring backup
11. Exploring Programming Environment
12. Writing programs and syntax
13. Controlling program execution
14. Connecting Data sources
15. Fetching and modifying data
16. Project assignment

**References**
4. ‘Introduction to Mathematics/Statistics’

Course structure 03 credit hour 3

Pre-requisites: None

Course outline:
This Course includes some of the basics of Mathematics and Statistics which are required for pursuing studies in the fields related to Image processing and GIS as well as data acquisition through orbiting satellite. It would cover simple as well as trigonometric differentiation and integration as well as the concept of spherical geometry. This course also covers topics relating to distribution of data and probability theory.

Objectives:
The objectives of this course are:
1. To refresh the mathematics related to space science and technology
2. To give an understanding on essential mathematics and statistical concepts which may be helpful in understanding image processing as well as various techniques employed in remote sensing and GIS.
Learning outcomes:
1. It would refresh the mathematics and statistics specially those topics which would be useful in understanding the mathematics involved in image processing.
2. An understanding of various mathematical computation involved in data processing.
3. The mathematical and statistical data theories and concepts will lead to understanding of image data, its interpretation and analysis.

Skills outcomes:
On completion of this course, students will be able to:
1. Efficiently process the image data
2. Acquire a better analytic ability to support any hypothesis developed in data interpretation and analysis process.

Course Syllabus
1. Measures of Central Tendency
   a. The Arithmetic Mean
   b. The Median
   c. The Mode
   d. Standard Deviation
2. Probability
   a. Mutually exclusive events
   b. Non Mutually exclusive events
   c. Independent events
   d. Dependent events
   e. Binomial distribution
   f. Poison distribution
   g. Normal distribution
3. Fourier Series
4. Partial Differential function
5. Trigonometric Differential Equations
6. Differential series
   a. Power series function
   b. Gamma function
   c. Beta function
   d. Bassel’s equation
   e. Generating function
   f. Legendre’s equation
   g. Rodrigue’s formula
   h. Laplace Transformation
7. Integration
   a. Chain Rule
   b. Euler's formulas
   c. Even odd function
8. **Error theory and Statistics**
9. **Data distribution**
   a. Data sampling and chi square
   b. Data sampling
10. **Spherical Trigonometry**
    a. Spherical Triangle
    b. Terrestrial Latitude and Longitude
11. **Celestial Sphere**
    a. Attitude and Azimuth
    b. Declination and hour angle
    c. Right Ascension and Declination
12. **Vector Analysis**
    1. Divergence of a vector
    2. Guass Divergence theorem
    3. Curl of a vector
    4. Stokes’ theorem
    5. Green’s theorem

**References**
1. Linear Algebra by David C Lay, 3ed, Amazon, 2002
2. Linear Algebra: A Modern Introduction -- by David Poole, Amazon, 2003
4. Schaum’s Easy Outline of Linear Algebra by Seymour Lipschutz, Marc Lipson, 2002
Table: 03 MS RS &GIS Core Courses

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Advanced Remote Sensing and Digital Image Processing</td>
</tr>
<tr>
<td>02</td>
<td>Advanced Geographic Information Systems</td>
</tr>
<tr>
<td>03</td>
<td>Advanced Programming and Customizing GIS</td>
</tr>
<tr>
<td>04</td>
<td>Advanced Research Methods</td>
</tr>
</tbody>
</table>

01: Advanced Remote Sensing and Digital Image Processing

Credit Hours: 3 (2+1)

Pre-requisites:

Course Objective:

The course is designed to enhance the professional skills aligned with the latest advancements in Remote Sensing and Digital Image Processing.

Learning Outcomes

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

1. Understand the advances in Remote Sensing technology
2. Analyze optical, thermal and microwave remotely sensed data sets.
3. Apply advance remote sensing techniques in earth resource management.

Course Outline:

- Overview of advances in satellite technology
- Data acquisition, image formats and conversion
- Geometric and Radiometric correction
- Data Fusion techniques
- Digital Image interpretation and analysis
  - Spatial filtering
  - Principle component Analysis
  - Raster calculations and model building
  - Indices development and change detection
  - Pattern recognition and artificial Intelligence
  - Image classification techniques (supervised, unsupervised, object based, knowledge based)
• Overview of support vector machine and neural network classifications
• **Fundamentals of DEM generation and quality assessment**
• **Principles of Microwave Remote Sensing and analysis techniques**
• Hyper-spectral remote sensing and interpretation
• Integration of Remote Sensing with Hydrological/environmental Modeling
• Remote Sensing application in agriculture, natural resources and disaster risk management

**Lab:**
1. Introduction to labs
2. Advance image Pre-processing (radiometric corrections, geometric rectification, image enhancement),
3. Advanced information extraction techniques,
4. Thematic accuracy assessment,
5. Spectrometer handling,
6. Digital change detection,
7. Ortho-rectification,
8. Image transformations,
9. Advance data Fusion techniques,
10. DEM extraction from various data sources,
11. Processing of Thermal, Hyper spectral, LIDAR data etc.

