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 04 years BS Degree in Hydrology and Water Resources Management (HWRM) under Semester System at the College of Earth and Environmental Sciences w.e.f. the Academic Session, 2021and onward.

The Revised Syllabi and Courses of Reading for 04 years BS Degree in Hydrology and Water Resources Management (HWRM) under Semester System is attached herewith as Annexure 'A'.

Sd/-
REGISTRAR

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

No. D/ 7672 /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
04 Year BS Degree in Hydrology and Water Resources Management (HWRM)

Program Title: **04 Year BS Degree in Hydrology and Water Resources Management**

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, M.Sc., 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 Management. 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, specially 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 Water resources management, hydrological cycle, Bachelors' Science in Hydrology and Water Resources Management. This programme will consist of four years covering all key aspects if hydrology and water resources management. This will also provide an opportunity to younger generations to be skilled in field of hydrology and water resources. 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, advancements in hydrology and to serve back to nation.

4. Program Objectives

This programme will have equipped the students with fundamental knowledge of hydrology and water resources management. 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 04 year and number of courses taught in BS degree in hydrology and water resources management **138 hours** total with 08 semesters varied by 15-19 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	General	Major	Elective	Semester Load
1st	07	03	01	02	01		17
2nd	06	04	01	--	01	--	16
3rd	07	02	01	--	04	--	18
4th	08	03	01	--	02	02	18
5th	06	01	01	03	01	--	16
6th	07	03	02	--	02	--	19
7th	07	02	02	01	01	01	17
8th	05	01	01	01	01	01	17
PU	**53**	**19**	**10**	**07**	**12**	**--**	**138**
HEC Guidelines	**40-44**	**09-09**	**09-10**	**07-08**	**11-13**	**04-04**	**124-136**
Difference HEC & PU	**+09**	**+10**	**NIL**	**NIL**	**NIL**	**NIL**	**+04**

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
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

Sr. #	Code	Course Title	Course Type	Prerequisite	Credit Hours
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**
Semester V					
29.	HQ-05	Translation of Holy Quran	Compulsory	HQ-04	Non Credit
30.	HYD-301	Surface Water Hydrology	Major	HYD-103	02+1
31.	HYD-302	Water Resources System Analysis	Foundation	HYD-207	02+1
32.	HYD-303	Applied Soil Mechanics	General	HYD-104	02+1
33.	HYD-304	Hydrochemistry and Pollution Control	General	HYD-210	03+1
34.	HYD-305	Soil and Water Conservation	General	HYD-205	03
Total Credit hrs Semester-V					**16**
Semester VI					
35.	HQ-06	Translation of Holy Quran	Compulsory	HQ-05	01
36.	HYD-306	Advance Mathematics in Hydrology	Compulsory	HYD-109	03
37.	HYD-307	Open Channel Hydraulics	Foundation	HYD-302	03
38.	HYD-308	Ground water and Surface water Interactions	Foundation	HYD-305	02+1
39.	HYD-309	Hydro-informatics	Major	HYD-203	03+1
40.	HYD-310	Irrigation-II	Major	HYD-205	03+1
41.	HYD-311	Hydrological Field studies II	Compulsory	HYD-212	01
Total Credit hrs Semester-VI					**19**
Semester VII					
42.	HQ-07	Translation of Holy Quran	Compulsory	HQ-06	Non Credit
43.	HYD-401	Water Resources Laws and Transboundary Issues	Compulsory	HYD-210	02
44.	HYD-402	Advance Fluid Mechanics	Foundation	HYD-307	02+1
45.	HYD-403	Drainage Engineering	Foundation	HYD-302	02+1

Sr. #	Code	Course Title	Course Type	Prerequisite	Credit Hours
46.	HYD-404	Watershed Management	Elective	HYD-210	03
47.	HYD-405	Advances in GIS and Remote Sensing	General	HYD-203	2+1
48.	HYD-406	Groundwater Modeling	Major	HYD-308	2+1
Total Credit hrs Semester-VII					**17**
Semester VIII					
49.	HQ-08	Translation of Holy Quran	Compulsory	HQ-07	01
50.	HYD-408	Reservoir Design and Operation	Foundation	HYD-301	03+1
51.	HYD-409	Sustainable Water Resources Development	Elective	HYD-404	03
52.	HYD-410	Environmental Issues in Water Resources	General	HYD-308	03
53.	HYD-411	Thesis / Viva Voce Examination	Major	--	06
Total Credit hrs Semester-VIII					**17**
Grand Total (I+II+III+IV+V+VI+VII+VIII):					**138**

10. Award of Degree

04 Year BS degree in Hydrology and Water Resources Management will be awarded on the successful completion of courses & syllabi and research Thesis / Project 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

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- short tests, quizzes etc.

