UNIVERSITY OF THE PUNJAB

NOTIFICATION

It is hereby notified that the Syndicate at its meeting held on 27-07-2023 has approved the recommendations of the Academic Council made at its meeting dated 24-05-2023 regarding approval of the Revised Syllabi and Courses of Reading for Associate Degree in Applied Hydrology under Semester System at the College of Earth and Environmental Sciences w.e.f. the Academic Session, 2021 and onward.

The Revised Syllabi and Courses of Reading for Associate Degree in Applied Hydrology under Semester System is attached herewith as Annexure 'A'.

Sd/-
REGISTRAR

Admin. Block,
Quaid-i-Azam Campus,
Lahore.

No. D/ 7668 /Acad. **Dated: 11 – 10 /2023.**

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

1. Dean, Faculty of Geo Sciences.
2. Principal, College of Earth and Environmental Sciences.
3. Controller of Examinations
4. Director, IT for placement at the website
5. Admin Officer (Statutes)
6. Secretary to the Vice-Chancellor.
7. PS to the Registrar.
8. Assistant Syllabus.

Assistant Registrar (Academic)
for Registrar

COLLEGE OF EARTH & ENVIRONMENTAL SCIENCES
UNIVERSITY OF THE PUNJAB

Courses & Syllabi for
02 Year Associate Degree in Applied Hydrology

Program Title: **02 Year Associate Degree in Applied Hydrology**

Department: **College of Earth and Environmental Sciences**

Faculty: **Geoscience**

1. Department Mission

The mission of the College is to groom the students into responsible and honest citizens and skilled professionals trained in their respective fields to serve the nation. Character building and moral training is an integral component of student-teacher relationship. student life in the College provides the students with all possible opportunities to acquire the most dynamic personalities with leadership qualities. Academically excellent and experienced faculty members are involved in teaching and research in the CEES. Classes are regularly held, well supplemented with laboratory work and observations in the field.

2. Introduction

The College of Earth and Environmental Sciences, University of the Punjab, Lahore is presently offering multidisciplinary degree program i.e. BS, MS, M.Phil. and Ph.D. degree programs in the disciplines of Environmental Sciences, Applied Hydrology, Tourism & Hospitality Management, Geomatics and Occupational Health and Safety. The purpose of these courses is to produce graduates in these emerging disciplines with the insight and knowledge to serve the nation for attaining environmentally sustainable development in the country.

Environmental changes, like desertification, silting of dam reservoirs, water logging, salinity and contamination of land as well as surface and groundwater, have created problems related to tourism. Over exploitation of resources has adversely impacted the tourism destinations and we are facing the danger of degradation and destruction of ecological infrastructure that is essential for sustainable tourism.

In Pakistan, as elsewhere in developing countries, environmental degradation is occurring due to heavy industrialization concentrated in narrow zones, especially hospitality industry.

Keeping in view the importance and the growing demands for training manpower in the emerging discipline, the College of Earth and Environmental Sciences has been established in the University of the Punjab in 2005. The new building of the College was completed in November 2008, featuring spacious rooms, moderately equipped laboratories, a library and large grounds.

3. Program Introduction

Since the beginning of life on this planet water has vital significance and without it life seems impossible, therefore, it is essential to understand fundamental knowledge of hydrology. As the time passed human development has casted disastrous impacts on water resources arability in quantitative and qualitative context as well. Global warming, climate change, hydrological cycle changes, land, air and Sea level rising area important issues of this century and these issues have significant effects on economy, society and environment. Therefore, it is need of hour to develop a comprehensive plan to tackle these issues on priority basis. Keeping in view of these issues and after getting an intensive feedback from society we have designed Associate Degree in Applied Hydrology. This programme will consist of two years covering all key aspects of Applied hydrology. This will also provide an opportunity to younger generations to be skilled in field of hydrology. Since the industry is global and expanding with every passing day, it has twofold employment opportunities; local and international. The program will focus on optimal realization of the potential of students. This will also include training of students through soft skills, technology knowledge, work ethics, advancement in hydrology and to serve back to nation.

4. Program Objectives

This programme will have equipped the students with fundamental knowledge of applied hydrology. It will cover all major area of hydrology including modelling and practical application of water resources management. This programme will consist of three major objectives given below

- Fundamental knowledge of hydrology and water resources management
- Practical applications of hydrological processes
- Modelling and solutions of societal problems

5. Market Need / Rationale of the Program

Hydrology is an ancient profession which has also referenced in old testimony and ancient chines history. This field has been evolving with the passage of time and now it has grown to an independent field. In 15th century the aim was to build basic knowledge of water resources, with the start of 19th century water resources sustainable problems become dominant field of research. Now the major areas of hydrology area climate changes, global warming and water resources sustainability issues.

Pakistan has a youth bulge whereby about 60% youth of its total population is between the age bracket of 15 and 30 years, which indicates immense human resource potential of Pakistan. The Pakistan has numerous departments in which numbers of professional already working and with the development of new projects further consumptions of hydrology professional will be prior task to these organizations. The WAPDA, Irrigations, PCRWR, ministry of water and Power, WASA, and large numbers of private consultancies firms including NESPAK, NDC, MMP, ECSP, ACE, etc. will also hire our professionally trained students.

6. Admission Eligibility Criteria

A student holding HSSC (F.Sc.) or equivalent with minimum 2nd division or equivalent 12 Years educations marks from any recognized institute of Pakistan. Admissions to which will be on Merit (Marks obtained in previous examination), entry test or interview or the criteria decided by the respective bodies of the university as per rules in vogue.

7. Duration of the Program

Total duration of the program will be 02 year and number of courses taught in Associate degree in Applied hydrology **69 credit hours** total with 04 semesters varied by 15-18 credit hrs in each semester. There shall be following 4 categories of courses offered to the students according to HEC standardized format/Scheme of studies.

8. Categorization of Courses as per HEC Recommendation and Difference

Semester	Courses	Category (Credit Hours)					
		Compulsory	Foundation	Major	General	Elective	Semester Load
1st	07	03	01	01	02	--	17
2nd	06	04	01	01	--	--	16
3rd	07	02	01	04	--	--	18
4th	08	03	01	02	--	02	18
PU	**28**	**12**	**04**	**08**	**02**	**02**	**69**
HEC Guidelines	**22**	**06**	**04**	**10**	**02**	**--**	**66**
Difference HEC & PU	**+06**	**+06**	**NIL**	**-02**	**NIL**	**NIL**	**+03**

9. Scheme of Studies / Semester –Wise Workload

Sr. #	Code	Course Title	Course Type	Prerequisite	Credit Hours
Semester I					
1.	HQ-01	Translation of Holy Quran	Compulsory	F.Sc. or equivalent	Non. Credit
2.	HYD-101	English I Functional English	Compulsory	-do-	03
3.	HYD-102	Islamic Studies & Ethics	Compulsory	-do-	02
4.	HYD-103	Introduction to Hydrology	Foundation	--	02+1
5.	HYD-104	General Geology	General	--	02+1
6.	HYD-105	Introductory Fluid Mechanics	General	--	02+1
7.	HYD-106	Fundamentals of Groundwater Hydrology	Major	--	02+1
Total Credit hrs Semester-I					**17**

Sr. #	Code	Course Title	Course Type	Prerequisite	Credit Hours
Semester II					
8.	HQ-02	Translation of Holy Quran	Compulsory	HQ-01	01
9.	HYD-107	English-II Communication Skills	Compulsory	HYD-101	03
10.	HYD-108	Computer Applications in Hydrology	Compulsory	F.Sc. or equivalent	02+1
11.	HYD-109	Applied Mathematics	Compulsory	F.Sc. or equivalent	03
12.	HYD-110	Hydrometeorology	Foundation	HYD-103	02+1
13.	HYD-111	Surveying Techniques for Water Resources Development	Major	F.Sc. or equivalent	02+1
Total Credit hrs Semester-II					**16**
Semester III					
14.	HQ-03	Translation of Holy Quran	Compulsory	HQ-02	Non Credit
15.	HYD-201	English-III Technical Writing and Presentation Skills	Compulsory	HYD-107	03
16.	HYD-202	Groundwater Development and Exploration	Foundation	HYD-106	2+1
17.	HYD-203	Introduction to Remote sensing and GIS	Major	HYD-108	02+1
18.	HYD-204	Statistical Methods in Hydrology	Major	F.Sc. or equivalent	02+1
19.	HYD-205	Irrigation-I	Major	F.Sc. or equivalent	02+1
20.	HYD-206	Hydrometry	Major	HYD-103	02+1
Total Credit hrs Semester-III:					**18**
Semester IV					
21.	HQ-04	Translation of Holy Quran	Compulsory	HQ-03	01
22.	HYD-207	Watershed Modeling	Foundation	HYD-108	02+1

Sr. #	Code	Course Title	Course Type	Prerequisite	Credit Hours
23.	HYD-208	Applications of Economics in Water Resources Management	Major	HYD-106	03
24.	HYD-209	Pakistan Studies	Compulsory	F.Sc. or equivalent	02
25.	HYD-210	Integrated Water resources management	Major	HYD-202	02
26.	HYD-211	Applied Climatology	Elective	HYD-110	02+1
27.	HYD-212	Urban hydrology	Elective	HYD-103	02+1
28.	HYD-213	Hydrological Field Studies I	Compulsory	--	01
Total Credit hrs Semester-IV					**18**
Grand Total (I+II+III+IV):					**69**

10. Award of Degree

02 Year Associate degree in Hydrology and Water Resources Management will be awarded on the successful completion of courses & syllabi with minimum required CGPA 2.5/4.00.

11. NOC from Professional Councils (if applicable)

Not Applicable

12. Faculty Strength

Degree	Area / Specialization	Total
PhD	1. Prof. Dr. Sajid Rashid Ahmad 2. Prof. Dr. Irfan Ahmad Shaikh 3. Prof. Dr. Nadia Jamil 4. Dr. Abdul Qadir 5. Dr. Yumna Sadef 6. Dr. Muhammad Kamran 7. Dr. Muzaffar Majid Ch. 8. Dr. Azhar Ali 9. Dr. Sana Ashraf 10. Dr. Muhammad Bilal Shakoor 11. Dr. Naeem Akhtar Abbasi 12. Dr. Mehwish Mumtaz 13. Dr. Muhammad Awais 14. Dr. Rizwan Aziz 15. Dr. Muhammad Asif Javed	**15**
MS / M.Phil.	16. Mr. Muhammad Waqar 17. Mr. Muhammad Dastgeer 18. Ms. Zahra Majid 19. Ms. Anum Tariq	**04**

13. Present Student Teacher Ratio in the Department

447: 19= (1:23)

14. Scheme of Study/Semester Wise Workload

1ST YEAR, FIRST SEMESTER				
Sr. #	**Code**	**Course Title**	**Course Type**	**Credit Hours**
1.	HQ-01	Translation of Holy Quran	Compulsory	Non Credit
2.	HYD-101	English I Functional English	Compulsory	03
3.	HYD-102	Islamic Studies / Ethics	Compulsory	02
4.	HYD-103	Introduction to Hydrology	Foundation	02+1
5.	HYD-104	General Geology	General	02+1
6.	HYD-105	Introductory Fluid Mechanics	General	02+1
7.	HYD-106	Fundamentals of Groundwater Hydrology	Major	02+1
			Total Credit hrs Semester-I	**17**

HQ-01: TRANSLATION OF HOLY QURAN (Non Credit)

PRE-REQUISITE: Intermediate: F.A/ F.Sc. / I.Com or equivalent

SYLLABUS OUTLINE

سورة الفاتحہ تا سورة آل عمران

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after mid term assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
1.	Mid Term Assessment	35%	It takes place at the mid-point of the semester
2.	Formative Assessment	25%	It is continuous assessment. It includes: classroom participation, attendance, assignments and presentation, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

HYD-101: ENGLISH-I (FUNCTIONAL ENGLISH) (03 Credit hrs)

PRE-REQUISITE: F.Sc. or equivalent

LEARNING OUTCOMES:

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

- Construct sentences using correct grammar.
- Write meaningful essays and précis and comprehend written English.
- Practice corrects English in speaking and writing.
- Comply even complex English language texts.
- Exhibit sound vocabulary and skills to use English in professional life.
- Avoid common errors usually made by the learners of English as second language.
- Improve their listening and reading skills in English
- Communicate in written and oral English with peers and teachers
- Rely less on their first languages and increase their use of English in formal and informal situations
- Deep understanding of correct English structures in descriptive, narrative, and instructional texts.

CONTENTS

Course Introduction & Objectives:

This course provides individualized and small group instruction in basic reading and writing skills. The course focuses on foundational phonics skills, functional vocabulary and comprehension, as well as writing personal information. The course will ensure that candidates will communicate effectively in English language.

Unit-1: Fundamentals of grammar

1.1. Parts of speech and their correct usage,
1.2. sentence structure and types of sentences,
1.3. Parts of speech & their correct usage,
1.4. spelling, vocabulary. Listening skills, speaking skills, Writing skills.

Unit –II: Message Design

2.1. Process of preparing effective business message.
2.2. The appearance and design of business message
2.3. Good-news and neutral messages.

Unit –III: Strategies for Oral Communication.

3.1. Strategies for successful speaking and successful listening.
3.2. Strategies for successful informative and persuasive speaking.

Unit –IV: The Job Application Process.