**Reference Material:**

02: Advanced Geographic Information Systems
Course Structure: Lectures: 2 / Labs : 1 Credit Hours: 3

Objectives
The course is designed to enhance the professional skills aligned with the latest advancements in GIS

Learning Outcomes
After studying this course, the students will be able to:-

- Acquire skills and knowledge on the selection, integration, spatial analysis/modeling and visualization/communication of spatial information using GIS
- Learn to identify and translate a spatial research question into a GIS modeling problem / solution
- Apply advanced GIS tools to recognize and critically evaluate specific spatial issues
- Develop and carry out a scientifically sound GIS project

Course Outline:
1. Review of geographical data,
2. Coordinate systems and Map projections,
3. Raster/Vector conversions,
4. Error estimations and rectification due to projection systems and cartographic procedures, advanced editing of spatial data,
5. Symbolization and Map layouts development,
6. Describing and analyzing fields,
7. Area Objects and Spatial autocorrelation,
8. 3D Visualization of Spatial Data,
9. Geocoding and survey data integration in GIS,
10. Point Pattern analysis,
11. Lines and Networks,
12. Performing Network analysis,
13. Geo-statistical analysis,
14. Map Overlay analysis,
15. Multivariate data analysis,
16. Multidimensional Space,
17. GIS Modeling and Simulation.
03. Advanced Programming and Customizing GIS

Credits: 3 (2-1) Credits Hours

2 Lectures + 1 Lab

Taught: Semester I

Pre-requisites:
Introduction to Databases and Computer Programming

Course Summary:
This Course looks at the advance programming concepts and their applications in developing Customized GIS software. Concepts of design architectures, constructs and features of the modern programming languages are explored. Investigation of mapping capabilities in user defined programs, querying and plotting user data on the map. Topics include Functions, Arrays, Object oriented programming, Files, Mapping in Computer programs, Analysis, Querying maps and Spatial Databases.

Objectives:
The objectives of this course are
1. To build upon the existing knowledge of computer programming and explore some advance topics
2. To introduce the concepts of GIS customization and its advantages in decision making

**Learning outcomes:**
1. An understanding of computer programming concepts and its role in application software development
2. Knowledge of GIS software, its customization and building standalone customized GIS programs
3. An understanding of the map querying and serving reports with them
4. Knowledge of spatial databases and their working

**Skills outcomes:**
On successful completion of the course students will be able to
1. Develop software applications using the computer programming knowledge
2. Build customized GIS applications incorporating user data, reports and analysis

**Course Assessment #:**
1. Mid Term Exam
2. Home Assignments
3. Class Interaction
4. Final Term Exam

# To be dependent upon instructors’ choice

**Part I - Computer Programming and Problem Solving**

1. **Defining Functions**
   a. Defining and using functions
   b. Main function
   c. Variable scope
   d. Arguments
   e. Return value from functions

2. **Arrays**
   a. Declaring arrays
   b. Accessing array elements
   c. Array types

3. **Working with Strings**
   a. String creation and variables
   b. String concatenation
   c. String comparison
   d. Searching and extracting substring
4. **Object Oriented Programming**
   a. What is object oriented programming?
   b. Defining classes
   c. Creating objects
   d. Static members
   e. Constructors
   f. Overloading methods and constructors
   g. Data encapsulation

5. **Inheritance and polymorphism**
   a. Inheritance
   b. Polymorphism
   c. Abstract classes

6. **Working with files**
   a. Reading and writing files
   b. File Streams

**Part II - Programming for GIS**

1. **GIS Applications**
   a. How to program?
   b. Modules and Components of a basic GIS Application

2. **GIS Customization**
   a. What is GIS Customization?
   b. Why Customize?

3. **Geo Databases**
   a. Spatial database concepts
   b. Saving and retrieving vector data
   c. Spatial query processing
   d. Spatial indexing

4. **Analysis and Design**
   a. Requirement analysis
   b. System design
   c. Data flow

5. **Planning**
   a. Selection of Hardware / Software
   b. Communication infrastructure

6. **Creating environment for customization**
   a. Add Mapping support
      i. Add Layers to map
      ii. Classifying / symbolizing layers
      iii. Layering controls
      iv. Navigational controls
      v. Querying

7. **Analysis and Reporting**
   b. Thematic Visualizations
   c. Paper based reports
8. Packaging and deployment
   a. Customized GIS packaging
   b. Deployment of customized package
   c. Feedback incorporation
   d. Customized Applications - Case Studies

Lab Outline

1) Writing programs using Functions/procedures
2) Using Arrays and Strings
3) Object Oriented Programming
   a) Defining classes and objects
   b) Overloading
   c) Using Derived classes
   d) Using Polymorphism and Overriding
   e) Using Abstract Classes
   f) Defining Interfaces
   g) Reading and Writing Files
   h) Programming GIS
   i) Programming a GIS Application
   j) Working with Geo Databases
   k) Custom Controls for mapping
   l) Programming for basic map features
   m) Programming for map analysis and reports

4) Project assignment

References

04. **Advanced Research Methods**

**Credits:** 3 (3-0) Credits Hours

**Taught:** Semester II

**Pre-requisites:** None

**Course Summary:**
This course deals with skills and knowledge required to pursue any research/scientific study/investigation. It however focuses on the research undertakings in the field of remote sensing and GIS. The course covers the standards methods and steps followed in any research activity right from the evolution of idea, statement of the problem, acquisition of information, qualitative and quantitative measurement techniques, surveys and sampling procedures, data interpretation and analysis, validation of results and accuracy assessment.