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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:

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. 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
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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. 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.
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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
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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
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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. 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:

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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
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-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
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. 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

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. 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
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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
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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
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-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

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

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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
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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

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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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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
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- hands-on-activities,
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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

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- homework
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- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

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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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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:

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

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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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- hands-on-activities,
- short tests, quizzes etc.

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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
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-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.

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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

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- 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. 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-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

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 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

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. 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
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.

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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
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

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

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. 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

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.

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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-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
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. 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
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 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:

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. 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

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.

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.
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

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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

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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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-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.

3rd YEAR, FIFTH SEMESTER				
Sr. #	**Code**	**Course Title**	**Course Type**	**Credit Hours**
1.	HQ-05	Translation of Holy Quran	Compulsory	Non Credit
2.	HYD-301	Surface Water Hydrology	Major	02+1
3.	HYD-302	Water Resources System Analysis	Foundation	02+1
4.	HYD-303	Applied Soil Mechanics	General	02+1
5.	HYD-304	Hydrochemistry and Pollution Control	General	03+1
6.	HYD-305	Soil and Water Conservation	General	03
		Total Credit hrs Semester-V		**16**

HQ-05: TRANSLATION OF HOLY QURAN (Non Credit)

PRE-REQUISITE: HQ-04 Translation of Holy Quran

COURSE OUTLINE

سورة مريم تا سورة الفرقان

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:

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

ASSESSMENT AND EXAMINATIONS:

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HYD-301 SURFACE WATER HYDROLOGY (THEORY) (02 Credit hrs)

PRE-REQUISITE: HYD-103 Introduction to Hydrology

LEARNING OUTCOMES:

- This course will provide an introduction to the surface water hydrology to the students.
- The students will learn about the precipitation as a process and its types
- The students will get used to the presentation and analysis of precipitation data
- They will become conversant with the different hydrological processes of the hydrological cycle
- Students will learn about the applications and the concepts of hydrographs and Unit hydrograph theory
- The student will be able to understand the different methods of stream routing and reservoir routing.

CONTENTS

This course provides an introduction to the hydrological cycle, hydrological data, precipitation, runoff, hydrographs and unit hydrographs, consistency analysis of hydrological data, PMF studies, S-Curves and flow duration curves channel routing and reservoir routing.

THEORY

Unit-I: Introduction:

1.1. Hydrological Cycle and its components
1.2. Water budget at global and catchment scale
1.3. Surface Water Resources

Unit-II: Precipitation:

2.1. Process and types of precipitation
2.2. Estimation of areal precipitation

Unit-III: Analysis of precipitation data:

3.1. Representation of precipitation data
3.2. Uncertainties of precipitation data
3.3. Consistency analyses and database handling

Unit-IV: Hydrological Processes:

4.1. Evaporation and evapotranspiration
4.2. Interception
4.3. Infiltration
4.4. Runoff

Unit-V: Runoff:

5.1. Processes in runoff
5.2. Components of runoff
5.3. Factor affecting runoff
5.4. Measurement and estimation of streamflow

Unit-VI: Analyses of Hydrological data:

6.1. Hydrographs, interpretations and components
6.2. Discharge rating curves.
6.3. Flow duration curves and Discharge analysis for water availability.
6.4. S-Curve,
6.5. PMF studies.
6.6. Unit hydrographs

Unit-VII: Flood Routing:

7.1. Basic of flood routing
7.2. Reservoir routing
7.3. Stream channel routing

TEACHING – LEARNING STRATEGIES

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

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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. Manning, J. C. (1996). *Applied Principles of Hydrology 3rd Edition* Prentice Hall ISBN-13: 978-0135655320
4. Viessman, Jr., Warren Lewis, Gary L. (2011). *Introduction to Hydrology*, 5th Edition, Upper Saddle River, N.J.; Harlow, ISBN: 9780132763608.
5. Viessman, W. and Lewis, G. L. (2002). *Introduction to Hydrology*. 5/e. Prentice Hall.

HYD-301 SURFACE WATER HYDROLOGY (LAB) (01 Credit hr)

PRE-REQUISITE: HYD-103 Introduction to Hydrology

LEARNING OUTCOMES:

- This course will provide a practical aspect of precipitation data handling and analyses
- The students will learn about the different methods of estimating areal precipitation
- They will have the knowledge about the measurement of hydrological losses
- They will become conversant with the construction of unit hydrograph for given catchment

CONTENTS

Practical course provides a introduction to the consistency analysis of hydrological data, mean areal precipitation estimation, measurement of hydrological losses, base flow separation techniques and development of unit hydrographs.