3.1. The written job presentation
3.2. The job application process-interviews and follow-up.

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

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3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED TEXT BOOKS/ SUGGESTED READINGS

1. Howe, D.H, Kirpatrick, TA. and Kirpartrick, D.L. (2004). Oxford English for undergraduates, Karachi: Oxford University Press.
2. Kakarla, U.,(2019). Functional English for Communication, SAGE Publications.
3. Books, C. and H. Gregson (2016). Functional Skills English Level 1 - Study & Test Practice, Coordination Group Publications Limited (CGP).
4. Banks, D. (2019). A Systemic Functional Grammar of English: A Simple Introduction, Routledge.

HYD-102 ISLAMIC STUDIES / ETHICS (02 Credit hrs)

PRE-REQUISITE: F.Sc. or equivalent

LEARNING OUTCOMES

Following are the learning outcomes of the course:

- Learning on the basic concepts and principles of Islam
- Learning of concepts of Holy Qural and Uloom ul Quran

CONTENTS

A. ISLAMIC STUDIES

Introduction:

This course is designed to provide the students with basic concepts and principles of Islam. The course also focuses on the life of Muhammad (S.A.W).

Unit-I: Introduction to Quranic Studies:

1.1 Basic concepts of Quran, History of Quran, Uloom-ul-quran

Unit-II: Study of the selected Text from the Holy Quran:

2.1. Verses of Surah Al-Baqara related to faith (verse No. 284-286)
2.2. Verses of Surah Al- Hujrat related to Adab Al-Nabi (verse No:1-18)
2.3. Verses of Surah Al- Ihzab related to Adab Al-Nabi (verse No:6, 21, 40,56,57,58)
2.4. Verses of surah Al-Mumanoon related to charactristcs of faithful (verse No: 1-11)
2.5. Verse Surah al-Furqan related to social ethics(verse No: 63-77)
2.6. Verses of surah Al-inam related to Ihkam (verse No:152-154)
2.7. Verses of surah Al-saf related to tafakar, tadabar (verse No; 1-14)

Unit-III: Basic concepts of Hadith:

3.1. History of Hadith
3.2. Kinds of Hadith
3.3. Uloomul Hadith
3.4. Legal position of Sunnah

Unit- IV: Life of Prophet Muhammad (P.B.U.H.):

4.1. Life of Muhammad bin Abdullah (before prophethood)
4.2. Life of the Holy prophet (S.A.W) in Makkah
4.3. Life of the prophet in(S.A.W) in MadinaUnit-4 Islamic Civilization:
4.4. Basic concepts of Islamic political system
4.5. Islamic concept of sovereignty
4.6. Basic institutions of Government in Islam

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

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3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Ahmad Hasan, (1993), "*Principles of Islamic Jurisprudence*" Islamic Research Institute: Islamabad: Pakistan, International Islamic University.
2. Bhatia, H. S. (1989) "*Studies in Islamic Law, Religion and Society*" New Delhi: Deep & Deep Publications
3. Dr. Muhammad Zia-ul-Haq, (2001). "*Introduction to Al Sharia Al Islamia*" Islamabad, Pakistan: AllamaIqbal Open University
4. Hameedullah Muhammad, „*Introduction to Islam* Mulana Muhammad YousafIslahi,"
5. Hameedullah Muhammad, "*Emergence of Islam*", Islamabad: IRI.
6. Hameedullah Muhammad, "*Muslim Conduct of State*" Islamabad, Pakistan: Hussain Hamid Hassan, u leaf Publication.
7. Mir Waliullah, (1982), "*Muslim Jurisprudence and the Quranic Law of Crimes*" Islamic Book Service.
8. Baker, R. W. (2015). *One Islam, Many Muslim Worlds: Spirituality, Identity, and Resistance Across Islamic Lands*. Oxford University Press, USA

HYD-103 INTRODUCTION TO HYDROLOGY (THEORY) (02 Credit hrs)

PRE-REQUISITE: F.Sc. or equivalent

COURSE LEARNING OUTCOMES

- This course will provide an introduction to the hydrology and hydrological cycle to the students.
- The students will learn about the surface water resources
- They will have the knowledge about the occurrences and importance of ground water resources and different water bearing formations
- The students will get used to the different methods for measurement of streamflow

CONTENTS

This course provides an introduction to the hydrological cycle, branches of hydrology, surface and ground water resources. This course will also provide basic knowledge about the streamflow measurements.

THEORY

Unit-I: Introduction

1.1. Occurrence of Water on Earth
1.2. Physical and chemical properties of water
1.3. Importance of Water

Unit-II: Hydrology as a Science

2.1. Introduction to Hydrology, origin and history
2.2. Importance of Hydrology
2.3. Branches of Hydrology

Unit-III: Hydrological Cycle

3.1. Introduction and importance of hydrological cycle
3.2. Components of Hydrological Cycle
3.3. Global Water Budget
3.4. Hydrological Losses (Interception, Infiltration, Evaporation, transpiration)

Unit-IV: Surface Water

4.1. Occurrence of fresh Water on Earth on earth
4.2. Runoff Process and hydrological losses
4.3. Rivers
4.4. Lakes and reservoirs
4.5. Glacier
4.6. Surface water resources of Pakistan

Unit-V: Ground Water

5.1. Ground water resources, occurrence and importance
5.2. Aquifers and types of aquifers
5.3. Hydraulic properties of aquifers

Unit-VI: Streamflow Measurements

6.1. Stage measurement
6.2. Velocity measurements using different methods
6.3. Velocity-Area method for streamflow measurement
6.4. Stream gauges

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
1.	Mid Term Assessment	35%	It takes place at the mid-point of the semester
2.	Formative Assessment	25%	It is continuous assessment. It includes: classroom participation, attendance, assignments and presentation, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Mays, L,W., (2011) *Ground and Surface Water Hydrology* 1st Edition Wiley ISBN-13: 978-0470169872
2. Guthrie, M., (2018) *Ground and Surface Water Hydrology* Larsen and Keller Education ISBN-13: 978-1635496949
3. John C. Manning (1996) *Applied Principles of Hydrology* 3rd Edition Prentice Hall ISBN-13: 978-0135655320.
4. Ghuman, A. R. (2013). *Introduction to Hydrology*. Department of Civil Engineering, the University of Engineering & Technology, Taxila, Pakistan.
5. Davie, T. (2008). *Fundamentals of Hydrology*. Routledge, Oxon, UK.
6. Raghunath, H.M. (2006). *Hydrology Principles, Analysis and Design*. New Age International Ltd.

HYD-103 INTRODUCTION TO HYDROLOGY (LAB) (01 Credit hrs)

PRE-REQUISITE: F.Sc. or equivalent

COURSE LEARNING OUTCOMES:

- This course will provide a demonstration about the different instruments used for recording hydrological data
- The students will learn about the practical aspects of the runoff measurement techniques
- They will have the knowledge about development and interpretation of unit hydrographs
- The students will get used to the concepts of frequency analysis of precipitation data
- They will become conversant with the different methods to measure infiltration

CONTENTS

This course if designed to provide practical aspects of hydrology. It will enable students to learn about the measurement different hydrological variables as well as problems related to frequency analysis of precipitation data.

PRACTICAL

Unit-I

1.1. Demonstration of weather recording instruments and practice in taking actual data from weather stations including a visit to weather station

Unit II

2.1. Measuring Runoff in the field by different techniques

Unit III

3.1 Development of and interpretation of hydrograph

Unit IV:

4.1 Frequency analysis of rainfall data

Unit V:

5.1. Measuring infiltration rate in the field

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
1.	Mid Term Assessment	35%	It takes place at the mid-point of the semester
2.	Formative Assessment	25%	It is continuous assessment. It includes: classroom participation, attendance, assignments and presentation, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Mays, L,W., (2011) *Ground and Surface Water Hydrology* 1st Edition Wiley ISBN-13: 978-0470169872
2. Guthrie, M., (2018) *Ground and Surface Water Hydrology* Larsen and Keller Education ISBN-13: 978-1635496949
3. John C. Manning (1996) *Applied Principles of Hydrology* 3rd Edition Prentice Hall ISBN-13: 978-0135655320.
4. Ghuman, A. R. (2013). *Introduction to Hydrology*. Department of Civil Engineering, the University of Engineering & Technology, Taxila, Pakistan.
5. Davie, T. (2008). *Fundamentals of Hydrology*. Routledge, Oxon, UK.
6. Raghunath, H.M. (2006). *Hydrology Principles, Analysis and Design*. New Age International Ltd.

HYD-104 GENERAL GEOLOGY (THEORY) (02 Credit hrs)

PRE-REQUISITE: F.Sc. or equivalent

LEARNING OUTCOMES:

- This course will provide a brief introduction to the geology to the students
- The students will learn about the history and evolution of earth
- They will have the knowledge about different dynamic process of the earth like weathering, soil erosion and earth quakes.
- The students will learn about different rock types
- They will become conversant with the different geological landscapes.

CONTENTS

This course provides an introduction to the evolution of the earth, types of rocks and erosion, landscapes and glaciers.

Theory

Unit I: Introduction:

1.1. Introduction to General Geology
1.2. Geo Science
1.3. applications of geology

Unit II: Earth History:

2.1. Evolution of the earth
2.2. Origin and age of the earth
2.3. Zones of the earth
2.4. The development of atmosphere
2.5. Continents and ocean floors
2.6. Fossilization, dating of rocks

Unit III: The dynamic of Earth:

3.1. Weathering and soil erosion and denudation

3.2. Plate tectonics

3.3. Volcanic and igneous activity

3.4. Earth quakes

Unit IV: Rocks:

4.1. Structure of the rocks

4.2. Types/classification of igneous rocks

4.3. Sedimentary and metamorphic rocks.

Unit V: Erosion:

5.1. Surface erosion and landscapes

5.2. Rivers and valleys

5.3. Process of down slope movement

5.4. Rain erosion and piedmonts

Unit VI: Glaciers:

6.1. Ice on earth
6.2. Mass budget of glaciers
6.3. Flow of glaciers
6.4. Glacier erosion and landscape

Unit VII: Aeolian landscapes:

7.1. Wind action and erosion
7.2. Formation of Aeolian Landscapes
7.3. Desert landscapes and its Hydrological Implications

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
1.	Mid Term Assessment	35%	It takes place at the mid-point of the semester
2.	Formative Assessment	25%	It is continuous assessment. It includes: classroom participation, attendance, assignments and presentation, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Park, G., (2010). *Introducing Geology: A Guide to the World of Rocks*. 2nd Ed., Dunedin Academic Press, ISBN-10: 1906716218.
2. Holmes, A. and Duff, D., (1993). *Principles of Physical Geology*. Nelson Thornes, ISBN-10: 041240320.
3. Billings, M. P., (1972). *Structural geology*. Prentice-Hall. ISBN-10: 0138538468.
4. Plummer, C., Geary, D, M., Carlson, D., Hammersley, L., (2009), *Physical Geology* (13th Edition) McGraw-Hill
5. Busch, R, M., (2011), *Laboratory Manual in Physical Geology* (9th Edition), American Geological Institute, Pearson Education
6. Plummer, C., Geary, D, M., Carlson, D., Hammersley, L., (2012), *Physical Geology* (14th Edition) McGraw-Hill

HYD-104 GENERAL GEOLOGY (LAB) (01 Credit hr)

PRE-REQUISITE: F.Sc. or equivalent

COURSE LEARNING OUTCOMES:

- This course will provide practical aspects of general geology to the students.
- The students will learn about the geological and topographical maps and their interpretations.
- They will have the practical knowledge on how to prepare geological sections
- They will become conversant with the identifications of minerals, fossils and rocks.

CONTENTS

This course is designed to provide practical aspects of general geology. The course will provide practical aspects on reading and development of geological/topo maps, constructions of geological sections and outcrops, utility of Brunton compass and GPS, as well as identifications of minerals, rocks and fossils.

PRACTICAL

Unit I:

1.1 Reading of geological maps, Topo map and geological maps.

Unit II:

2.1 Preparation of geological sections

Unit III:

3.1 Regional geological maps of watersheds

Unit IV:

4.1 Construction of outcrops

Unit V:

5.1 Use of Brunton compass and GPS

Unit VI:

6.1 Identification of different Minerals

Unit VII:

7.1 Identifications of different types of Rocks

Unit VIII:

8.1 Fossil identifications

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
1.	Mid Term Assessment	35%	It takes place at the mid-point of the semester
2.	Formative Assessment	25%	It is continuous assessment. It includes: classroom participation, attendance, assignments and presentation, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Park, G., (2010). *Introducing Geology: A Guide to the World of Rocks*. 2nd Ed., Dunedin Academic Press, ISBN-10: 1906716218.
2. Holmes, A. and Duff, D., (1993). *Principles of Physical Geology*. Nelson Thornes, ISBN-10: 041240320.
3. Billings, M. P., (1972). *Structural geology*. Prentice-Hall. ISBN-10: 0138538468.
4. Plummer, C., Geary, D, M., Carlson, D., Hammersley, L., (2009), *Physical Geology* (13th Edition) McGraw-Hill
5. Busch, R, M., (2011), *Laboratory Manual in Physical Geology* (9th Edition), American Geological Institute, Pearson Education
6. Plummer, C., Geary, D, M., Carlson, D., Hammersley, L., (2012), *Physical Geology* (14th Edition) McGraw-Hill

HYD-105: INTRODUCTORY FLUID MECHANICS (THEORY) (02 Credit hrs)

PRE-REQUISITE: F.Sc. or equivalent

LEARNING OUTCOMES:

- This course will provide an introduction to the fluids, and fluid mechanics.
- The students will learn about the concepts of fluid at rest and fluid properties
- They will have the knowledge about the governing laws of fluid flows
- The students will get used to the concepts of dimensional analysis, dimensionless numbers and hydraulic similitude.
- They will become conversant with working principles and design of various hydraulic machines.