**Objectives:**

The objectives of the course will be:
1. To analyze a problem and formulate research questions
2. To make a critical selection from secondary sources (literature, electronic information sources, including the internet, etc.) that provide the information required to deal with the research questions.
3. To critically analyze, review and summarize intellectual material with an emphasis on problem-solving.
4. To review existing scientific papers on the subject and provide feedback to the authors.

**Learning outcomes:**
1. An understanding of the concepts and theories of scientific research.
2. An understanding of how to formulate research problem as well as to review literature through different sources
3. An understanding of designing and basic elements of a research study
4. An understanding of major types of research methods such as qualitative, quantitative and surveying methods and their relative functions, as well as reliability and validity of results produced.
5. An understanding of sampling technique and its types.
6. An understanding of data collection methods and concerning issues.
7. An understanding of analysis and interpretation
8. An understanding of formulating research proposal and writing the research report.
Skills outcomes:
On completion of this module students will be able to:
1. Design or formulate a research study.
2. Familiar with authentic literature review techniques as well as data collection methods.
3. To formulate the research proposal and report it in a written form
4. To write the research report/papers
5. to develop presentation skills

Course Assessment #:
1. Mid Term Exam
2. Home Assignments
3. Class Interaction
4. Final Term Exam
# To be dependent upon instructors choice
Course Syllabus

1. Introduction
   a. Defining research through different perspectives
   b. Scope of Research
   c. Research and theory
   d. The scientific approach
   e. Stages of research process
   f. Ethics of Research
      i. Principals of Right to Know and Right to Protect
      ii. Ethical dilemmas and conflicts

2. Information Acquisition
   a. Sources of research topics and questions
   b. Literature review and the exploratory study
   c. Introduction to Library Resources
   d. Primary and secondary sources
   e. Specification of objectives
   f. Hypotheses Uni-variate, Bi-variate, Multivariate and Characteristics of a Testable Hypothesis-e Null Hypothesis and Alternate Hypothesis
   g. Concepts and variables

3. Assessment Of Short Comings and Reliabilities Of Measurement
   a. Levels of measurement: nominal, ordinal, interval and ratio
   b. Reliability and validity
   c. Construction of composite scores: typology, index and scaling
   d. Problems of making causal inference

4. Study Designs and Measurement
   a. Basic elements of study design
   b. Major types of design and their relative functions
   c. Qualitative Research Methods
      i. Field research
      ii. Focus groups
      iii. Participatory research appraisal
      iv. Elite interviews
   d. Quantitative Research Methods
      i. Experimental research
      ii. Aggregate data (Analyzing existing statistics)
      iii. Content analysis (Analyzing recorded human communications)
   e. Social Survey Methods
      i. The Interview Method
      ii. The Questionnaire Method
      iii. Formulating Questions for a Survey
      iv. Survey Implementation
v. Editing, Coding and Data Entry
vi. Analysis of Survey Data
vii. Writing a Survey Report
f. Evaluation Research Methods
   i. Social survey
   ii. Case study: its exploratory nature
g. Reliability and validity of measurement
h. Level of Measurement
   i. Cross-sectional, Longitudinal, and Sequential Designs
5. Sampling
   a. Population and the source list
   a. Sampling errors and sample size
   b. Probability sampling
   c. Non-probability sampling
6. Data Collection Methods
   a. Interview and questionnaire
      1. Structured
      2. Semi-structured
      3. Unstructured
   b. Observation
   c. Documents and content analysis
d. Unobtrusive measures
e. Data collection issues
7. Data Analysis And Interpretation
   a. Editing, coding, and tabulation
   b. Statistical analysis: Description and inference
   c. The meanings and implications of results: why so and so what?
8. Anticipated Out Puts
   a. Formulating the research proposal
   b. Writing the research report
   c. Research Publications
9. Presentation Skills

References
1. Ranjit Kumar, Research Methodology, Sage Publications
2. Ingeman Arbonor And Bjoran Berke, Methodology for Creating Business Knowledge, Sage Publications
3. Dam Remenyl, Doing Research in Business and Management, Sage Publications
5. C. William Emory, Business Research Methods, IRWIN
MS (RS & GIS) ELECTIVE COURSES

On the recommendation of NCRC, students can choose electives either from the following specialized field list or any other postgraduate courses offered by their respective university/institution:

Specialization Fields
Natural Resource Management (NRM)
Food Security (FS)
Environmental Management (EM)
Urban and Regional Planning (URP)
Socio-Economic and Infrastructure Management (SIM)
Disaster Management (DM)
Climate Change (CC)
Geo-Enterprise Resource Planning and Management (GERPM)
Geoinformatics (GIM)

The following Table provides brief details of some of the key elective of the MS (RS &GIS) program that may be chosen by the postgraduate students:

Table 4: List of Elective Courses

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Course Title</th>
<th>Credits Theory + Practical</th>
<th>Specialization Field</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Agriculture and Food Security</td>
<td>2+1=3</td>
<td>NRM</td>
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<tr>
<td>2.</td>
<td>Forest Management</td>
<td>2+1=3</td>
<td>NRM, EM</td>
</tr>
<tr>
<td>3.</td>
<td>Soil Geomorphology and Classifications</td>
<td>2+1=3</td>
<td>NRM</td>
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<tr>
<td>4.</td>
<td>Hydrology and Water Resources</td>
<td>2+1=3</td>
<td>NRM</td>
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<tr>
<td>5.</td>
<td>Biodiversity</td>
<td>2+1=3</td>
<td>NRM, EM</td>
</tr>
<tr>
<td>6.</td>
<td>Management of Energy Resources</td>
<td>2+1=3</td>
<td>NRM</td>
</tr>
<tr>
<td>7.</td>
<td>Management of Mineral Resources</td>
<td>2+1=3</td>
<td>NRM</td>
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<tr>
<td>8.</td>
<td>Coastal Zone Management</td>
<td>2+1=3</td>
<td>NRM, EM</td>
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<td>9.</td>
<td>Natural Resources Exploration</td>
<td>2+1=3</td>
<td>NRM</td>
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<td>10.</td>
<td>Natural Hazards and Disaster Management</td>
<td>2+1=3</td>
<td>EM</td>
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<td>11.</td>
<td>Environmental Pollution</td>
<td>2+1=3</td>
<td>EM</td>
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<td>12.</td>
<td>Environmental Impact Assessment</td>
<td>2+1=3</td>
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<td>Course Description</td>
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<tr>
<td>Environmental Decisions and Conflict Resolution</td>
<td>2+1=3</td>
<td>EM</td>
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<tr>
<td>Disease Ecology</td>
<td>2+1=3</td>
<td>EM</td>
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<tr>
<td>Climatology</td>
<td>2+1=3</td>
<td>EM</td>
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<tr>
<td>Land use Planning and Management</td>
<td>2+1=3</td>
<td>URP</td>
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<tr>
<td>District Planning and Management</td>
<td>2+1=3</td>
<td>URP</td>
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<tr>
<td>Urban Planning</td>
<td>2+1=3</td>
<td>URP</td>
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<tr>
<td>Infrastructure and Transport Planning</td>
<td>2+1=3</td>
<td>URP, SID</td>
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<tr>
<td>E-Governance</td>
<td>2+1=3</td>
<td>URP</td>
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<tr>
<td>Planning and Management of Housing</td>
<td>2+1=3</td>
<td>URP</td>
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<tr>
<td>Poverty Alleviation</td>
<td>2+1=3</td>
<td>SID</td>
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<td>Tourism Development</td>
<td>2+1=3</td>
<td>SID</td>
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<tr>
<td>Education and Health Services</td>
<td>2+1=3</td>
<td>SID</td>
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<tr>
<td>Business and Marketing</td>
<td>2+1=3</td>
<td>SID</td>
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<tr>
<td>Land Information and Management System</td>
<td>2+1=3</td>
<td>SID</td>
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<tr>
<td>Utilities and services Management</td>
<td>2+1=3</td>
<td>SID, URP</td>
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<tr>
<td>Advanced Geodesy</td>
<td>2+1=3</td>
<td>GIM</td>
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<tr>
<td>GIS Standards, Security and Ethics</td>
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<td>GIM</td>
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<tr>
<td>Integrated Geo-Technologies</td>
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<td>Corporate GIS</td>
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<td>GIM</td>
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<td>Web GIS</td>
<td>2+1=3</td>
<td>GIM</td>
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<tr>
<td>Fuzzy GIS</td>
<td>2+1=3</td>
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<tr>
<td>Neural Networks and Artificial Intelligence</td>
<td>2+1=3</td>
<td>GIM</td>
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<tr>
<td>Climate Change</td>
<td>2+1=3</td>
<td>CC</td>
<td></td>
</tr>
<tr>
<td>Emergency Response Planning and Management</td>
<td>2+1=3</td>
<td>DM</td>
<td></td>
</tr>
<tr>
<td>Flood Modelling</td>
<td>2+1=3</td>
<td>DM</td>
<td></td>
</tr>
<tr>
<td>Archeology</td>
<td>2+1=3</td>
<td>URP, GIM</td>
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<tr>
<td>GIS for Energy Management</td>
<td>2+1=3</td>
<td>NRM</td>
<td></td>
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<tr>
<td>Agro-meteorology</td>
<td>2+1=3</td>
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<tr>
<td>Ground Water Modeling</td>
<td>2+1=3</td>
<td>NRM, CC, EM</td>
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<tr>
<td>Watershed Modeling and Management</td>
<td>2+1=3</td>
<td>NRM, DM, EM</td>
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<tr>
<td>Crop Growth Modeling</td>
<td>2+1=3</td>
<td>NRM, FS</td>
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<tr>
<td>Course</td>
<td>Credits</td>
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<tr>
<td>Advanced Mobile GIS</td>
<td>2+1=3</td>
<td>GIM</td>
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<tr>
<td>Advanced topics in GIS</td>
<td>2+1=3</td>
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<tr>
<td>Advanced topics in Remote Sensing</td>
<td>2+1=3</td>
<td>GIM</td>
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<tr>
<td>Risk Assessment and Mapping</td>
<td>2+1=3</td>
<td>GIM, DM</td>
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</tr>
<tr>
<td>Early Warning System</td>
<td>2+1=3</td>
<td>GIM, DM</td>
<td></td>
</tr>
</tbody>
</table>

**MS (RS & GIS) Thesis Research**

**Credit Hours:** 6  
**Prerequisite:** 24 credits course work (RS &GIS)

**Objective:**  
The thesis is seen as a major component of the program in which the student will demonstrate an ability to independently integrate knowledge, skills and competencies acquired from all earlier courses, together with an opportunity to consolidate and develop additional skills in the use and application of research methodologies.