PRACTICAL

Unit-1 Analysis of Precipitation data:

1.1. Hydrological data consistency analysis through graphical, numerical and mathematical procedures

Unit-II Areal Precipitation:

2.1. Arithmetic mean method
2.2. Theisen polygon method,
2.3. Isohyet method

Unit-III: Hydrological Losses:

3.1. Measurement/estimation of Evaporation. Interception. Infiltration

Unit –IV: Hydrograph Analyses:

4.1. Baseflow separation techniques
4.2. Development of Unit Hydrographs

TEACHING – LEARNING STRATEGIES

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

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HYD-302 WATER RESOURCES SYSTEM ANALYSIS (THEORY) (02 Credit hours)

PRE-REQUISITE: HYD-207 Watershed Modeling

LEARNING OUTCOMES:

- This course will provide an introduction to the Water resource systems analysis as a discipline.
- The students will learn about the Classification of Mathematical Programming Models.
- They will have the knowledge about the categories of Numerical Programming Models.
- The Water Supply Problems and their possible solutions will be illustrated to them.
- The students will get used to the phenomena of Dynamic Programming.
- The students will be equipped with the various Regional water supply planning processes.

CONTENTS

Unit-1 Introduction:

1.1. Water resource systems analysis as a discipline
1.2. Linear Programming with reference to hydrology and water resources constraints
1.3. Problem statement, Problem formulation
1.4. Graphical representation of decision space
1.5. Finding the problem solution, Beyond optimality

Unit-II Classification of Mathematical Programming Models:

2.1. Linear Programming
2.2. Integer Programming
2.3. Nonlinear Programming
2.4. Static vs. Multistage Models
2.5. Deterministic vs. Stochastic Models
2.6. Solving Linear Programs by the Simplex method
2.7. Characteristics of the Simplex Algorithm

Unit-III: Category of Numerical Programming Models:

3.1. Overview of the methodology by steps
3.2. Determination of shadow prices from final table
3.3. Dealing with equality constraints
3.4. Recognizing and unbounded objective function.
3.5. Recognizing a decision variable that is nonunique
3.6. Practice LP Problem Formulation

Unit-IV: Water Supply Problem:

4.1. Problem statement,
4.2. Solution formulation,
4.3. Application of Lp to Groundwater simulation-optimization,
4.4. Water resources Network Models,
4.5. Integer Programming Nonlinear Programming,
4.6. Wastewater treatment problem revisited with nonlinear costs,
4.7. Piecewise approximations of nonlinear functions,
4.8. Lagrange multipliers, Gradient search techniques.

Unit-V: Dynamic Programming:

1.1. Mathematical Description and its Effect on Solution of Discounting Future Returns
1.2. Fuzzy Optimization,
1.3. Data-Based Optimization,
1.4. Artificial Neural Networks,
1.5. Genetic Algorithms,
1.6. Optimal Control Uncertainty and Reliability Analysis.

Unit-VI: Regional water supply planning:

6.1. River-reservoir system operation,
6.2. Water distribution system operation,
6.3. Irrigation water delivery,
6.4. Groundwater remediation,
6.5. Reservoir simulations and Multicriteria decision analysis.

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2. Karamouz, (2013) *Water Resources System Analysis*. LEWIS Publishers.
3. Jain & Singh. (2003) *Water Resources Systems Planning & Management*. Elsevier SAcademic Press.
4. Mays, L. (2005) *Water Resource Systems Management Tools*, McGraw Hill.
5. Hax, B. and Magnanti, (1977) *Applied Mathematical Programming*, Addison- Wesley.

HYD-302 WATER RESOURCES SYSTEM ANALYSIS (LAB) (01 Credit hr)

PRE-REQUISITE: HYD-207 Watershed Modeling

LEARNING OUTCOMES:

- This course will provide an introduction to the Linear programming techniques for water resources system analysis.
- The students will learn about the Use of MATLAB programming software for water resources system analysis.
- They will have the knowledge about Use of R programming language for the optimization of water resources system analysis.
- The Use of different GIS/RS software's for advancement in water resources system analysis will be elaborated to the students.
- The students will be equipped with the use of any other latest software to execute programming and optimization algorithms.