CONTENTS

This course introduces the fluid properties, basic laws and their application. This course will also provide introduction to dimensional analyses, flow of compressible fluids, and fluid machinery and their applications.

THEORY

Unit-I: Introduction:

1.1 Introduction to fluid mechanics
1.2 Applications of fluid mechanics
1.3 Branches of fluid mechanics

Unit-II: Fluid statics:

2.1. Properties of fluids
2.2. Mano meters
2.3. Forces on immersed surfaces, buoyancy & flotation
2.4. Hydrostatic forces acting on dam
2.5. Forces of submerged plane areas and curved areas

Unit-III: Fundamentals of fluid flow

3.1. Basic laws (continuity equation,
3.2. Momentum equation, energy equation, application of basic laws to engineering problems).
3.3. Flow in closed conduits,
3.4. Pipeline network system.
3.5. Flow in open channels. (uniform flow, Chezy and Manning equations, best hydraulic section, normal depth and its computations)

Unit-IV: Dimensional Analysis:

4.1. Principles of Similarity and Dimensional Analysis,
4.2. Reynolds Number
4.3. Euler Number
4.4. Froude Number
4.5. Mach numbers Number

Unit-V: Flow of Compressible Fluids:

5.1. Governing equations for flow in compressible fluids
5.2. One-dimensional, two- dimensional compressible flow
5.3. Flow characteristics in convergent-divergent ducts

Unit-VI: Hydraulic Machinery:

6.1. Introduction to hydraulic machinery
6.2. Elementary pump theory

6.3. Centrifugal/axial-flow pumps
6.4. Turbines and its types

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
1.	Mid Term Assessment	35%	It takes place at the mid-point of the semester
2.	Formative Assessment	25%	It is continuous assessment. It includes: classroom participation, attendance, assignments and presentation, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Panton, Ronald L. (2013). *Incompressible Flow*. 4th ed. Wiley, ISBN: 9781118013434.
2. Kundu, Pijush K., and Ira M. Cohen. (2015) *Fluid Mechanics*. 6th ed. Academic Press, ISBN:9780124059351.
3. Tritton, D. J., *(2013). Fluid Dynamics*. Springer, ISBN: 9780442301323.9780124059351
4. Homsy, G. M., ed. (2011). *Multimedia Fluid Mechanics*. 2nd ed. Cengage Learning, ISBN: 9780521721691.
5. Smits, A. J. (1999). *A Physical Introduction to Fluid Mechanics*. New York, NY: John Wiley & Sons, ISBN: 9780471253495.
6. Roache, Patrick J. (1998). *Fundamentals of Computational Fluid Dynamics*. Hermosa Publishers, ISBN: 9780913478097.
7. Chung, T. J., (2010). *Computational Fluid Dynamics*. 2nd ed. Cambridge University Press, ISBN: 9780521769693.

HYD-105: INTRODUCTORY FLUID MECHANICS (LAB) (01 Credit hr)

PRE-REQUISITE: F.Sc. or Equivalent

LEARNING OUTCOMES:

- This course will provide practical aspects of measuring fluid properties
- The students will learn about the types and characteristic of flow
- They will have the knowledge about the measuring principles of headless in pipe flow
- The students will get knowledge about the practical applications of dimensionless numbers

CONTENTS

This course provides an introduction practical aspects and measurements fluid properties, flow characteristics and flow conditions. This course also includes calculation of headless in pipe flows.

PRACTICAL

Unit-I: Properties of Fluids

1.1 Measurement of Specific Weight
1.2 Specific Volume
1.3 Specific Gravity and Density
1.4 Stability of a Floating Body

Unit-II: Flow Characteristic

2.1. Verification of Bernoulli's Theorem.
2.2. Flow Through a venturi meter and Orifice
2.3. Head Loss Due to Friction and pipe fittings
2.4. Verification of Reynold's Number.
2.5. Flow Condition by Reynold's Number.

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
1.	Mid Term Assessment	35%	It takes place at the mid-point of the semester
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1. Panton, Ronald L. (2013). *Incompressible Flow*. 4th ed. Wiley, ISBN: 9781118013434.
2. Kundu, Pijush K., and Ira M. Cohen. (2015) *Fluid Mechanics*. 6th ed. Academic Press, ISBN:9780124059351.
3. Tritton, D. J., (2013). *Fluid Dynamics*. Springer, ISBN: 9780442301323.9780124059351
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5. Smits, A. J. (1999). *A Physical Introduction to Fluid Mechanics*. New York, NY: John Wiley & Sons, ISBN: 9780471253495.
6. Roache, Patrick J. (1998). *Fundamentals of Computational Fluid Dynamics*. Hermosa Publishers, ISBN: 9780913478097.
7. Chung, T. J., (2010). *Computational Fluid Dynamics.* 2nd ed. Cambridge University Press, ISBN: 9780521769693.

HYD-106 FUNDAMENTALS OF GROUNDWATER HYDROLOGY (THEORY) (02 Credit hrs)

PRE-REQUISITE: F.Sc. or equivalent

LEARNING OUTCOMES:

- This course will introduce the basic concepts of ground water and soil properties to the students.
- The students will learn about the occurrences and movement of the ground water
- They will have the knowledge about well hydraulics and well construction techniques
- They will become conversant with different aspects of ground water quality

CONTENTS

This course is designed to provide fundamentals of groundwater, aquifer, and groundwater flow system, groundwater movement, well hydraulics, flow nets groundwater flow construction of wells as well as ground water quality.

THEORY

Unit I: Introduction:

1.1 Basic concepts of Ground Water and Soil water
1.2 Types of subsurface water, Water Potential
1.3 Aquifer types, Soil water movement and Ground water movement
1.4 Forms and origins of Ground water
1.5 Aquifer functions, Porosity, Storage coefficient
1.6 Hydraulic conductivity, transmissivity

Unit II: Occurrence of Groundwater:

2.1. Origin & Age of GW
2.2. Vertical Distribution of groundwater
2.3. Zone of aeration, Zone of saturation
2.4. GW in Hydrologic Cycle.

Unit III: Ground Water Movement:

3.1. Darcy's Law and its applications
3.2. Observation wells, Piezometers
3.3. Flow nets, Streamlines
3.4. Equipotential lines
3.5. Steady and non-steady flow

Unit IV: Well Hydraulics:

4.1. Steady flow in confined and un-confined aquifers,
4.2. Steady flow in confined with uniform recharge
4.3. Unsteady flow in un-confined aquifer
4.4. Wells near aquifer boundaries
4.5. Multiple well system
4.6. Specific capacity, well losses
4.7. well efficiency and aquifer testing

Unit V: Construction of Water Wells:

5.1. Well drilling methods
5.2. Selecting and setting of screens, design and placing of gravel pack
5.3. methods of well development
5.4. Tube well performance tests

Unit VI- Quality of Ground Water:

6.1. Natural GW Quality, Sources of salts
6.2. Measures of water quality,
6.3. Analysis of water quality
6.4. Water quality criteria
6.5. Saline Groundwater.

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
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RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Guthrie, M., (2018) *Ground and Surface Water Hydrology*, Larsen and Keller Education ISBN-13: 978-1635496949.
2. Mandel, S., (2012). *Groundwater Resources: Investigation and Development.* Elsevier, ISBN 0323157823, 9780323157827
3. Agarwal. V. C., (2012). *Groundwater Hydrology*. PHI Learning Pvt. Ltd. ISBN 812034619X, 9788120346192
4. Karamouz, M Ahmadi,A, Akhbari. A., (2011). *Groundwater Hydrology: Engineering, Planning, and Management*. CRC Press. ISBN 1439891214, 9781439891216.
5. Todd, D.K. and Mays, L. W. (2005). *Groundwater Hydrology*. 3rd ed., Hoboken: John Wiley & Sons.

HYD-106 FUNDAMENTAL OF GROUNDWATER HYDROLOGY (LAB) (01 Credit hrs)

PRE-REQUISITE: F.Sc. or equivalent

LEARNING OUTCOMES:

- This course will provide an introduction to the sieve analysis of soil as well as hydraulic conductivity test.
- Students will learn how to find out the texture of soil.
- The students will practice on flow net problems
- They will have the knowledge about the principles of working of as well as design of observation wells.
- The students will get used to the application of computer software for solution of ground water problems.

CONTENTS

This course provides fundamentals of groundwater, assessment of soil moisture, estimation of hydraulic properties of soil, practical examples of flow nets as well as design and operation of observation wells.

PRACTICAL

Unit 1

1.1 Water level measurements using different techniques

Unit II:

2.1 Determination of hydraulic properties of aquifers.

Unit III:

3.1 Determination of groundwater flow rates

Unit IV:

4.1 Determination of groundwater flow directions using flow nets

Unit V:

5.1 Determination of soil moisture contents

Unit VI:

6.1 Demonstration of ground water computer models

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

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- classroom participation,
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- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

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2. Mandel, S., (2012). *Groundwater Resources: Investigation and Development.* Elsevier, ISBN 0323157823, 9780323157827
3. Agarwal. V. C., (2012). *Groundwater Hydrology*. PHI Learning Pvt. Ltd. ISBN 812034619X, 9788120346192
4. Karamouz, M Ahmadi,A, Akhbari. A., (2011). *Groundwater Hydrology: Engineering, Planning, and Management*. CRC Press. ISBN 1439891214, 9781439891216.
5. Todd, D.K. and Mays, L. W. (2005). *Groundwater Hydrology*. 3rd ed., Hoboken: John Wiley & Sons.
6. Todd, D.K., and Mays, L.W., (2008), *Groundwater Hydrology*, 3rd edition, Wiley.
7. McWhorter, D.B., and Sunada, D.K., (2010), *Ground-Water Hydrology and Hydraulics*, Water Resources Pubns; Reprint edition.
8. Rushton, K.R., (2003), *Groundwater Hydrology: Conceptual and Computational Models*, 1st Edition, Wiley.
9. Sterrett, R.J., Edited (2007), *Groundwater and Wells*, 3rd Edition, Smyth Co Inc.

1ST YEAR, SECOND SEMESTER				
Sr. #	**Code**	**Course Title**	**Course Type**	**Credit Hours**
1.	HQ-02	Translation of Holy Quran	Compulsory	01
2.	HYD-107	English-II Communication Skills	Compulsory	03
3.	HYD-108	Computer Application in Hydrology	Compulsory	02+1
4.	HYD-109	Applied Mathematics	Compulsory	03
5.	HYD-110	Hydrometeorology	Foundation	02+1
6.	HYD-111	Surveying Techniques for Water Resources Development	Major	02+1
			Total Credit hrs Semester-II	**16**

HQ-02: TRANSLATION OF HOLY QURAN (01 Credit hr)

PRE-REQUISITE: HQ-01

COURSE OUTLINE

سورة النسا تا سورة الانعام

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after mid term assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
1.	Mid Term Assessment	35%	It takes place at the mid-point of the semester
2.	Formative Assessment	25%	It is continuous assessment. It includes: classroom participation, attendance, assignments and presentation, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

HYD-107 ENGLISH-II COMMUNICATION SKILLS (03 Credit hrs)

PRE-REQUISITE: HYD-101 English I Functional English

LEARNING OUTCOMES

Followings will be learning outcomes of this subjects

- Student will learn Paragraph writing
- Student will learn Essay writing
- Student will learn CV and job application
- Student will learn Study skills
- Student will learn Academic skills
- Student will learn Presentation skills

CONTENTS

This course provides an introduction to the English language, enhance English skills and to develop critical thinking of students

Unit-I: Paragraph writing

1.1. Practice in writing a good, unified and coherent paragraph

Unit-II: Essay writing

2.1. Introduction

Unit-III: CV and job application

3.1. Translation skills

3.2. Urdu to English

Unit-IV: Study skills

4.1. Skimming and scanning, intensive and extensive, and speed reading,

4.2. summary and précis writing and comprehension

Unit-V: Academic skills

5.1. Letter/memo writing, minutes of meetings

5.2. Use of library and internet

Unit-VI: Presentation skills

6.1. Personality development (emphasis on content, style and pronunciation)

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
1.	Mid Term Assessment	35%	It takes place at the mid-point of the semester
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3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Thomson, A. J., Martinet, A. V., & Draycott, E. (1986). *A practical English grammar* (Vol. 332). Oxford: Oxford university press.
2. Downing, A., & Locke, P. (2006). *English grammar: A university course*. Routledge.
3. Collins, P., & Hollo, C. (2016). *English grammar: An introduction*. Macmillan International Higher Education.

HYD-108: COMPUTER APPLICATIONS IN HYDROLOGY (THEORY) (02 Credit hrs)

PRE-REQUISITE: F.Sc. or equivalent

LEARNING OUTCOMES

Upon completion of this course, students will:

- Be able to identify computer hardware and peripheral devices
- Be familiar with software applications
- Understand file management
- Accomplish creating basic documents, worksheets, presentations and databases
- Distinguish the advantages and disadvantages of networks
- Experience working with email and recognize email netiquette
- Explore the Web and how to conduct research
- Identify computer risks and safety
- Be able to develop a general understanding of applications of computer software's and programming packages in hydrology.