This independent study will be defined in consultation with the course coordinator and will be based on:

a) A specific research topic brought from the Remote Sensing &GIS industry. In this case, the topic will be discussed and finalized by mutual consultation of the corresponding industry, student and the MS (RS&GIS) course coordinator of the University.

b) A research project proposed by research supervisor or associate researchers within or outside the host university.

c) A development from a guided project pursued in RS and GIS, Applied Remote Sensing or an idea developed by the student during the earlier taught parts of the course.

d) The research project should be focused on real time problems and it should incorporate collaboration with the key stakeholders.

In all cases there will be a close liaison prior to, and during the project between the student, the course contributors and relevant industry organizations.
English I (Functional English)

Objectives: Enhance language skills and develop critical thinking.

Course Contents
Basics of Grammar
Parts of speech and use of articles
Sentence structure, active and passive voice
Practice in unified sentence
Analysis of phrase, clause and sentence structure
Transitive and intransitive verbs
Punctuation and spelling

Comprehension
Answers to questions on a given text

Discussion
General topics and every-day conversation (topics for discussion to be at the discretion of the teacher keeping in view the level of students)

Listening
To be improved by showing documentaries/films carefully selected by subject teachers

Translation skills

Urdu to English
Paragraph writing
Topics to be chosen at the discretion of the teacher

Presentation skills
Introduction

Note: Extensive reading is required for vocabulary building

Recommended Books
1. Functional English
   a) Grammar
   b) Writing
c) Reading/Comprehension

d) Speaking
   English II (Communication Skills)
   Objectives: Enable the students to meet their real life communication needs.
   Course Contents:
   Paragraph writing
   Practice in writing a good, unified and coherent paragraph
   Essay writing
   Introduction
   CV and job application
   Translation skills
   Urdu to English
   Study skills
   Skimming and scanning, intensive and extensive, and speed reading, summary and précis writing and comprehension
   Academic skills
   Letter/memo writing, minutes of meetings, use of library and internet
   Presentation skills
   Personality development (emphasis on content, style and pronunciation)
   Note: documentaries to be shown for discussion and review

Recommended Books
Communication Skills
a) Grammar

b) Writing
435406 5 (particularly good for writing memos, introduction to presentations, descriptive and argumentative writing).

c) Reading
2. Reading and Study Skills by John Langan

**English III (Technical Writing and Presentation Skills)**

**Objectives:** Enhance language skills and develop critical thinking

**Course Contents**

**Presentation skills**

**Essay writing**
Descriptive, narrative, discursive, argumentative

**Academic writing**
How to write a proposal for research paper/term paper
How to write a research paper/term paper (emphasis on style, content, language, form, clarity, consistency)

**Technical Report writing**

**Progress report writing**

*Note: Extensive reading is required for vocabulary building*

**Recommended Books**

Technical Writing and Presentation Skills

a) Essay Writing and Academic Writing

b) Presentation Skills

c) Reading
The Mercury Reader. A Custom Publication. Compiled by Northern Illinois University. General Editors: Janice Neulib; Kathleen Shine Cain; Stephen Ruffus and Maurice Scharton. (A reader which will give students exposure to the best of twentieth century literature, without taxing the taste of engineering students).
Pakistan Studies (Compulsory)

Introduction/Objectives

- Develop vision of historical perspective, government, politics, contemporary Pakistan, ideological background of Pakistan.
- Study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan.

Course Outline

1. **Historical Perspective**
   b. Factors leading to Muslim separatism
   c. People and Land
      i. Indus Civilization
      ii. Muslim advent
      iii. Location and geo-physical features.

2. **Government and Politics in Pakistan**
   
   Political and constitutional phases:
   a. 1947-58
   b. 1958-71
   c. 1971-77
   d. 1977-88
   e. 1988-99
   f. 1999 onward

3. **Contemporary Pakistan**
   a. Economic institutions and issues
   b. Society and social structure
   c. Ethnicity
   d. Foreign policy of Pakistan and challenges
   e. Futuristic outlook of Pakistan

**Recommended Books**

ISLAMIC STUDIES

(Compulsory)

Objectives
This course is aimed at:
1. To provide Basic information about Islamic Studies
2. To enhance understanding of the students regarding Islamic Civilization
3. To improve Students skill to perform prayers and other worships
4. To enhance the skill of the students for understanding of issues related to faith and religious life.