CONTENTS

PRACTICAL

Unit-1

1.1. Utilization of Linear programming techniques for water resources system analysis

Unit-II

2.1. Use of MATLAB for water resources system analysis

Unit-III:

3.1. Use of R programming for optimization of water resources system analysis

Unit-IV

4.1. Use of GIS/RS software's for advancement in water resources system analysis

Unit-V:

5.1. Use of any other latest software to execute programming and optimization algorithms

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5. Hax, B. and Magnanti, (1977) *Applied Mathematical Programming*, Addison- Wesley.

HYD-303 APPLIED SOIL MECHANICS (THEORY) (02 Credit hrs)

PRE-REQUISITE: HYD-104 General Geology

LEARNING OUTCOMES:

- This course will provide an introduction to the Applied soil mechanics & soil formation.
- The students will learn about the Classification of Soils.
- They will have the knowledge about Physical Properties of soils.
- Compaction and its techniques and theory will be learnt by the students.
- The students will get used to Permeability and Seepage analysis.
- The students will be equipped with the Vertical Stresses distribution in Soils.
- They will become conversant with Soil Exploration phenomena.

CONTENTS

Unit-1 Soil Formation

1.1. Soil and its Constituents
1.2. Weathering of Rocks and Types of Soils
1.3. Description and identification of soil

Unit-II Classification of Soils

2.1. Grain Size Classification
2.2. Bureau of Soils
2.3. Textural Classification by Triangular Chart
2.4. Unified Soil Classification
2.5. ASTM
2.6. AASHTO

Unit-III: Physical Properties

3.1. Water Content
3.2. Void Ratio, Porosity, Degree of Saturation, Specific Gravity
3.3. Unit Weight and their determination
3.4. Atterberg limits
3.5. Sieve Analysis
3.6. Hydrometer and Pipette Analysis
3.7. Stoke's Law
3.8. Grain Size distribution

Unit-IV: Permeability and Seepage

4.1. Definition,
4.2. Hydraulic Gradient,
4.3. Darcy's Law, Factors affecting Permeability,
4.4. Permeability of stratified soils,
4.5. Laboratory and Field determination of coefficient of Permeability,
4.6. Seepage Force

Unit-V: Compaction

5.1. Purpose and theory of Compaction,
5.2. Moisture Content and Dry Density relationship,
5.3. Degree of Compaction and its determination in the Field.
5.4. Methods of compaction in the field;
5.5. Factors affecting compaction of soils.

Unit-VI: Vertical Stresses in Soils

6.1. Definition
6.2. Stresses caused by self-weight of soil
6.3. Geostatic stresses
6.4. Stresses caused by Point Loads and Uniformly distributed Loads.

Unit-VII: Soil Exploration

7.1. Importance of Soil Exploration,
7.2. Soil Exploration methods,
7.3. Probing, Test Trenches and Pits, Auger boring, wash boring, rotary boring,
7.4. Percussion drilling and Geophysical methods,
7.5. Soil Samples, Disturbed and Un-disturbed samples.

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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RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Das. B.M, (2019) *Advanced Soil Mechanics*. CRC Press. Taylor & Francis Group.
2. Kaliakin .V. (2017) *Soil Mechanics: Calculations, Principles and Methods.* Butterworth-Heinemann. Elsevier.
3. Garg, S K. (2001) *Soil Mechanics and Foundation Engineering* Fourth Edition.
4. Jumikis, A.R. (1994). *Soil Mechanics*, D. Van Nostrand Company Inc., Princeton, New Jersey.
5. Terzaghi, K. (1997). *Soil Mechanics in Engineering Practice*. John Wiley & Sons, New York.

HYD-303 APPLIED SOIL MECHANICS (LAB) (01 Credit hr)

PRE-REQUISITE: HYD-104 General Geology

LEARNING OUTCOMES:

- This course will provide an introduction to the Identification of different soils.
- The students will learn about the determination of water content of soil.
- They will have the knowledge about Specific Gravity of Soil.
- The Determination of Liquid Limit of Soil will be learned by the students.
- The students will get used to Determination of Plastic Limit and Plasticity Index of Soil.
- The students will be equipped with the Determination of Shrinkage Limit of Soil.
- They will become conversant with Classification of Soil according to AASHTO and USCS standards.