CONTENTS

This course is designed to familiarize students with computers and their applications. Students will learn fundamental concepts of computer hardware and software and become familiar with a variety of computer applications, including word processing, spreadsheets, databases, and multimedia presentations, mapping and graphs. Students will also be learning the basic concepts of computer programming and its utility in hydrology and water resources.

THEORY

Unit-I: Introduction to computer

1.1 Definition, types and classification of computers

1.2 Hardware, Input hardware, storage hardware; processing hardware

1.3 Output hardware, Software, application software, system software, software packages

1.4 Different types of Microprocessors & other Hardware Terminology

Unit-II: Use and Applications:

2.1. Application & the uses of Information Technology in the Hydrology. Examples of use of Computers hydrological calculations, Introduction to different Computer Related terms/concepts, Overall windows operation

2.2. Introduction to different windows-based packages

Unit-III: Operating Systems

3.1. Introduction to different kinds of OS used in case of standalone PC/Network,

3.2. Single user/multi user OS(DOS/UNIX),

3.3. Microsoft Windows.

3.4. File Handling Concepts under DOS/WINDOW,

3.5. Concept of Computer File & its storage,

3.6. Ways of maintaining Files under DOS/Windows.

Unit-IV: The Application of Microsoft Office

4.1. Utilities / Application of MS-Word,

4.2. Application of MS- Excel.

4.3. MS PowerPoint

Unit-V: The Application of Computer Programming

5.1. Introduction to programming:

5.2. the purpose of programming,

5.3. Object orientation: the concept model, class, object, encapsulation, Inheritance, instance variables, constructors and methods.

5.4. Class variable and class method. Data Types, Type Conversion, Variable Types, Operators, Selection Statements, Iterative Statements, Array, Algorithm components: assignment, sequence, selection, iteration.

5.5. Arithmetic and logical expressions, terminal I/Programming: writing programs, classes and using built-in classes, implementation, testing, debugging and documentation.

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
1.	Mid Term Assessment	35%	It takes place at the mid-point of the semester
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3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Tale, S. (2016) *Java: The Ultimate Beginners Guide to Java Programming* Create Space Independent Publishing Platform ISBN-13: 978-1539591214

2. Althoff, C. (2017) *The Self-Taught Programmer: The Definitive Guide to Programming Professionally* Self-Taught Media ISBN-13: 978-0999685907

3. Dawson, M. (2014) *Beginning C++ Through Game Programming* Cengage Learning PTR; 4 edition ISBN-13: 978-1305109919
4. Tale S. (2016) Python: *The Ultimate Beginners Guide: Start Coding Today* Create Space Independent Publishing Platform ISBN-13: 978-1539497479
5. Conner, J (2018) *R Programming computer programming for beginners* Create Space Independent Publishing Platform ISBN-13: 978-1717004383
6. Hoffman, A. (2016). Java: The Best Guide to Master Java Programming Fast-Volume 2.

HYD-108: COMPUTER APPLICATIONS IN HYDROLOGY (LAB) (01 Credit hr)

PRE-REQUISITE: F.Sc. or equivalent

LEARNING OUTCOMES

Upon completion of this course, students will:

- Be able to identify computer hardware and peripheral devices
- Be familiar with software applications
- Understand file management
- Accomplish creating basic documents, worksheets, presentations and databases
- Distinguish the advantages and disadvantages of networks

CONTENTS

This course provides an introduction to the computer system, programming languages and applications

PRACTICAL

Unit-I: Introduction to Computers

1.1 Familiarize with a PC and identify the various components of a Computer.
1.2 Identify the various Input and Output Devices.

Unit-II: Introduction to Operating Systems

2.1. Introduction to Basic DOS commands.
2.2. Introduction to Windows as an Operating System.
2.3. Getting familiar to Windows Environment.

Unit-III: Introduction to MS Office and its Applications

3.1. Introduction to the various packages of MS-Office.
3.2. Introduction to the Word Processor.
3.3. MS-Word: Entering a document, Editing a Text. Inserting, replacing and deleting
3.4. Characters. Saving a document. Opening an Existing Document, and changing Page Layout.
3.5. Utilities / Application of MS-Word
3.6. Application of MS- Excel

Unit-IV: Introduction to Programming

4.1. Elements of programming.
4.2. Computer languages.
4.3. Programming statements including control statements, input and output statements, do loops, use of subroutines and function sub-programs.
4.4. Debugging techniques for FORTRN (or visual basic or C++) Programming.
4.5. Introduction to Programming Packages like R and MATLAB and their use in solving water resources problems. Use of microcomputers.

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
1.	Mid Term Assessment	35%	It takes place at the mid-point of the semester
2.	Formative Assessment	25%	It is continuous assessment. It includes: classroom participation, attendance, assignments and presentation, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Tale, S. (2016) *Java: The Ultimate Beginners Guide to Java Programming* Create Space Independent Publishing Platform ISBN-13: 978-1539591214
2. Althoff, C. (2017) *The Self-Taught Programmer: The Definitive Guide to Programming Professionally* Self-Taught Media ISBN-13: 978-0999685907
3. Dawson, M. (2014) *Beginning C++ Through Game Programming* Cengage Learning PTR; 4 edition ISBN-13: 978-1305109919
4. Tale S. (2016) Python: *The Ultimate Beginners Guide: Start Coding Today* Create Space Independent Publishing Platform ISBN-13: 978-1539497479
5. Conner, J (2018) *R Programming computer programming for beginners* Create Space Independent Publishing Platform ISBN-13: 978-1717004383
6. Hoffman, A. (2016). Java: The Best Guide to Master Java Programming Fast-Volume 2.

HYD-109 APPLIED MATHEMATICS (03 Credit hrs)

PRE-REQUISITE: F.Sc. or equivalent

LEARNING OUTCOMES:

- This course will provide an introduction to the preliminaries of mathematics to the students.
- The students will learn about the matrices
- They will have the knowledge about Solution to the quadratic equations
- The students will get used to the concepts of Sequences and Series and binomial theorem
- They will become conversant with trigonometry and its applications

CONTENTS

This course is designed to provide an introduction to the mathematics and to improve their problems solving skills with thorough understanding of the basic arithmetic's, matrices operations, quadratic equations and solutions, sequences and series as well as the basic principles of trigonometry.

THEORY

Unit-I: Preliminaries

1.1 Real-number system
1.2 Complex numbers
1.3 Introduction to sets
1.4 Set operations
1.5 Functions and types of functions

Unit-II: Matrices:

2.1. Introduction to matrices
2.2. Types of Matrix
2.3. Matrix inverse
2.4. Determinants
2.5. System of linear equations

Unit-III: Quadratic Equations

3.1. Solution of quadratic equations
3.2. Qualitative analysis of roots of a quadratic equation
3.3. Equations reducible to quadratic equations
3.4. Cube roots of unity
3.5. Relation between roots and coefficients of quadratic equations

Unit-IV: Sequences and Series:

4.1. Arithmetic progression
4.2. Geometric progression
4.3. Harmonic progression

Unit-V: Binomial Theorem:

5.1. Introduction to mathematical induction
5.2. Binomial theorem with rational and irrational indices

Unit-VI: Trigonometry:

6.1. Fundamentals of trigonometry
6.2. Trigonometric identities

Module-VII: Integration and Differentiation

7.1. Differentiation Methods
7.2. Integration Methods
7.3. Basic of Numerical Methods

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
1.	Mid Term Assessment	35%	It takes place at the mid-point of the semester
2.	Formative Assessment	25%	It is continuous assessment. It includes: classroom participation, attendance, assignments and presentation, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Zill, D., & Dewar, J. (2011). *Algebra and trigonometry*. Jones & Bartlett Publishers.
2. Aufmann, R. N., Barker, V. C., & Nation, R. D. (2010). *College algebra and trigonometry*. Cengage Learning.
3. Christy, D. T., & Levine, D. R. (1989). *Fundamentals of Algebra and Trigonometry:* Bender, C. M., Orszag, S., & Orszag, S. A. (1999). *Advanced mathematical methods for scientists and engineers I: Asymptotic methods and perturbation theory* (Vol. 1). Springer Science & Business Media.
4. Stewart, J., Redlin, L., & Watson, S. (2015). *Algebra and trigonometry*. Cengage Learning.

HYD-110 HYDROMETEOROLOGY (THEORY) (02 Credit hrs)

PRE-REQUISITE: HYD-103 Introduction to Hydrology

LEARNING OUTCOMES:

- This course will provide an introduction to the hydrometeorology to the students.
- The students will learn about the Air masses, Air fronts and the associated weathers.
- They will have the knowledge about different thermal and moist process in atmosphere.
- The students will get learn about formation and types of clouds and associated precipitations.
- They will become conversant with meteorological observations and instruments used.
- Student will be able to perform different analysis on the hydrometeorological data sets.

CONTENTS

This course provides an introduction to the hydrometeorology, weather, climate, precipitation, air masses and fronts, atmospheric stability and clouds, atmospheric process and circulation.

THEORY

Unit-I: Introduction

1.1 Basics of hydrometeorology
1.2 Applications of hydrometeorology
1.3 Local and global aspects of meteorology
1.4 Climate and weather. Seasons,
1.5 Structure of Earth's atmosphere
1.6 Energy and energy balance

Unit-II: Air Masses and Fronts

2.1. Air masses and its types
2.2. Atmospheric motion
2.3. Fronts, cold front, warm front, stationary fronts and associated weather systems

Unit-III: Atmospheric Process

3.1. Thermal processes
3.2. Adiabatic and nonadiabatic processes
3.3. Laps rates
3.4. Moist processes
3.5. Condensation, air mass lifting, latent heat

Unit-IV: Clouds

4.1. Atmospheric stability and cloud formation.
4.2. Types and properties of clouds and associated weather

Unit-V: Observations:

5.1. Instruments for hydro meteorological data observation.
5.2. Hydro-meteorological network design and planning.
5.3. Climatological data measurements and accuracy.

Unit-VI: Precipitation analysis

6.1. Probable maximum precipitation
6.2. Depth-area-duration analysis
6.3. Intensity duration frequency analysis
6.4. Antecedent precipitation index

Unit-VII: Atmospheric Circulation Systems

7.1. Scales of Atmospheric Motion
7.2. Global Scale Circulation
7.3. Cyclones and Anticyclones
7.4. Monsoon Circulation, Small Scale Circulations

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
1.	Mid Term Assessment	35%	It takes place at the mid-point of the semester
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3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Shonk, J. (2013) *Introducing Meteorology: A Guide to the Weather (Introducing Earth and Environmental Sciences*) Dunedin Academic Press ISBN-13: 978-1780460024
2. Lackmann, G. (2012) *Multitude Synoptic Meteorology: Dynamics, Analysis, and Forecasting* American Meteorological Society ISBN-13: 978-1878220103
3. Ahrens, C, D. (2008) *Meteorology Today: An Introduction to Weather, Climate, and the Environment, 9th Edition* Cengage Learning ISBN-13: 978-0495555735
4. Ahrens, C, D. and Henson, R. (2017) *Essentials of Meteorology: An Invitation to the Atmosphere (Mind Tap Course List) 8th Edition* Cengage Learning ISBN-13: 978-1305628458
5. Ackerman, S, A. and Knox, J, A. (2013) *Meteorology: Understanding the Atmosphere 4th Edition* Jones & Bartlett Learning ISBN-13: 978-1284030808
6. Ahrens, C, D. (2014) *Essentials of Meteorology: An Invitation to the Atmosphere 7th Edition* Cengage Learning ISBN-13: 978-1285462363

HYD-110 HYDROMETEOROLOGY (LAB) (01 Credit hr)

PRE-REQUISITE: HYD-103 Introduction to Hydrology

LEARNING OUTCOMES:

- This course will provide practical aspects of hydrometeorology.
- The students will learn about the weather observatories and the equipment.
- They will have the knowledge about the measurement of atmospheric temperature and soil temperature.
- The students will get knowledge about the measure of other hydro climatological variables like precipitation, evaporation, wind speed etc.
- They will become conversant with estimation of evapotranspiration.

CONTENTS

This course provides an introduction to the practical measurements, calculations, and evaluation of meteorological phenomena in hydrology.

PRACTICAL

Unit-I: Introduction to Weather Observatory

1.1 Weather Instruments
1.2 Handling of meteorological instruments and weather data recording
1.3 Site selection, and considerations and precautions for weather observations

Unit-II: Weather Data:

2.1. Processing and tabulation of weather data
2.2. Presentation of weather data
2.3. Analysis of temperature and precipitation data

Unit III: Measurement of Temperature:

3.1. Measurement of maximum and minimum temperature
3.2. Measurement of soil temperature
3.3. Measurement of dew point temperature
3.4. Dry bulb and wet bulb thermometers

Unit-IV: Measurement of Precipitation:

4.1. Measurement of Precipitation
4.2. Recording and non-recording gauge
4.3. Measurement of snow

Unit-V: Estimation of Evaporation and Evapotranspiration

5.1. Measurement of wind direction and speed
5.2. Measurement and determination of evaporation
5.3. Measurement of transpiration
5.4. Solar radiation, estimation of evapotranspiration using different techniques.