Detail of Courses

Introduction to Quranic Studies
1. Basic Concepts of Quran
2. History of Quran
3. Uloom-ul-Quran

Study of Selected Text of Holly Quran
1. Verses of Surah Al-Baqara Related to Faith (Verse No. 284-286)
2. Verses of Surah Al-Hujrat Related to Adab Al-Nabi (Verse No. 1-18)
3. Verses of Surah Al-Mumanoon Related to Characteristics of faithful (Verse No.1-11)
4. Verses of Surah al-Furqan Related to Social Ethics (Verse No. 63-77)
5. Verses of Surah Al-Inam Related to Ihkam (Verse No. 152-154)

Study of Selected Text of Holly Quran
1. Verses of Surah Al-Ihzab Related to Adab al-Nabi (Verse No. 6, 21, 40, 56, 57, 58.)
2. Verses of Surah Al-Hashar (18, 19, 20) Related to thinking, Day of Judgment
3. Verses of Surah Al-Saf Related to Tafakar, Tadabar (Verse No. 1, 14)

Seerat of Holy Prophet (S.A.W) I
1. Life of Muhammad Bin Abdullah (Before Prophet Hood)
2. Life of Holy Prophet (S.A.W) in Makkah
3. Important Lessons Derived from the life of Holy Prophet in Makkah

Seerat of Holy Prophet (S.A.W) II
1. Life of Holy Prophet (S.A.W) in Madina
2. Important Events of Life Holy Prophet in Madina
3. Important Lessons Derived from the life of Holy Prophet in Madina

Introduction to Sunnah
1. Basic Concepts of Hadith
2. History of Hadith  
3. Kinds of Hadith  
4. Uloom –ul-Hadith  
5. Sunnah & Hadith  
6. Legal Position of Sunnah

**Selected Study from Text of Hadith**

**Introduction to Islamic Law & Jurisprudence**  
1. Basic Concepts of Islamic Law & Jurisprudence  
2. History & Importance of Islamic Law & Jurisprudence  
3. Sources of Islamic Law & Jurisprudence  
4. Nature of Differences in Islamic Law  
5. Islam and Sectarianism

**Islamic Culture & Civilization**  
1. Basic Concepts of Islamic Culture & Civilization  
2. Historical Development of Islamic Culture & Civilization  
3. Characteristics of Islamic Culture & Civilization  
4. Islamic Culture & Civilization and Contemporary Issues

**Islam & Science**  
1. Basic Concepts of Islam & Science  
2. Contributions of Muslims in the Development of Science  
3. Quran & Science

**Islamic Economic System**  
1. Basic Concepts of Islamic Economic System  
2. Means of Distribution of wealth in Islamic Economics  
3. Islamic Concept of Riba  
4. Islamic Ways of Trade & Commerce

**Political System of Islam**  
1. Basic Concepts of Islamic Political System  
2. Islamic Concept of Sovereignty  
3. Basic Institutions of Govt. in Islam

**Islamic History**  
1. Period of Khlaft-E-Rashida  
2. Period of Ummayyads  
3. Period of Abbasids

**Social System of Islam**  
1. Basic Concepts of Social System of Islam  
2. Elements of Family  
3. Ethical Values of Islam

**Reference Books**  
1. Hameed ullah Muhammad, *Emergence of Islam*, IRI, Islamabad  
2. Hameed ullah Muhammad, *Muslim Conduct of State*
3. Hameed ullah Muhammad, "Introduction to Islam"
ANNEXURE - D

Note: One course will be selected from the following six courses of Mathematics.

COMPULSORY MATHEMATICS COURSES FOR BS (4 YEAR) (FOR STUDENTS NOT MAJORING IN MATHEMATICS)

1. MATHEMATICS I (ALGEBRA)

Prerequisite(s): Mathematics at secondary level
Credit Hours: 3 + 0
Specific Objectives of the Course: To prepare the students, not majoring in mathematics, with the essential tools of algebra to apply the concepts and the techniques in their respective disciplines.

Course Outline:
Preliminaries: Real-number system, complex numbers, introduction to sets, set operations, functions, types of functions. Matrices: Introduction to matrices, types, matrix inverse, determinants, system of linear equations, Cramer’s rule.
Quadratic Equations: Solution of quadratic equations, qualitative analysis of roots of a quadratic equations, equations reducible to quadratic equations, cube roots of unity, relation between roots and coefficients of quadratic equations.
Sequences and Series: Arithmetic progression, geometric progression, harmonic progression.
Binomial Theorem: Introduction to mathematical induction, binomial theorem with rational and irrational indices.
Trigonometry: Fundamentals of trigonometry, trigonometric identities.

Recommended Books

2. MATHEMATICS II (CALCULUS)

Prerequisite(s): Mathematics I (Algebra)
Credit Hours: 3 + 0
Specific Objectives of the Course: To prepare the students, not majoring in mathematics, with the essential tools of calculus to apply the concepts and the techniques in their respective disciplines.

Course Outline
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.

Recommended Books
4. Thomas GB, Finney AR, Calculus (11th edition), 2005, Addison-Wesley, Reading, Ma, USA

3. MATHEMATICS III (GEOMETRY)
Prerequisite(s): Mathematics II (Calculus)
Credit Hours: 3 + 0

Specific Objectives of the Course: To prepare the students, not majoring in mathematics, with the essential tools of geometry to apply the concepts and the techniques in their respective disciplines.