CONTENTS

Unit-1

1.1. Identification of Soil (Visual and Manual)

Unit-II

2.1. Determination of Moisture Content of Soil

Unit-III:

3.1. Determination of Specific Gravity of Soil

Unit-IV:

4.1. Determination of Liquid Limit of Soil

Unit-V:

5.1. Grain Analysis of Soil (including both Mechanical and Hydrometer Analysis)

Unit-VI:

6.1. Determination of Plastic Limit and Plasticity Index of Soil

Unit-VII:

7.1. Determination of Shrinkage Limit of Soil

Unit-VIII:

8.1. Classification of Soil according to AASHTO and USCS

Unit-IX:

9.1. Modified/Proctor Compaction Test

Unit-X:

10.1. Constant Head Permeability Test (Granular Soil)

Unit-11

11.1. Falling Head Permeability (Granular and Fine Grained Soils)

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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RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Das. B.M, (2019) *Advanced Soil Mechanics*. CRC Press. Taylor & Francis Group.
2. Kaliakin. V. (2017) *Soil Mechanics: Calculations, Principles and Methods.* Butterworth-Heinemann. Elsevier.
3. Garg, S K. (2001) *Soil Mechanics and Foundation Engineering* Fourth Edition.
4. Jumikis, A.R. (1994). *Soil Mechanics*, D. Van Nostrand Company Inc., Princeton, New Jersey.
5. Terzaghi, K. (1997). *Soil Mechanics in Engineering Practice*. John Wiley & Sons, New York.

HYD-304 HYDROCHEMISTRY AND POLLUTION CONTROL (THEORY) (03 Credit hrs)

PRE-REQUISITE: HYD-210 Integrated Water Resources Management

LEARNING OUTCOMES:

- This course will provide an introduction to the hydrochemistry and pollution control techniques particularly about water pollution.
- The students will learn about the different sources of pollutants**.**
- They will have the knowledge about the phenomena of Contaminant Transport.
- The students will get used to various water quality standards.
- They will become conversant with latest techniques used in water pollution and control processes.

CONTENTS

Unit-1 Introduction:

1.1. Physical properties of water/wastewater
1.2. Chemistry properties of water/wastewater
1.3. Biology of inorganic, organic and microbial contaminants in groundwater
1.4. And surface water systems.

Unit-II Sources of Pollutants

2.1. Mechanism by which contaminants are introduced in water
2.2. Transport and transformation of contaminants in surface waters
2.3. The vadose zone and its correlation with water quality
2.4. The saturated zone and its significance in water quality.

Unit-III: Contaminant Transport

3.1. Movement and capillary trapping
3.2. And solubility of relatively immiscible organic liquids.
3.3. Contaminant isolation and remediation techniques.
3.4. Water Quality Models.

Unit-IV: WQ Standards.

4.1. Water quality standards: Organizations
4.2. Effluent types and standardization
4.3. Surface, streams and their water quality status
4.4. Irrigation with waste water its implications
4.5. US- EPA, NEQS ETC.

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. Bui. E. (2019). *Water and Wastewater Treatment Technologies*. Springer publishers.
2. Geol, P.K. (2011). *Water Pollution: Causes, Effects and Control*. New Age International (P) Limited Publishers. IBN (10): 81-224-1839-2.
3. Salpekar, A. (2008). *Water Pollution*. Jnanada Prakashan (P&D), ISBN: 978-81-7139-23-5
4. Agarwal, S.K. (2005). *Water pollution*. Kul Bhushan Nangla APH Publishing Corporation. ISBN: 81-7648-832-1.
5. Viessman. J. W (2014). *Water Supply & Pollution Control*. Pearson Education Limited.

HYD-304 HYDROCHEMISTRY AND POLLUTION CONTROL (LAB) (01 Credit hr)

PRE-REQUISITE: HYD-210 Integrated Water Resources Management

LEARNING OUTCOMES

- The students will work on drinking water quality standards. Monitoring and control of pollution in Lakes, Rivers and coastal water.
- The students will learn about the water sampling techniques, sites and sample frequencies.
- They will have the knowledge about how to determine water quality parameter analysis on spot.
- They will learn how to determination of Biochemical oxygen demand, chemical oxygen demand in the lab.
- The students will get used to different physiochemical parameters analysis techniques.
- The students will be equipped with the bacteriological parameters analysis of water samples.
- They will become conversant with water quality analysis by utilizing DO sag curve.