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

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- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

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1. Shonk, J. (2013) *Introducing Meteorology: A Guide to the Weather (Introducing Earth and Environmental Sciences*) Dunedin Academic Press ISBN-13: 978-1780460024
2. Lackmann, G. (2012) *Multitude Synoptic Meteorology: Dynamics, Analysis, and Forecasting* American Meteorological Society ISBN-13: 978-1878220103
3. Ahrens, C, D. (2008) *Meteorology Today: An Introduction to Weather, Climate, and the Environment, 9th Edition* Cengage Learning ISBN-13: 978-0495555735
4. Ahrens, C, D. and Henson, R. (2017) *Essentials of Meteorology: An Invitation to the Atmosphere (Mind Tap Course List) 8th Edition* Cengage Learning ISBN-13: 978-1305628458
5. Ackerman, S, A. and Knox, J, A. (2013) *Meteorology: Understanding the Atmosphere 4th Edition* Jones & Bartlett Learning ISBN-13: 978-1284030808

HYD-111: SURVEYING TECHNIQUES FOR WATER RESOURCES DEVELOPMENT (THEORY)
(02 Credit hrs)

PRE-REQUISITE: F.Sc. or equivalent

LEARNING OUTCOMES:

- This course will provide an introduction to the surveying and leveling to the students.
- The students will learn about the different equipment used for surveying and leveling
- They will have the knowledge about various types of surveying like compass survey and plane table survey etc.
- The students will get knowledge about various types of leveling techniques, computations of area and volumes, Cut-fill ratio and earthwork calculations etc.
- Students will get knowledge about modern instruments used for surveying and leveling purposes.

CONTENT

This course is designed to provide Introduction to the principles and practices of surveying and leveling techniques, methods and applications in water resources management.

THEORY

Unit-1 Introduction to Surveying:

1.1. Introduction to Surveying:
1.2. Definition; importance, types of survey
1.3. Planning survey and leveling of an area
1.4. Surveying Instruments
1.5. Chains, tapes, steel bands, their types and uses, GPS

Unit-II Compass Surveying:

2.1. Prismatic compass survey
2.2. Surveyor compass, uses
2.3. Bearing
2.4. Local attraction

Unit-III: Plane Table Surveying:

3.1. Parts and accessories
3.2. methods of plane table surveying and topographic mapping
3.3. Contour map preparation and uses, contour lines
3.4. Two point and three-point problems

Unit-IV: Introduction to Leveling:

4.1. Definition, benefits, general principles and methods of leveling
4.2. Types and uses of levels
4.3. Trigonometric leveling
4.4. Leveling instruments/equipment
4.5. Temporary and permanent adjustments of levels
4.6. computation of areas and volumes
4.7. Precision land leveling, land grading
4.8. Cut-fill ratio and earthwork calculations
4.9. Measurement of area, cross-section, elevations, contour lines, mass diagram, planimeter and its uses.

Unit-V: Modern Survey Instruments:

5.1. Total station, theodolites, electronic distance measurement (EDM), GPS
5.2. Temporary and permanent adjustments
5.3. Measurement of horizontal and vertical distances and angles
5.4. Control hydrographic surveys

5.5. Photogrammetry and GPS surveys

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

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- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

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RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Wolf P. R. & Ghilani C. D., (2012), *Elementary Surveying – An introduction to Geomatics*, 13th Edition, Prentice Hall, USA.
2. Thomas, M. Lillesand & Ralph W. Kiefer, (2005), *Remote Sensing and Images Interpretation*, 5th edition, John Wiley & Sons, Inc.
3. Kavanagh Barry, (2010), *Surveying with Construction Applications*, 7th Edition, Pearsons Education.
4. havikatti, S. S. (2008). *Surveying and Levelling*, Volume 1. I. K. International Pvt Ltd, India
5. Kanetkar, T.P. (2006). *Surveying and Leveling* (Part 1). Pune Vidyarthi Griha Prakashan, India.
6. Johnson, A. (2004). *Plane and Geodetic Surveying*. Spon Press, London.
7. Schofield, W., and Breach, M. (2007). *Engineering Surveying*. Butterworth-Heinemann Burlington, MA, USA.
8. Brinker, A.C. and Taylor, W.C. (2002). *Elementary Surveying*. International Textbook Co. Scranton, Pennsylvania.

HYD-111: SURVEYING TECHNIQUES FOR WATER RESOURCES DEVELOPMENT (LAB)

(01 Credit hr)

PRE-REQUISITE: F.Sc. or equivalent

LEARNING OUTCOMES

- This course will provide practical demonstrations on various equipment used for surveying and leveling.
- The students will learn about the practical applications of surveying and leveling in water resources management
- They will learn how to set up instruments and perform different types of surveying and leveling procedures

CONTENTS

This course is designed to make student practices on surveying and levelling equipment, performing different methods to plan and conduct survey and levelling of an area using different methods and well as related calculations.

PRACTICAL

Unit-I Surveying in Water Management

1.1. Introduction to Surveying equipment and demonstrations
1.2. Measurement of distances by different methods, pacing, Chain and Tape Survey
1.3. Plane Table Survey, Compass surveying and traversing
1.4. Profile and cross-sectioning
1.5. Coordinates and area determination using GPS

Unit-II: Leveling in Water Management

2.1. Introduction to the leveling equipment and demonstrations, level books
2.2. Setting up, elimination of parallax, Level adjustments by two-peg method
2.3. Theodolite traversing,
2.4. Contour mapping through Surfer software
2.5. Total station demonstration

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

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- classroom participation,
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- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

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RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Wolf P. R. & Ghilani C. D., (2012), *Elementary Surveying – An introduction to Geomatics*, 13th Edition, Prentice Hall, USA.
2. Thomas, M. Lillesand & Ralph W. Kiefer, (2005), *Remote Sensing and Images Interpretation*, 5th edition, John Wiley & Sons, Inc.
3. Kavanagh Barry, (2010), *Surveying with Construction Applications*, 7th Edition, Pearsons Education.
4. havikatti, S. S. (2008). *Surveying and Levelling*, Volume 1. I. K. International Pvt Ltd, India
5. Kanetkar, T.P. (2006). *Surveying and Leveling* (Part 1). Pune Vidyarthi Griha Prakashan, India.
6. Johnson, A. (2004). *Plane and Geodetic Surveying*. Spon Press, London.
7. Schofield, W., and Breach, M. (2007). *Engineering Surveying*. Butterworth-Heinemann Burlington, MA, USA.
8. Brinker, A.C. and Taylor, W.C. (2002). *Elementary Surveying*. International Textbook Co. Scranton, Pennsylvania.

2nd YEAR, THIRD SEMESTER				
Sr. #	**Code**	**Course Title**	**Course Type**	**Credit Hours**
1.	HQ-03	Translation of Holy Quran	Compulsory	Non Credit
2.	HYD-201	English-III Technical Writing and Presentation Skills	Compulsory	03
3.	HYD-202	Groundwater Development and Exploration	Foundation	2+1
4.	HYD-203	Introduction to Remote sensing and GIS	Major	02+1
5.	HYD-204	Statistical Methods in Hydrology	Major	02+1
6.	HYD-205	Irrigation-I	Major	02+1
7.	HYD-206	Hydrometry	Major	02+1
			Total Credit hrs Semester-III	**18**

HQ-03: TRANSLATION OF HOLY QURAN (Non Credit)

PRE-REQUISITE: HQ-02 Translation of Holy Quran

COURSE OUTLINE

سورة الاعراف تا سورة يونس

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after mid term assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

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3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

HYD-201 ENGLISH-III TECHNICAL WRITING AND PRESENTATION SKILLS (03 Credit hrs)

PRE-REQUISITE: HYD-107 English-II Communication Skills.

LEARNING OUTCOMES:

Followings will be learning outcomes of this subject

- Student will learn technical writing
- Student will learn Academic skills
- Student will learn Presentation skills

CONTENTS

This course provides an introduction to the English language, enhance English skills for technical writing.

Unit-I Presentation skills

Unit-II Essay Writing

2.1. Descriptive (Job Description, Observation Report, Incident Report, CV, Process Description, Book Review, Email Message, Webpage, Memo, Agenda, Letter of Recommendation, Survey, Training Manual, Meeting Minutes, Newsletter, Marketing Plan, Poster, Brochure, Catalog)
2.2. Narrative (Observation and/or Progress Report).
2.3. Discursive
2.4. Argumentative

Unit-III: Academic Writing

3.1. Academic writing
3.2. How to write a proposal for research paper/term paper?
3.3. How to write a research paper/term paper?
3.4. Emphasis on style, content, language, form, clarity, consistency

Unit-IV: Technical Writing

4.1. Technical Report
4.2. Writing Progress report writing.

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

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- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

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3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. White, R. (1992). *Writing. Advanced Oxford Supplementary Skills.* Third Impression ISBN 0 19 435407 3 (particularly suitable for discursive, descriptive, argumentative and report writing).
2. Langan, J. (2004). *College Writing Skills* McGraw-Hill Higher Education.
3. Laurie G. Kirszner and Stephen R. Mandell. *Patterns of College Writing (4th edition)* St. Martin's Press.

HYD-202 GROUNDWATER DEVELOPMENT AND EXPLORATION (THEORY) (02 Credit hrs)

PRE-REQUISITE: HYD-106 Fundamentals of Groundwater Hydrology

LEARNING OUTCOMES

- This course will provide practical demonstrations on Reconnaissance survey and geological mapping
- The students will learn about the practical applications of Subsurface Investigation for water resources development
- They will learn how to set water wells, construction and their performance

CONTENTS

This course provides an introduction to understanding of groundwater development and investigation techniques.

Unit-I Introduction

1.1. Groundwater facts & Historical Background
1.2. Recent Developments in Groundwater
1.3. Groundwater in Hydrologic Cycle
1.4. Hydrologic Budget
1.5. Groundwater Resources and use in Pakistan

Unit-II Groundwater Occurrence

2.1. Origin and Age of Groundwater
2.2. Water Zones below the surface
2.3. Soil Moisture & Soil Water
2.4. Zone's properties and their relationship
2.5. Measurement of water content

Unit-III Groundwater Flow

3.1. Water Flow in soils and rocks
3.2. Permeability, Intrinsic permeability concepts
3.3. Hydraulic Conductivity
3.4. Determination of Hydraulic Conductivity
3.5. Pumping and Slug Test

Unit-IV Groundwater Development

4.1. Groundwater Development and Surveying
4.2. Construction of abstraction system
4.3. Groundwater resources historical developments
4.4. Groundwater use, advantages, and limitations
4.5. Problems of GW Development in Pakistan
4.6. Problems of GW Management

Unit-V Investigation of Groundwater

5.1. Geophysical methods of GW development
5.2. Electrical Resistivity method
5.3. Gravity Geophysical method
5.4. Electromagnetic method
5.5. Geothermal and Seismic methods

Unit-V Water Well Design & Construction

6.1 Stages of Well Design

6.2 Drilling Methods
6.3 Drilling Fluids
6.4 Well Logging
6.5 Well Development Techniques

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
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3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Mandel, S. (2012). *Groundwater Resources: Investigation and Development*. Elsevier, ISBN 0323157823, 9780323157827
2. Kresic, N., (2009). *Groundwater Resources: Sustainability, Management, and Restoration*. McGraw Hill, ISBN-10: 0071492739 | ISBN-13: 978-0071492737
3. Todd, D.K. and Mays, L. W. (2005). *Groundwater Hydrology*. 3rd ed., Hoboken: John Wiley & Sons.

HYD-202: GROUNDWATER DEVELOPMENT AND EXPLORATION (LAB) (01 Credit hr)

PRE-REQUISITE: HYD-106 Fundamentals of Groundwater Hydrology

LEARNING OUTCOMES

- This course will provide practical demonstrations on Interpretation geological maps
- The students will learn about the practical applications of Subsurface Investigation for water resources development
- They will learn how to set Pumping wells, construction and their performance

CONTENTS

This course provides an introduction to understanding of groundwater development and investigation techniques.

PRACTICAL

Unit-I

1.1. Water Table Contouring

Unit-II

2.1. Interpretation of Geological Maps

Unit-III

3.1. Aquifer Testing: General and Theis Solution

Unit-IV

4.1. Aquifer Testing: Diagnostic plots and Cooper Jacob solution

Unit-V

5.1 Aquifer Testing: Cooper Jacob solution II & III

Unit-VI

6.1 Well Logging Techniques and their use

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
1.	Mid Term Assessment	35%	It takes place at the mid-point of the semester
2.	Formative Assessment	25%	It is continuous assessment. It includes: classroom participation, attendance, assignments and presentation, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Mandel, S. (2012). *Groundwater Resources: Investigation and Development*. Elsevier, ISBN 0323157823, 9780323157827
2. Kresic, N., (2009). *Groundwater Resources: Sustainability, Management, and Restoration*. McGraw Hill, ISBN-10: 0071492739 | ISBN-13: 978-0071492737
3. Todd, D.K. and Mays, L. W. (2005). *Groundwater Hydrology*. 3rd ed., Hoboken: John Wiley & Sons.

HYD-203 INTRODUCTION TO REMOTE SENSING AND GIS (THEORY) (02 Credit hrs)

PRE-REQUISITE: HYD-108 Computer Applications in Hydrology

LEARNING OUTCOMES:

- The course emphasizes on an integrative and interdisciplinary approach to spatial decision-making and problem solving, and gives an introduction to GIS in hydrology.
- The students will learn about different spatial data structures, data capture, analysis and map making.
- The students will be Introduced to the software (basic functions); Data acquisition; Alphanumerical information;
- They will conduct exercises on queries, selection; Coordinate systems, Geo referencing; Database design; Spatial analysis; Matrix models (DEM); Geographical Information Editing.
- The students will be equipped with various image processing techniques.