Course Outline
Geometry in Two Dimensions: Cartesian-coördinate mesh, slope of a line, equation of a line, parallel and perpendicular lines, various forms of equation of a line, intersection of two lines, angle between two lines, distance between two points, distance between a point and a line.
Circle: Equation of a circle, circles determined by various conditions, intersection of lines and circles, locus of a point in various conditions.
Conic Sections: Parabola, ellipse, hyperbola, the general-second-degree equation.

Recommended Books
4. COURSE FOR NON-MATHMATICS MAJORS IN SOCIAL SCIENCES

Title of subject: MATHEMATICS
Discipline: BS (Social Sciences).
Pre-requisites: SSC (Metric) level Mathematics
Credit Hours: 03 + 00
Minimum Contact Hours: 40
Assessment: written examination;
Effective: 2008 and onward

Aims: To give the basic knowledge of Mathematics and prepare the students not majoring in mathematics.

Objectives: After completion of this course the student should be able to:

- Understand the use of the essential tools of basic mathematics;
- Apply the concepts and the techniques in their respective disciplines;
- Model the effects non-isothermal problems through different domains;

Contents:

1. **Algebra**
   - **Preliminaries:** Real and complex numbers, Introduction to sets, set operations, functions, types of functions.
   - **Matrices:** Introduction to matrices, types of matrices, inverse of matrices, determinants, system of linear equations, Cramer’s rule.
   - **Quadratic equations:** Solution of quadratic equations, nature of roots of quadratic equations, equations reducible to quadratic equations.
   - **Sequence and Series:** Arithmetic, geometric and harmonic progressions.
   - **Permutation and combinations:** Introduction to permutation and combinations.
   - **Binomial Theorem:** Introduction to binomial theorem.
   - **Trigonometry:** Fundamentals of trigonometry, trigonometric identities.
   - **Graphs:** Graph of straight line, circle and trigonometric functions.

2. **Statistics**
   - **Introduction:** Meaning and definition of statistics, relationship of statistics with social science, characteristics of statistics, limitations of statistics and main division of statistics.
   - **Frequency distribution:** Organisation of data, array, ungrouped and grouped data, types of frequency series, individual, discrete and continuous series, tally sheet method, graphic presentation of the frequency distribution, bar frequency diagram histogram, frequency polygon, cumulative frequency curve.
   - **Measures of central tendency:** Mean medium and modes, quartiles, deciles and percentiles.
   - **Measures of dispersion:**
Range, inter quartile deviation mean deviation, standard deviation, variance, moments, skewness and kurtosis.

**Recommended Books**

4. Wilcox, R. R., ‘*Statistics for The Social Sciences*’,

**5. MATHEMATICS FOR CHEMISTRY**

**Credit Hours:** 3

**Prerequisites:** Mathematics at Secondary level

**Specific Objectives of Course:**

To prepare the students not majoring in mathematics with the essential tools of Calculus to apply the concepts and the techniques in their respective disciplines.

**Course Outline**


**Recommended Books**


6. MATHEMATICS FOR PHYSICS
Contents
1. Preliminary calculus.
   • Differentiation
     Differentiation from first principles; products; the chain rule; quotients; implicit differentiation; logarithmic differentiation; Leibnitz’ theorem; special points of a function; theorems of differentiation.
   • Integration
     Integration from first principles; the inverse of differentiation; integration by inspection; sinusoidal function; logarithmic integration; integration using partial fractions; substitution method; integration by parts; reduction formulae; infinite and improper integrals; plane polar coordinates; integral inequalities; applications of integration.
2. Complex numbers and hyperbolic functions
   • The need for complex numbers
   • Manipulation of complex numbers
     Additions and subtraction; modulus and argument; multiplication; complex conjugate; division
   • Polar representation of complex numbers Multiplication and division in polar form
   • de Moivre’s theorem
     Trigonometrical identities; finding the nth roots of unity; solving polynomial equations
   • Complex logarithms and complex powers
   • Applications to differentiation and integration
   • Hyperbolic functions
     Definitions; hyperbolic-trigonometric analogies; identities of hyperbolic functions; solving hyperbolic equations; inverses of hyperbolic functions; calculus of hyperbolic functions
3. Series and limits
   • Series
     • Summation of series
       Arithmetic series; geometric series; arithmetico-geometric series; the difference method; series involving natural numbers; transformation of series
     • Convergence of infinite series
       Absolute and conditional convergence; convergence of a series containing only real positive terms; alternating series test
   • Operations with series
• Power series
  Convergence of power series; operations with power series
• Taylor series
  Taylor’s theorem; approximation errors in Taylor series; standard
  McLaurin series
• Evaluation of limits

4. **Partial differentiation**
• Definition of the partial derivative
• The total differential and total derivative
• Exact and inexact differentials
• Useful theorems of partial differentiation
• The chain rule
• Change of variables
• Taylor’s theorem for many-variable functions
• Stationary values of many-variable functions
• Stationary values under constraints