CONTENTS

Unit-1

1.1. Drinking water quality standards. Monitoring and control of pollution in Lakes, Rivers and coastal water.

Unit-II

2.1. Water sampling techniques, sites and sample frequencies.

Unit-III:

1.1. Water quality parameter analysis on spot: Hydrogen-ion-concentration, Dissolve oxygen, Electrical conductivity and turbidity,

Unit-IV

1.1. Physiochemical parameters analysis: Total dissolve solids, Alkalinity, Hardness, Calcium, magnesium, chlorides, fluorides, Iodine, Nitrogen,

Unit-V:

1.1. Determination of Biochemical oxygen demand, chemical oxygen demand.

Unit-6

6.1. Bacteriological parameters analysis of water samples.

Unit-VII:

7.1. Water quality analysis by DO sag curve, controlling hardness in natural waters.

Unit-VIII:

8.1 Detection of metals and their ions

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. Agarwal, S.K. (2005). *Water pollution*. Kul Bhushan Nangla APH Publishing Corporation. ISBN: 81-7648-832-1.
5. Viessman. J. W (2014). *Water Supply & Pollution Control*. Pearson Education Limited.

HYD 305 SOIL AND WATER CONSERVATION (03 Credit hrs)

PRE-REQUISITE: HYD-205 Irrigation

LEARNING OUTCOMES

Following are the learning outcomes of the course:

- Student will learn about Soil Water Conservation
- Student will learn about Rainfall -Runoff Processes
- Student will learn about Evaporation and Evapotranspiration
- Student will learn about Water Erosion
- Student will learn about Wind Erosion
- Student will learn about Watershed Management
- Student will learn about Vegetation and its Role to control Erosion

CONTENTS

This course will provide an insight learning of soil water conservation and sustainability of water resources.

THEORY

Unit-1 Soil Water Conservation

1.1. Soils types
1.2. Soil System
1.3. Functions of Soils,
1.4. Soil and water resources
1.5. Conservation ethics

Unit-II Rainfall -Runoff Processes

2.1. Rainfall and Runoff
2.2. Rainfall intensity and duration
2.3. Runoff process,
2.4. Factors affecting runoff
2.5. Design runoff rates
2.6. Infiltration
2.7. infiltration capacity
2.8. Factors affecting infiltration capacity
2.9. Evaporation & Transpiration
2.10. Factors affecting infiltration

Unit-III: Evaporation and Evapotranspiration

3.1. Evaporation
3.2. Types of evaporation
3.3. Transpiration and its Causes
3.4. Evapotranspiration,
3.5. Prediction of ET

Unit-IV: Water Erosion

4.1. Water Erosion
4.2. Erosion agents
4.3. Geologic and accelerated erosion
4.4. Damages caused by soil erosion
4.5. Water erosion and its types, Factors affecting water erosion,

4.6. Sedimentation and pollution in relation to water erosion
4.7. Water erosion prediction equation, Erosion control practices

Unit-V: Wind Erosion

5.1. Wind Erosion
5.2. Factors affecting wind erosion
5.3. Types of soil movement
5.4. Mechanics of wind erosion
5.5. Wind erosion control principles
5.6. Wind erosion prediction equation
5.7. Cropping System and Agronomic Measures for Erosion Control

Unit-VI: Watershed Management

6.1. Watershed management,
6.2. Plant cover
6.3. Crop rotation
6.4. Strip-cropping
6.5. Conservation tillage
6.6. Contour cultivation
6.7. Land capability classification
6.8. Terracing and Field terrace

Unit-VII: Vegetation and its Role to control Erosion

7.1. Classification of terraces
7.2. Broad base terraces
7.3. Bench terraces
7.4. Terrace design
7.5. Planning the terrace system,
7.6. Terrace construction and maintenance
7.7. Vegetated Outlet
7.8. Use of vegetated outlets and water courses in the control of erosion
7.9. Design of vegetated outlets
7.10. Water-way construction and maintenance

TEACHING – LEARNING STRATEGIES

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

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

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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. Huffman, R. L. (2013). *Soil & Water Conservation Engineering*, American Society of Agricultural and Biological Engineers.ISBN: 1892769867.
2. Pierce, E. J. and Fryer, W. W. (2018). *Advances in Soil & Water Conservation*, CRC Press.
3. Micheal, A. M. (2003). *Irrigation Theory and Practices*. Vikas Publishing House (Pvt), New Delhi.
4. Morgan, R.P.C. (2005). *Soil Erosion & Conservation*. Third Edition. Blackwell Pub.ISBN; 9781405117814
5. Schwab, G.O. (1993). *Soil & Water Conservation* Engg- Fourth Edition, John Willey & Sons, Inc.