CONTENTS

Unit-1 Introduction:

1.1. Application of remote sensing in meteorology
1.2. Application of remote sensing in hydrology.
1.3. Sources of remoter sensing information.

Unit-II Aerial photographs and multispectral images

2.1. Characteristics of aerial photographs
2.2. Photomosaic phenomena
2.3. Stereo pairs its significance in water management
2.4. Black and White photographs, history, and development.
2.5. Advent of Color science

Unit-III: Land use and land cover analysis.

3.1. Manned satellite images, theory and importance
3.2. Gemini and Apollo mission's history and significance
3.3. Skylab, space shuttle, source of images.
3.4. Landsat images: satellite platforms and orbit patterns
3.5. Multispectral scanner system
3.6. Thematic mapper system

Unit-IV Landsat mosaics:

4.1. Interpretation methods in GIS/RS science.
4.2. Thermal infrared images, its characteristics and importance.
4.3. Thermal processes and their properties
4.4. Land use and Land cover analysis.

Unit-V Digital image processing:

5.1. Image structure
5.2. Image Processing
5.3. Image restoration and enhancement
5.4. Information extraction from imagery
5.5. Resource exploration for agriculture, irrigation system, snow cover and geology

Unit-VI: Environmental Application of GIS/RS

6.1. Environmental application of GIS/RS
6.2. Natural hazards applications,
6.3. Floods monitoring and Drought forecasting

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS

Sr. No.	Elements	Weightage	Details
1.	Mid Term Assessment	35%	It takes place at the mid-point of the semester
2.	Formative Assessment	25%	It is continuous assessment. It includes: classroom participation, attendance, assignments and presentation, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Brown, C. And Harder, C., (2016). *The ArcGIS Imagery Book*. Esri Press, Redlands, Californinia.
2. Heywood, i., Cornelius, A. and Carver, S., (2006). *An introduction to Geographical Information Systems*. 3rd ed.Perason Education Limited.
3. Jansen, M., Judas, M.E. and Saborowski, J., (2002). *Spatial Modelling in Forest Ecology and management*- A Case Study. Springer 223.
4. Rao, D.P., (1998). *Remote Sensing for Earth Resources*, Association of Exploration Geophysicist, Hyderabad.
5. Zeiler, Michael, (1999). *Modeling Our World*: The ESRI Guide to Geodatabase Design. ESRI Press, 216 pp.

HYD-203 INTRODUCTION TO REMOTE SENSING AND GIS (LAB) (01 Credit hr)

PRE-REQUISITE: HYD-108 Computer Applications in Hydrology

LEARNING OUTCOMES:

- The practical exercises will cover classical cartographic concepts, as well as modern concepts of digital GIS.
- The course emphasizes on an integrative and interdisciplinary approach to spatial decision-making and problem solving, and gives an introduction to GIS in hydrology.
- The students will learn about different spatial data structures, data capture, analysis and map making.
- The students will be Introduced to the software (basic functions); Data acquisition; Alphanumerical information;
- They will conduct exercises on queries, selection; Coordinate systems, Geo referencing; Database design; Spatial analysis; Matrix models (DEM); Geographical Information Editing.

CONTENTS

Unit-I

1.1 To acquaint the students, with the understanding of methods of GIS and remote sensing.

Unit-II

2.1 Introduction to ArcGIS and QGIS.

Unit-III

3.1 Use of ERDAS-Imagine software for water data analysis.

Unit-IV

4.1 Coupling of GIS with Surface/Groundwater Models.

Unit-V

5.1 Hands on exercises on data analysis and image analysis using different software's.

Unit-VI

6.1 Field Visit to SUPARCO and other allied departments

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

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3. Jansen, M., Judas, M.E. and Saborowski, J., (2002). *Spatial Modelling in Forest Ecology and management*- A Case Study. Springer 223.
4. Rao, D.P., (1998). *Remote Sensing for Earth Resources*, Association of Exploration Geophysicist, Hyderabad.
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HYD-204: STATISTICAL METHODS IN HYDROLOGY (THEORY) (02 credit hrs)

PRE-REQUISITE: F.Sc. or equivalent

LEARNING OUTCOMES

- This course will provide an introduction to the basic concepts of statistics and its application in hydrology.
- The students will learn to perform various statistical analyses (consistency and homogeneity test, estimating the measures of central tendency, dispersion and symmetry etc.) on hydrological data.
- The students will learn the concepts of frequency distributions and learn about flood frequency analysis
- The students will get used to the concepts of hypothesis testing.
- Students will learn about the correlations and regression analysis.

CONTENTS

This course provides an introduction to the statistical theories, flood frequency analysis and probability theories and their applications in hydrology. This course will also provide an correlation and regression analyses as well as hypothesis testing.

THEORY

Unit-I: Introduction and Basic Concepts

1.1. Introduction to Statistics and definitions
1.2. Applications of Statistics in Hydrology
1.3. Statistical presentation of Hydrologic data
1.4. Consistency and homogeneity of data
1.5. Probability and Axioms of Probabilities
1.6. Properties of Random Variable

Unit-II: Statistical Analysis of Hydrological Data

2.1. **M**easures of central tendency, dispersion and symmetry.
2.2. Expectation and estimation.
2.3. Discrete and continuous probability distributions, especially normal and extreme-value distributions.

Unit-III: Frequency Analysis

3.1. Return Period
3.2. Extreme Value Distributions
3.3. Frequency Analysis using Frequency Factors
3.4. Probability Plotting
3.5. Confidence Limits

Unit-IV: Correlation and Regression

4.1. Correlation Analysis, Serial or Auto-Correlation, Cross-Correlation, Inferences on Correlation Coefficient, Kendall's Rank Correlation Test
4.2. Simple Linear Regression, Estimation of Parameters, Goodness of Regression
4.3. Multiple Linear Regression, Estimation of Parameters, Goodness of Regression

Unit-V: Hypothesis Testing

5.1. The t-distribution
5.2. Chi-Square Distribution
5.3. Tests Concerning Variances of Two Populations

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

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- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS

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RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Haan, C, T. (1977). *Statistical Methods in Hydrology* 1st Edition Iowa State Pr ISBN-13: 978-0813815107
2. Harvey J. E. Rodda, Max A. Little (2016). *Understanding Mathematical and Statistical Techniques in Hydrology an Examples-based Approach 1st Edition* Wiley-Blackwell ISBN-13: 978-1444335491
3. Vujica V. Yevjevich (2010). *Probability and Statistics in Hydrology Second Edition* Water Resources Pubns ISBN-13: 978-1887201605
4. Maity, R. (2018). *Statistical Methods in Hydrology and Hydro climatology (Springer Transactions in Civil and Environmental Engineering) 1st ed* Springer ISBN-13: 978-9811087783
5. Haan, C.T., (2002) *Statistical Methods in Hydrology, 2nd edition*, Iowa State Press,

HYD-204: STATISTICAL METHODS IN HYDROLOGY (LAB) (01 Credit hr)

PRE-REQUISITE: F.Sc. or equivalent

LEARNING OUTCOMES:

- This course will get practical knowledge about the statistical applications in hydrology.
- The students will be able to calculate the measures of central tendency, dispersion and symmetry for different hydrometer logical variables.
- They will practice on distribution fitting and parameter estimation techniques.
- The students will be able to perform flood frequency analyses on real flow data
- They will become conversant with different software packages and their applications in performing statistical analysis on hydrological data.

CONTENTS

This course if design to make student learn about various statistical analysis on hydrological records along with the practical applications on probability distributions, frequency analysis using real hydrological data. This course also includes practical applications of different software's packages for statistical analyses in hydrology.

PRACTICAL

Unit-I: Statistical Analysis of Hydrological Data

1.1. Practical examples on measures of central tendency, dispersion and symmetry
1.2. Estimation of correlation of different hydrometeorological variables
1.3. Practical applications of simple and multiple regression analysis for hydrological data sets

Unit-II: Probability Distributions

2.1. Distribution fitting
2.2. Parameter estimation problems
2.3. Comparisons of different frequency distributions goodness of fit analysis

Unit-III: Frequency Analyses

3.1. Estimation return levels and return periods for hydrological data using frequency distributions
3.2. Flood frequency analysis of different rivers of Pakistan

Unit-IV Software Packages for Statistics

4.1. Statistical Analysis using MS Excel
4.2. Introduction to R- Programming for Statically analysis of Hydrological data
4.3. Introduction to MATLAB- Programming for Statistical analysis of Hydrological data

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

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- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

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2. Harvey J. E. Rodda, Max A. Little (2016). *Understanding Mathematical and Statistical Techniques in Hydrology an Examples-based Approach 1st Edition* Wiley-Blackwell ISBN-13: 978-1444335491
3. Vujica V. Yevjevich (2010). *Probability and Statistics in Hydrology Second Edition* Water Resources Pubns ISBN-13: 978-1887201605
4. Maity, R. (2018). *Statistical Methods in Hydrology and Hydro climatology (Springer Transactions in Civil and Environmental Engineering) 1st ed* Springer ISBN-13: 978-9811087783
5. Haan, C.T., (2002) *Statistical Methods in Hydrology*, *2nd edition*, Iowa State Press,

HYD-205: IRRIGATION-I (THEORY) (03 Credit hrs)

PRE-REQUISITE: F.Sc. or equivalent

LEARNING OUTCOMES:

- This course will provide an introduction to the irrigation and its objectives to the students.
- The students will learn about the different types of irrigation systems and their advantages and disadvantages
- They will have the knowledge about the concepts of crop water requirement of irrigation scheduling
- The students will learn about irrigation canals, types and design considerations
- They will become conversant with flow measurements using different hydraulic structures

CONTENTS

This course includes introduction to the principles and various practices of irrigation, basic concepts regarding crop water requirements, Canal Irrigation system as well as measurement of flow.

THEORY

Unit- 1 Introduction:

1.1. Introduction to irrigation, Definition of Irrigation
1.2. Necessity and Advantages of Irrigation
1.3. An overview on hydrology and water resources of Pakistan
1.4. Quality of Irrigation Water

Unit-II: Types of Irrigation:

2.1. Surface Irrigation methods, Free flooding, Check flooding, Furrow irrigation method, Drip irrigation method, Border irrigation, Basin Irrigation, Sprinkler irrigation.
2.2. Subsurface Irrigation methods

Unit-III: Crop Water Requirement

3.1. Crop period or Base Period
3.2. Duty and Delta of a Crop
3.3. Irrigation Efficiencies
3.4. Consumptive Use or Evapotranspiration and Estimation of Consumptive Use
3.5. Effective Rainfall
3.6. Net Irrigation Requirement
3.7. Soil-Moisture-Irrigation Relationship
3.8. Estimating Depth and Frequency of Irrigation on the Basis of Soil Moisture Regime Concept

Unit-IV: Irrigation Canals

4.1. Important Definitions; and types of Canals
4.2. Alignment of Canals, watershed canal or ridge canal, contour canal; and side-slope canals
4.3. Distribution System for Canal Irrigation, Main canal; Branch canals; Distributaries, also called major distributaries; Minors, also called minor distributaries, Watercourses.
4.4. Curves in Channels
4.5. Gross Command Area, Culturable or Cultivable Command Area, Intensity of Irrigation, Time Factor, Capacity Factor Computing the Design Capacity of an Irrigation Canal, Canal Regulation and Warabandi

Unit-V: Hydraulic Structures

5.1. Weirs, types and design considerations
5.2. Flumes, types and design considerations
5.3. Outlets

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
1.	Mid Term Assessment	35%	It takes place at the mid-point of the semester
2.	Formative Assessment	25%	It is continuous assessment. It includes: classroom participation, attendance, assignments and presentation, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
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RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Withers, B., and Vipond, S. (1980). *Irrigation Design and Practice*. Batsford London.
2. Kay, M. (1983). *Sprinkler Irrigation*. Batsford, London, 120 pp.
3. Kay, M. (1986). *Surface Irrigation*. Cranfield Press. Bedford, 142 pp.
4. Smedema, L.K and Rycroft, D.W. (1983). *Land Drainage*. Batsford, London.
5. Kay, M. (2007). *Practical Hydraulics*. 2nd Ed., Taylor and Francis, London

HYD-205 IRRIGATION-I (Lab) (01 Credit hr)

PRE-REQUISITE: F.Sc. or Equivalent

LEARNING OUTCOMES:

- Student will learn different methods to calculate consumptive use of water for different crops.
- This course will learn step by step procedure to calculate crop water requirements.
- Student will get practical understanding of irrigation scheduling.
- The students will learn how to measure flow using different hydraulic structures like weirs and flumes.
- Students will also perform a comparative analysis of different irrigations systems

CONTENTS

This course also provides a practical calculation regarding consumptive use of a crop, crop water requirements and irrigation scheduling. This course also includes measurements of flow using different hydraulic structures.