5. **Multiple integrals**
• Double integrals
• Triple integrals
• Applications of multiple integrals
  Areas and volumes; masses, centers of mass and centroids;
  Pappus’ theorems; moments of inertia; mean values of functions
• Change of variables in multiple integrals
  Change of variables in double integrals;

6. **Vector algebra**
• Scalars and vectors
• Addition and subtraction of vectors
• Multiplication by a scalar
• Basis vectors and components
• Magnitude of a vectors
• Multiplication of vectors
  Scalar product; vector product; scalar triple product; vector triple
  product
• Equations of lines and planes
  Equation of a line; equation of a plane
• Using vectors to find distances
  Point to line; point to plane; line to line; line to plane
• Reciprocal vectors

7. **Matrices and vector spaces**
• Vectors spaces Basic vectors; the inner product; some useful
  inequalities
• Matrices
• The complex and Hermitian conjugates of a matrix
• The determinant of a matrix
  Properties of determinants
• The inverse of a matrix
• The rank of a matrix
• Simultaneous linear equations
  N simultaneous linear equations in N unknowns
• Special square matrices
  Diagonal; symmetric and antisymmetric; orthogonal; Hermitian; unitary normal
• Eigen vectors and eigen values
  Of a normal matrix; of Hermitian and anti-Hermitian matrices; of a unitary matrix; of a general square matrix
• Determination of eigen values and eigen vectors Degenerate eigen values

8. Vector calculus
• Differentiation of vectors Composite vector expressions; differential of a vector
• Integration of vectors
• Space curves
• Vector functions of several arguments
• Surfaces
• Scalar and vector fields
• Vector operators
  • Gradient of a scalar field; divergence of a vector field; curl of a vector field
  • Vector operator formulae
  • Vector operators acting on sums and products; combinations of grad, div and curl
• Cylindrical and spherical polar coordinates
• Cylindrical polar coordinates; spherical polar coordinates.
ANNEXURE - E

Statistics-I  Credit 3 (2-1)
Definition and importance of Statistics in Agriculture, Data Different types of data and variables

Classification and Tabulation of data, Frequency distribution, stem-and-Leaf diagram, Graphical representation of data Histogram, frequency polygon, frequency curve.

Measure of Central tendency, Definition and calculation of Arithmetic mean, Geometric mean, Harmonic mean, Median quantiles and Mode in grouped and un-grouped data.

Measure of Dispersion, Definition and Calculation of Range, quartile deviation, Mean deviation, Standard deviation and variance, coefficient of variation.

Practical
a. Frequency Distribution
b. Stem-and-Leaf diagram
c. Various types of Graphs
d. Mean, Geometric mean Harmonic Mean,
e. Median, Quartiles Deviation, mean Deviation.
f. Standard Deviation, Variance, Coefficient of variation,
g. Skewness and keness

Recommended Books
1. Introduction to Statistical Theory Part- I by Sher Muhammad and Dr. Shahid Kamal (Latest Edition)
2. Statistical Methods and Data Analysis by Dr. Faquir Muhammad

Statistics-II  Credit 3 (2-1)
Sampling Probability and non-Probability Sampling, Simple random sampling stratified random sampling Systematic sampling error, Sampling distribution of mean and difference between two means. Interference Theory: Estimation and testing of hypothesis, Type—I and type-II error, Testing of hypothesis about mean and difference between two means using Z-test and t-test, Paired t-test, Test of association of attributes using X2 (chi-square) Testing hypothesis about variance.
Practical
a. Sampling random sampling
b. Stratified random sampling.
c. Sampling distribution of mean
d. Testing of hypotheses regarding population mean
e. Testing of hypotheses about the difference between population means
f. Chi-square test
g. Testing of Correlation Coefficient
h. Fitting of simple linear regression
i. One-way ANOVA
j. Two-way ANOVA

Recommended Books
1. Introduction to Statistical Theory Part-II by Sher Muhammad and Dr. Shahid Kamal (Latest Edition)
2. Statistical Methods and Data Analysis by Dr. Faquir Muhammad
Introduction to Information and Communication Technologies

Course Structure:  
Lectures: 2  Labs: 1  
Credit Hours: 3
Pre-requisite:  None  
Semester: 1

Course Description
This is an introductory course on Information and Communication Technologies. Topics include ICT terminologies, hardware and software components, the internet and World Wide Web, and ICT based applications.
After completing this course, a student will be able to:

- Understand different terms associated with ICT
- Identify various components of a computer system
- Identify the various categories of software and their usage
- Define the basic terms associated with communications and networking
- Understand different terms associated with the Internet and World Wide Web.
- Use various web tools including Web Browsers, E-mail clients and search utilities.
- Use text processing, spreadsheets and presentation tools
- Understand the enabling/pervasive features of ICT

Course Contents
Basic Definitions & Concepts
Hardware: Computer Systems & Components
Storage Devices, Number Systems
Software: Operating Systems, Programming and Application Software
Introduction to Programming, Databases and Information Systems
Networks
Data Communication
The Internet, Browsers and Search Engines
The Internet: Email, Collaborative Computing and Social Networking
The Internet: E-Commerce
IT Security and other issues
Project Week
Review Week

Text Books/Reference Books