3rd YEAR, SIXTH SEMESTER				
Sr. #	**Code**	**Course Title**	**Course Type**	**Credit Hours**
1.	HQ-06	Translation of Holy Quran	Compulsory	01
2.	HYD-306	Advance Mathematics in Hydrology	Compulsory	03
3.	HYD-307	Open Channel Hydraulics	Foundation	03
4.	HYD-308	Groundwater and Surface Water Interactions	Foundation	02+1
5.	HYD-309	Hydro-Informatics	Major	03+1
6.	HYD-310	Irrigation-II	Major	03+1
7.	HYD-311	Hydrological Field Studies II	Compulsory	01
			Total Credit hrs Semester-VI	**19**

HQ-06: TRANSLATION OF HOLY QURAN (01 Credit hr)

PRE-REQUISITE: HQ-05 Translation of Holy Quran

COURSE OUTLINE

سورة الشعرا تا سورة ص

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

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- homework
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HYD-306: ADVANCE MATHEMATICS IN HYDROLOGY (03 Credit hrs)

PRE-REQUISITE: HYD-109 Applied Mathematics

LEARNING OUTCOMES:

- This course will provide an introduction to the Numerical Methods and Problem Solving techniques used in Hydrology & Water resources
- The students will learn about the Fundamentals of MATLAB programming software
- They will have the knowledge about Round off and Truncation Errors
- The students will get used to the phenomena of Roots: Bracketing Methods & Open Methods.
- The students will be equipped with the concept of Optimization & Gauss Elimination method.
- They will become conversant with Linear Algebraic Equations and Matrices.

CONTENTS

Unit-1 Numerical Methods and Problem Solving

4.1. A Simple Mathematical Model
4.2. Conservation Laws in Engineering and Science
4.3. Numerical Methods with Case Study

Unit-II MATLAB Fundamentals

2.1. The MATLAB Environment
2.2. Mathematical Operations
2.3. Use of Built-In Functions
2.4. Graphics & Other Resources
2.5. Exploratory Data Analysis

Unit-III: Round off and Truncation Errors

3.1. Errors & their types
3.2. Roundoff Errors
3.3. Truncation Errors
3.4. Total Numerical Error
3.5. Blunders, Model Errors, and Data Uncertainty

Unit-IV Roots: Bracketing Methods

4.4. Roots in Engineering and Science
4.5. Graphical Methods
4.6. Bracketing Methods and Initial Guesses
4.7. Bisection
4.8. False Position
4.9. Case Study: Greenhouse Gases and Rainwater

Unit-V: Roots: Open Methods

7.1 Simple Fixed-Point Iteration
7.2 Newton-Raphson
7.3 Secant Methods
7.4 Brent's Method
7.5 MATLAB Function
7.6 Polynomials

Unit-VI: Optimization

6.1. Introduction and Background
6.2. One-Dimensional Optimization
6.3. Multidimensional Optimization
6.4. Equilibrium and Minimum Potential Energy

Unit-VII: Linear Algebraic Equations and Matrices

7.1. Matrix Algebra Overview
7.2. Solving Linear Algebraic Equations with MATLAB
7.3. Currents and Voltages in Circuits

Unit-VIII: Gauss Elimination

8.1. Solving Small Numbers of Equations
8.2. Naive Gauss Elimination
8.3. Pivoting
8.4. Tridiagonal Systems
8.5. Model of a Heated Rod

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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RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Steven, C. and Canale, R. (2020) *Numerical Methods for Engineers*. 8th ed. McGraw–hill Higher Education, ISBN13: 9781260232073
2. Herbert, E. I. and Keller, B. (2012) *Analysis of Numerical Methods* Dover Publications ISBN-13: 978-0486680293
3. Householder, A. S. (2006) *The Theory of Matrices in Numerical Analysis* Dover Publications ISBN-13: 978-0486449722
4. Esfandiari, R. S. (2017) *Numerical Methods for Engineers and Scientists* Using MATLAB CRC Press ISBN 9781498777421
5. Sastry S.S (2012) *Introductory Methods of Numerical Analysis* Prentice Hall India Learning Private Limited ISBN-13: 978-8120345928

HYD-307 OPEN CHANNEL HYDRAULICS (03 Credit hours)

PRE-REQUISITE: HYD-302 Water Resources System Analysis

LEARNING OUTCOMES

Following are the learning outcomes of the course:

- Students will learn Fluid Flow Mechanism
- Student will be trained about energy and momentum equations
- Student will learn applications of momentum and energy equations
- Student will be trained about uniform flow in open channel
- Student will learn about of non-uniform flow in open channel

CONTENTS

This course provides deep learning of open channel flows and its governing principles.