PRACTICAL

Unit-I Irrigation Scheduling and Crop water requirement

1.1. Solution of practical problems for estimation of irrigation efficiencies
1.2. Estimation of Consumptive Use by using different methods
1.3. Estimation of Crop water requirements for selected crops

Unit-II Flow Measurements

2.1. Practical demonstrations and calculations for flow measurement using different type of Weirs
2.2. Practical demonstrations and calculations for flow measurement using different type of Flumes

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS

Sr. No.	Elements	Weightage	Details
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2.	Formative Assessment	25%	It is continuous assessment. It includes: classroom participation, attendance, assignments and presentation, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
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2. Kay, M. (1983). *Sprinkler Irrigation*. Batsford, London, 120 pp.
3. Kay, M. (1986). *Surface Irrigation*. Cranfield Press. Bedford, 142 pp.
4. Smedema, L.K and Rycroft, D.W. (1983). *Land Drainage*. Batsford, London.
5. Kay, M. (2007). *Practical Hydraulics*. 2nd Ed., Taylor and Francis, London

HYD-206 HYDROMETRY (THEORY) (02 Credit hrs)

PRE-REQUISITE: HYD-103 Introduction to hydrology

LEARNING OUTCOMES:

- This course will provide an introduction to the metrological science and fundamentals of Hydrometry.
- The students will learn about Units & measurement techniques.
- They will have the knowledge about different measurement instruments.
- The students will get used to velocity determination methods.
- The students will be equipped with the climatology & sedimentation.
- They will become conversant with sedimentation process.

CONTENTS

Unit-I Introduction

1.1. Introduction to metrological science
1.2. Fundamental of Hydrometry
1.3. Measurement Units
1.4. Hydrologic Cycle

Unit-II: Units & Measurement Techniques

2.1. Measurement methods in hydrology
2.2. Flow measurement velocity-area method
2.3. Measurement of stage
2.4. State-discharge relationships

Unit –III: Measurement Instrumentation

3.1. Current meters
3.2. Slope-area method
3.3. Weirs and flumes
3.4. Ultrasonic cross-path method
3.5. Electromagnetic methods

Unit-IV: Velocity Determination methods

4.1. Acoustic Doppler velocity meters
4.2. Local methods
4.3. Rain measurements and rain gauges

Unit-V: Climatology

5.1. Measurements of weather parameters
5.2. Water table measurements methods and techniques

Unit-VI: Sedimentation

6.1. Sediments measuring methods and instruments
6.2. Remote sensing techniques in Hydrometry

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS

Sr. No.	Elements	Weightage	Details
1.	Mid Term Assessment	35%	It takes place at the mid-point of the semester
2.	Formative Assessment	25%	It is continuous assessment. It includes: classroom participation, attendance, assignments and presentation, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Boiten W. (2013) *Hydrometry*: IHE Delft Lecture Note Series, CRC Press, ISBN 9789054104230
2. Boiten W., (2007) *Hydrometry* (IHE Delft Lecture Note Series) 1st Edition, Kindle Edition. Wiley, ASIN: B000Q361PE
3. Gupta S.V., (2002) *Practical Density Measurement and Hydrometry* (Series in Measurement Science and Technology) 1st Edition, CRC Press. ISBN-13: 978-0750308472
4. Herschy, R.W., (1999). *Hydrometry: Principles and Practice*. 2nd Ed., Wiley. ISBN-13: 978-0471973508
5. Herschy, R.W., (2008). *Streamflow Measurement.* 3rd Ed., CRC Press. ISBN-13: 978-0415413428
6. Shaw E. M., Beven K. J., Chappell N. A., Lamb R., (2010) *Hydrology in Practice* 4th Edition, CRC Press. ISBN-13: 978-0415370424
7. Stevenson D., (2017) *A Treatise on the Application of Marine Surveying Hydrometry*: To the Practice of Civil Engineering, Forgotten Books. ISBN-13: 978-1332001354

HYD-206 HYDROMETRY (LAB) (01 Credit hrs)

PRE-REQUISITE: HYD-103 Introduction to hydrology

LEARNING OUTCOMES:

- This course will provide an introduction to the metrological science and fundamentals of Hydrometry.
- The students will learn about Units & measurement techniques.
- They will have the knowledge about different measurement instruments.

CONTENTS

Unit-I Hydrological Measurements

1.1. Fundamental of Hydrometry
1.2. Measurement Units
1.3. Discharge Measurements
1.4. Precipitation measurements

Unit –II: Instrumentation for hydrological measurements

2.1. Current meters
2.2. Slope-area method
2.3. Weirs and flumes
2.4. Ultrasonic cross-path method
2.5. Electromagnetic methods

Unit-III: Velocity Determination methods

3.1. Acoustic Doppler velocity meters
3.2. Local methods
3.3. Rain measurements and rain gauges
3.4. Sediments measuring methods and instruments
3.5. Remote sensing techniques in Hydrometry

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS

Sr. No.	Elements	Weightage	Details
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2. Boiten W., (2007) *Hydrometry* (IHE Delft Lecture Note Series) 1st Edition, Kindle Edition. Wiley, ASIN: B000Q361PE
3. Gupta S.V., (2002) *Practical Density Measurement and Hydrometry* (Series in Measurement Science and Technology) 1st Edition, CRC Press. ISBN-13: 978-0750308472
4. Herschy, R.W., (1999). *Hydrometry: Principles and Practice*. 2nd Ed., Wiley. ISBN-13: 978-0471973508
5. Herschy, R.W., (2008). *Streamflow Measurement.* 3rd Ed., CRC Press. ISBN-13: 978-0415413428
6. Shaw E. M., Beven K. J., Chappell N. A., Lamb R., (2010) *Hydrology in Practice* 4th Edition, CRC Press. ISBN-13: 978-0415370424
7. Stevenson D., (2017) *A Treatise on the Application of Marine Surveying Hydrometry*: To the Practice of Civil Engineering, Forgotten Books. ISBN-13: 978-1332001354

2nd YEAR, FOURTH SEMESTER				
Sr. #	**Code**	**Course Title**	**Course Type**	**Credit Hours**
1.	HQ-04	Translation of Holy Quran	Compulsory	01
2.	HYD-207	Watershed Modeling	Foundation	02+1
3.	HYD-208	Application of Economics in Water Resources Management	Major	03
4.	HYD-209	Pakistan Studies	Compulsory	02
5.	HYD-210	Integrated Water Resources Management	Major	02
6.	HYD-211	Applied Climatology	Elective	02+1
7.	HYD-212	Urban Hydrology	Elective	02+1
8.	HYD-213	Hydrological Field Studies I	Compulsory	01
			Total Credit hrs Semester-IV	**18**

HQ-04: TRANSLATION OF HOLY QURAN (01 Credit Hrs)

PRE-REQUISITE: HQ-03 Translation of Holy Quran

COURSE OUTLINE

سورة هود تا سورة الكهف

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after mid term assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
1.	Mid Term Assessment	35%	It takes place at the mid-point of the semester
2.	Formative Assessment	25%	It is continuous assessment. It includes: classroom participation, attendance, assignments and presentation, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

HYD-207: WATERSHED MODELING (THEORY) (02 Credit hours)

PRE-REQUISITE: HYD-108 Computer Applications in Hydrology

LEARNING OUTCOMES

Following are the learning outcomes of the course:

- Student will learn about Introduction to Catchment Modeling
- Student will learn about Catchment Characteristics
- Student will learn about Types of Models
- Student will learn about Applications of Different Models to Execute Catchment Modeling

CONTENTS

Introduction to the principles and practices of catchment modeling, watershed analysis and rainfall runoff modeling.

THEORY

Unit-I: Introduction to Catchment Modeling

1.1. Introduction to catchment modeling.
1.2. Catchment processes and hydrologic losses
1.3. Evaporation
1.4. Interception
1.5. Infiltration
1.6. Water storage

Unit-II Catchment Characteristics

2.1. Catchment characteristic and morphology
2.2. Runoff generation
2.3. Types of runoff, factors effecting runoff
2.4. Theories of runoff generation

Unit-III: Types of Models

3.1. Conceptual watershed modeling
3.2. Computer simulation approaches in catchment hydrology,
3.3. Types of catchment models,
3.4. Black box models
3.5. Conceptual models
3.6. Semi-distributed models
3.7. Distributed models

Unit-IV Applications of Different Models to Execute Catchment Modeling

4.1. Model calibration and validation and prediction
4.2. Study of Stanford watershed model
4.3. SWMM model
4.4. HEC 1 model
4.5. HEC- HMS model
4.6. SARR model
4.7. HBV model

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS

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3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Dixon, B. and Uddameri, V. (2016) *GIS and Geocomputation for Water Resource Science and Engineering* 1st Edition American Geophysical Union ISBN-13: 978-1118354131
2. Maidment, D, R. and Morehouse, S. (2002) *Arc Hydro: GIS for Water Resources* 3rd Edition Esri Press ISBN-13: 978-1589480346
3. Armstrong, L. (2011) *Hydraulic Modeling and GIS* Esri Press ISBN-13: 978-1589483019
4. Vieux, B, E. (2016) *Distributed Hydrologic Modeling* Using GIS 3rd edition Springer ISBN-13: 978-9402409284
5. Maity, R. (2018) *Statistical Methods in Hydrology and Hydro climatology* (Springer Transactions in Civil and Environmental Engineering) 1st ed Springer ISBN-13: 978-9811087783
6. Kumar, D. (2011) *Watershed Modeling and Management*: A Concise Approach VDM Verlag Dr. Müller ISBN-13: 978-3639371482
7. Westervelt, J. (2001) *Simulation Modeling for Watershed Management* 2001st Edition Springer ISBN-13: 978-0387988931
8. Eslamian, S. (2014) *Handbook of Engineering Hydrology: Modeling, Climate Change, and Variability* (Volume 1) 1st Edition CRC Press ISBN-13: 978-1466552463

HYD-207 WATERSHED MODELING (LAB) (01 Credit hrs)

PRE-REQUISITE: HYD-108 Computer Applications in Hydrology

LEARNING OUTCOMES

Following are the learning outcomes of the course:

- Student will learn about Practical Performance of Spatial Models
- Student will learn about Practical Performance of Hydrological Models

CONTENTS

Introduction to the principles and practices of catchment modeling techniques with practical skills through the use of computer

PRACTICAL

Unit-1 Practical Performance of Spatial Models

1.1. Practical aspects regarding Rainfall-Runoff Modeling,
1.2. Practical performance of ARC SWAT Model
1.3. Practical performance of SARR Model
1.4. Practical performance of ARC-HYDRO Tools

Unit-II Practical Performance of Hydrological Models

2.1. SWMM model
2.2. HEC 1 model
2.3. HEC- HMS model
2.4. SARR model
2.5. HBV model

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

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- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

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4. Vieux, B, E. (2016) *Distributed Hydrologic Modeling* Using GIS 3rd edition Springer ISBN-13: 978-9402409284
5. Maity, R. (2018) *Statistical Methods in Hydrology and Hydro climatology* (Springer Transactions in Civil and Environmental Engineering) 1st ed Springer ISBN-13: 978-9811087783
6. Kumar, D. (2011) *Watershed Modeling and Management*: A Concise Approach VDM Verlag Dr. Müller ISBN-13: 978-3639371482
7. Westervelt, J. (2001) *Simulation Modeling for Watershed Management* 2001st Edition Springer ISBN-13: 978-0387988931
8. Eslamian, S. (2014) *Handbook of Engineering Hydrology: Modeling, Climate Change, and Variability* (Volume 1) 1st Edition CRC Press ISBN-13: 978-1466552463

HYD-208 APPLICATIONS OF ECONOMICS IN WATER RESOURCES (03 Credit Hrs)

PRE-REQUISITE: HYD-106 Fundamentals of Groundwater Hydrology

LEARNING OUTCOMES:

- This course will provide an introduction to the applications of economics in Water Resources.
- The students will learn about the different economical approaches to manage water.
- They will have the knowledge about
- As part of the course, a role-play game will be conducted with the course participants to help understanding of water resource management in the real world.
- The students will get used to various Economic Models.

CONTENTS

Unit-1 Introduction

1.1. Economics definitions, history, principles, theories.
1.2. Importance of economics in water management,
1.3. Cases and examples in which economics can play or have played a role,
1.4. Principles of water management economics.

Unit-II Approaches to Managing water

2.1. Including quantity and price based policy instruments
2.2. Institutional role, and benefit-cost analysis
2.3. Money-time relationships
2.4. Present and future worth of capital, cash flow diagrams
2.5. Defining alternatives, alternative evaluations using B/C ratio
2.6. NPV & IRR, public Vs. Private projects

Unit-III: Economic Models;

3.1. Economic valuation of water uses and decision-making context.
3.2. Institutional economics,
3.3. Water law, how economics is used in policy and cost-benefit analysis,
3.4. The roles of water marketing and water pricing.
3.5. Demand and supply estimation,
3.6. Privatization, and modeling with demand and supply functions

Unit-IV Presentation

4.1. As part of the course, a role-play game will be conducted with course participants to help understanding of water resource management in the real world.
4.2. Group work,
4.3. Presentation,
4.4. And individual assignment will be part of learning process to improve understanding

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
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3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Chandarkanth. M.G. (2015) *Water Resources Economics*. Springer Publishers.
2. Merrett, S. (2014). *Introduction to the Economics of Water Resources: An International Perspective.* Routledge, USA.
3. Griffin, R. C. (2006). *Water Resource Economics: The Analysis of Scarcity, Policies, and Projects*. Massachusetts Institute of Technology, USA.
4. Karamouz, M., Szidarovszky, F. and Zahraie, B. (2003). *Water Resources System Analysis with Emphasis On Conflict Resolution.* LEWIS Publisher.
5. Douglas, L, R. James, R. L. (1971). *Economics of Water Resources Planning*. McGraw Hill Book Company.

HYD-209 PAKISTAN STUDIES (02 Credit hrs)

PRE-REQUISITE: F.Sc. or equivalent

LEARNING OUTCOMES:

- This course will provide a detail introduction to develop vision of historical perspective, government, politics,
- Student will learn contemporary Pakistan, ideological background of Pakistan.
- Students will be familiarizing to Study the process of governance, national development,
- Student will learn issues arising in the modern age and posing challenges to Pakistan.

CONTENTS

THEORY

Unit-I: Historical Perspective

1.1. Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-e-Azam Muhammad Ali Jinnah.
1.2. Factors leading to Muslim separatism
1.3. People and Land
1.4. Indus Civilization
1.5. Muslim advent
1.6. Location and geo-physical features.

Module-II: Government and Politics in Pakistan

2.1. Political and constitutional phases:
2.2. 1947-58
2.3. 1958-71
2.4. 1971-77
2.5. 1977-88
2.6. 1988-99
2.7. 1999 onward

Unit-III: Contemporary Pakistan

3.1 Economic institutions and issues
3.2 Society and social structure
3.3 Ethnicity
3.4 Foreign policy of Pakistan and challenges
3.5 Futuristic outlook of Pakistan

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
1.	Mid Term Assessment	35%	It takes place at the mid-point of the semester
2.	Formative Assessment	25%	It is continuous assessment. It includes: classroom participation, attendance, assignments and presentation, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Javed, B. S. (1980). *State & Society in Pakistan,* The MacMillan Press Ltd
2. Zaidi, A. S. (2000) Issue *in Pakistan's Economy.* Karachi: Oxford University Press.
3. Burke, S. M. and Ziring, L. (1993) Pakistan's *Foreign policy*: An Historical analysis. Karachi: Oxford University Press,
4. Safdar, M. (1994) Pakistan *Political Roots & Development.* Lahore,
5. Wayne, W. (1972) *The Emergence of Bangladesh*, Washington: American Enterprise, Institute of Public Policy Research,

HYD-210: INTEGRATED WATER RESOURCES MANAGEMENT (02 Credit hrs)

PRE-REQUISITE: HYD-202 Groundwater Exploration and Management

LEARNING OUTCOMES:

- This course will provide an introduction to the Integrated water resources management and key issues of Pakistan with reference to water resources management.
- The students will learn about the status of waters Classes & water quality.
- They will have the knowledge about Rivers-Estuaries.
- The Introduction to Indus Basin and its treaties will be elaborated to them.
- The students will get used to Climate, glaciology, and agro-ecosystems.
- The students will be equipped with the know-how of Indus Basin Environmental Management strategies & issues.
- They will become conversant with Water Management Decision Support Systems.

CONTENTS

Unit-1 Introduction:

1.1. Concept and objectives of sustainable development
1.2. Global environmental problems
1.3. Integrated Water Resources Management (IWRM).
1.4. Global water policy
1.5. Legislative and institutional framework.

Unit-II Status of waters Classes of water quality:

2.1. The WFD, Status of waters Classes of water quality
2.2. Reference conditions, typology, and water bodies,
2.3. Analysis of the pressures and impacts on water bodies
2.4. Modelling and Decision Support Systems (DSS) in IWRM,
2.5. Rivers-Estuaries:
2.6. Water quality modelling.

Unit-III: Rivers-Estuaries:

3.1. River restoration
3.2. Lakes-Reservoirs: IWRM in lakes
3.3. IWRM in urban areas
3.4. Groundwater management
3.5. Economic analysis of water use
3.6. Presentation and analysis of a RBMP

Unit-IV Introduction to Indus Basin:

4.1. Indus basin-salient features,
4.2. Overview of surface water resources,
4.3. Groundwater resources,
4.4. Multiple use of water systems, water management challenges in the ibis.
4.5. Indus Water Treaty: the context, Indus water treaty and apportioned rivers,
4.6. Wular Barrage on river Jhelum, Kishenganga hydropower project,
4.7. Key policy issues. Pakistan Water Apportionment Accord: the context,
4.8. Disputes on water entitlements,
4.9. Water apportionment accord, key issues and challenges

Unit-V: Climate, glaciology, and agro-ecosystems:

5.1. Climate in the Indus basin
5.2. Agro-climatic zones of Pakistan
5.3. Snow and ice melt contribution to the total flow in the Indus basin
5.4. Climate change impacts on the Indus basin

5.5. Integrated Flood and Drought Management
5.6. Causes of floods, impacts of floods
5.7. Causes and impacts of droughts
5.8. Flood and drought management options in Pakistan

Unit-VI: Indus Basin Environmental Management

6.1. Flows below Kotri barrage
6.2. Rivers to low flows below Kotri
6.3. Minimum environmental flows (e-flows)
6.4. Issues of degradation of delta below Kotri
6.5. Wastewater – industrial and domestic effluents

Unit-VII: Water Management Decision Support Systems:

7.1. Need of optimization and different system levels,
7.2. What is optimization
7.3. Optimization models and tools
7.4. Decision support system models
7.5. Example of DSS model.

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
1.	Mid Term Assessment	35%	It takes place at the mid-point of the semester
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RECOMMENDED TEXTBOOKS / SUGGESTED READINGS

1. Lenton, R. and Muller, M. (2008) *IWRM in Practice Better Water Management for Development*. ISBN: 978-1-84407-650-5.
2. Moriarty, P. and Butterwoth, J. (2004), *Integrated Water Resources Management*.IRC.
3. Nijland H., and Menke U. (2005*). Flood Risk Management and Multifunctional Land Use in River Catchments*. Conference Proceedings Mainz, Germany 17th – 19th Oct.
4. Serban P. and Galie A. (2006). Managementul apelor - principii şi reglementări europene. TIPORED Edition.
5. Bund W. (2002). *Assigning water body types: an analysis of the refcond questionnaire results*, European Commission, Joint Research Centre, Italy
6. Groot S. and Villass M. (1995). *Monitoring water quality in the future*. Delft Hydraulics.
7. Ahmad, N. (1993). *Water Resources of Pakistan*, Shahzad Nazir, 61 B/2, Gulberg, III, Lahore.

HYD-211 APPLIED CLIMATOLOGY (THEORY) (02 Credit hrs)

PRE-REQUISITE: HYD-110 Hydrometeorology

LEARNING OUTCOMES

Following are the learning outcomes of the course:

- Student will learn about Climate and Water Resources
- Student will learn about Climate and Weather
- Student will learn about Regional Climate
- Student will learn about Research Methods in Climatology
- Student will learn about Climate and Society

CONTENTS

THEORY

Unit-1 Climate and Water Resources

1.1. Climate and Water Resources
1.2. The Global Hydrologic System
1.3. The Water Budget at The Earth's Surface
1.4. Evapotranspiration, Soil Moisture and Ground Water, Runoff and Floods
1.5. Climatic Causes of Floods
1.6. Runoff Forecasting
1.7. Snow Surveying
1.8. Water Resources Management
1.9. The Greenhouse Effect
1.10. The Runaway Greenhouse Effect

Unit-II Climate and Weather

2.1. Basic principles of the general circulation
2.2. Climate, and weather
2.3. Explore principles of general circulation and atmospheric motion that are critical to understanding relationships between regional climates and regional climate variability

Unit-III: Regional Climate

3.1. Regional climate and society
3.2. Explore relationships among regional climate variability,
3.3. Agriculture
3.4. Transportation
3.5. Resource management
3.6. Health, and energy

Unit-IV: Research Methods in Climatology

4.1. Research and methods in climatology
4.2. Explore current research topics in climatology
4.3. Identify various means of generating regional climatologist
4.4. Research projects that link regional climatologies to social–economic endeavors.

Unit-V: Climate and Society

5.1. Climate, Agriculture, And Food
5.2. Climate Modification, Past Climates, And Climate Forecasting
5.3. Forecasting Climate, Energy, And Industrial Technology
5.4. Climate and Soil Erosion, Marine Life
5.5. Sediments and Past Climates
5.6. Effects of Winds and Currents On Fisheries
5.7. Climate and The Biosphere

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

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3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Hidore, J. J. Oliver, J. E. Snow, M. and Snow, R. (2009): *Climatology: An atmospheric science* (3rd Ed.). Prentice Hall. 408 pp.
2. Pierre, G. (ed.). (2010). *Geographical Information and Climatology*. Wiley Press.
3. Hartmann, D. (1994): *Global Physical Climatology*. Academic Press. 411 pp.
4. Rohli, R. and Vega, A. J. (2015): *Climatology* (Revised Edition) Jones & Bartlett Learning.

HYD-211 APPLIED CLIMATOLOGY (LAB) (01 Credit hr)

PRE-REQUISITE: HYD-110 Hydrometeorology

LEARNING OUTCOMES

Following are the learning outcomes of the course:

- Student will learn about Climate and Water Resources
- Student will learn about Climate and Weather
- Student will learn about Research Methods in Climatology
- Student will be able to analyzed Climatic data

CONTENTS

PRACTICAL

Unit-1

1.1. Solar Radiation estimation
1.2. The Seasons, Basic Climate Statistics, Other Types of Means
1.3. Assessment of Variability of Temperature, Precipitation
1.4. Assessment of Wind Speed, Cumulative Frequency

Unit-II

2.1. Identification of climatic Distributions and Wind Roses
2.2. Climatic Variability and Classification
2.3. Study of Tropical Humid, Subtropical climates
2.4. Study of Temperature Climates,
2.5. Study of Boreal, Polar
2.6. Study of Semi-Arid Climates

Unit-III:

3.1. The Greenhouse Effect analysis
3.2. The Runaway Greenhouse Effect
3.3. Microclimates of Cities, Climates – Past, Present, And Future
3.4. Forecasting Difference Schemes of climate

Unit-IV:

4.1. Introduce laboratory assignments that involve statistical analyses to explore and interpret climatic data

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

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- hands-on-activities,
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4. Rohli, R. and Vega, A. J. (2015): *Climatology* (Revised Edition) Jones & Bartlett Learning.

HYD-212 URBAN HYDROLOGY (THEORY) (02 Credit Hrs)

PRE-REQUISITE: HYD-103 Introduction to Hydrology

LEARNING OUTCOMES

Following are the learning outcomes of the course:

- Student will learn about Concepts of Urban Hydrology
- Student will learn about Urban Drainage
- Student will learn about Urban Runoff
- Student will learn about Urban Flooding and Storm Water Management

CONTENTS

THEORY

Unit-1 Concepts of Urban Hydrology

1.1. Introduction Urbanization and
1.2. Urban water demands
1.3. Review of hydrological process
1.4. Storm water runoff generation

Unit-II Urban Drainage

2.1. The main design criteria used in drainage systems:
2.2. Type of sections design
2.3. The Concept of maximum and minimum velocities in urban drains
2.4. Return period
2.5. Hydrologic risk
2.6. Flood Frequency analysis
2.7. IDF relationships
2.8. Design events

Unit-III: Urban Runoff

3.1. Open channel flow in urban watersheds
3.2. Estimation of runoff rates from urban watersheds
3.3. Flow routing
3.4. Storm water drainage structures
3.5. storm water detention

Unit-IV: Urban Flooding and Storm Water Management

4.1. Urban flooding
4.2. Structural and non-structural control of urban flood
4.3. Measures of urban flooding
4.4. Introduction to urban groundwater systems
4.5. Storm water quality, pollutants
4.6. Urban storm water models
4.7. Urban water distribution networks

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
1.	Mid Term Assessment	35%	It takes place at the mid-point of the semester
2.	Formative Assessment	25%	It is continuous assessment. It includes: classroom participation, attendance, assignments and presentation, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Butler, D. & Davies, J.W. (2004) *Urban Drainage*, Spon Press, 2nd Edn., 2004.
2. Akan A.O and Hioughtalen R.J. (1984) *Urban Hydrology, Hydraulics and Stormwater Quality Engineering, Applications and Computer Modeling*, John Wiley & Sons 2003
3. Hall, M.J. (1984) *Urban Hydrology*. Elsevier, 1984.
4. Shaw, E.M. (1994) *Hydrology in Practice*. 3rd Edn., Chapman & Hall, 1994.
5. Ladson, T. (2005) *Hydrology* - An Australian Introduction. Oxford University Press, South Melbourne

HYD-212 URBAN HYDROLOGY (LAB) (01 Credit Hrs)

PRE-REQUISITE: HYD-103 Introduction to Hydrology

LEARNING OUTCOMES

Following are the learning outcomes of the course:

- Student will learn about Concepts of Urban Hydrology
- Student will learn about Urban Drainage
- Student will learn about Urban Runoff
- Student will learn about Urban Flooding and Storm Water Management

CONTENTS

THEORY

Unit-1 Land Use classification analysis

1.1. Introduction Urbanization
1.2. Land use classification

Unit-II Urban Drainage Analysis

2.1. Return period
2.2. Hydrologic risk
2.3. Flood Frequency analysis
2.4. IDF relationships
2.5. Design events

Unit-III: Urban Flooding and Storm Water Management

3.1. Measures of urban flooding
3.2. Storm water quality, pollutants estimation
3.3. Urban storm water models

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

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HYD-213 HYDROLOGICAL FIELD STUDIES I (01 Credit Hrs)

PRE-REQUISITE: HYD-103 Introduction to Hydrology

Hydrological Measurements

Study of Dams/Reservoirs/Wetlands, Flow measurements, Weather stations, Seepage control through Dams and Foundations, Power houses, Spillways.

ASSESSMENT STRATEGIES

1. Field Work
2. Field Report
3. Vive-voce

Distribution of Marks

1. Field Work Study	50%
2. Quality of Report	25%
3. Viva Voce	25%

Book Recommended

As suggested by the Instructor.