Unit-1 Fluid Flow Mechanism

1.1. Basic Concepts of Fluid Flow
1.2. Types, state and regimes of fluid flow,
1.3. Channel flow types
1.4. Channel geometry
1.5. Measurement of velocity in channel
1.6. Velocity distribution in channel and its coefficients
1.7. Pressure distribution in channel
1.8. Effect of slope on pressure distribution.

Unit-II Energy and Momentum Equations

2.1. Energy equation
2.2. Momentum Principle: Basic equations,
2.3. Specific energy
2.4. Specific energy and alternate depths
2.5. E-Y relationship
2.6. Criteria for a critical state of flow
2.7. Computation of critical flow,
2.8. Fluid flow Control

Unit-III: Applications of Momentum and Energy Equations

3.1. Application of flow control in rectangular channel,
3.2. Momentum in open channel flow
3.3. Specific momentum
3.4. Hydraulic jump
3.5. M-Y relationship

Unit-IV: Uniform Flow in Open Channel

4.1. Establishment of uniform flow
4.2. The Chezy's equation
4.3. Manning's equations
4.4. Resistance coefficient estimation
4.5. Normal depth and velocity
4.6. Normal and critical slopes
4.7. Free board and its estimation
4.8. Analysis of hydraulic section
4.9. Determination of section dimensions

Unit-V: Non Uniform Flow in Open Channel

5.1. Rapidly Varied Flow
5.2. Characteristics of varied flow
5.3. Sharp crested weir
5.4. Aeration of the nappe crest shape
5.5. Discharge over spillway
5.6. Type and characteristics of the hydraulic jump
5.7. Jump as energy dissipater
5.8. Flow through sudden transitions

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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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. Kay, M. (2008). *Practical Hydraulics*. Taylor & Francis, Abingdon, UK.
2. Douglas, J. F J. M. Gasiorek, J. A. Swaffield and Jack. L. B. (2005). *Fluid Mechanics. Pearson Education Limited*, Edinburgh, UK.
3. Khurmi, R.S. (2012). *Textbook of Hydraulics and Fluid Mechanics.* Chand & Co Ltd., India
4. Subramanya, K. (2008). *Flow in Open Channels*. Tata McGraw-Hill.
5. Akan, A. O. (2006). *Open Channel Hydraulics*. Butterworth-Heinemann, Burlington, MA, USA.
6. Chaudhry, M.H. (2008) *Open Channel Flow* (Second Edition). Springer Science Business Media, LLC.
7. Sturm, (2001), *Open-Channel Hydraulics*, McGraw Hill

HYD 308 GROUNDWATER AND SURFACE WATER INTERACTIONS (02 Credit hrs)

PRE-REQUISITE: HYD-305 Soil and Water Conservation

LEARNING OUTCOMES

Following are the learning outcomes of the course:

- Student will learn fundamental of ground and surface water interaction
- Students will be trained about ground water flow analysis
- Students will learn about hydrodynamics of unsaturated flow
- Students will learn about infiltration theory and its applications
- Student will also learn ground water interaction with different mediums

CONTENTS

This course provides deep learning of surface and ground water interaction and its significance with reference to hydrology and water resources management

THEORY

Unit-1 Fundamental of Ground and Surface Water Interaction

1.1. Basics of groundwater & surface-water hydrology
1.2. Base flow analysis and separation techniques
1.3. Geologic aspects of ground and surface water interaction
1.4. landscape control analysis of ground and surface water interaction
1.5. climate controls on groundwater-surface water interaction
1.6. Local & Regional flow systems

Unit-II Ground Water Flow Analysis

2.1. Flow nets
2.2. Equipotential lines and flow lines.
2.3. Soil Water Hydrostatics
2.4. Soil water content
2.5. Soil water retention
2.6. Potential, Soil water retention curves & hysteresis.
2.7. Estimation of characteristics curves
2.8. Pedo-transfer functions

Unit-III: Hydrodynamics of Unsaturated Flow

3.1. Soil Water Hydrodynamics
3.2. Darcy's Law in the unsaturated zone
3.3. Unsaturated steady state flow
3.4. Unsaturated hydraulic conductivity models & applications

Unit-IV: Infiltration Theory and its Applications

4.1. Infiltration theory
4.2. Approximate Solutions to Infiltration
4.3. Green Ampt
4.4. Philip Equations
4.5. Numerical Modeling in Variably Saturated Porous Media
4.6. 1-D Spreadsheet Model Applications.

Unit-V: Ground Water Interaction with different Mediums

5.1. Interaction of Groundwater and Streams

5.2. Interaction of Groundwater and Lakes
5.3. Interaction of Groundwater and Wetlands. Chemical
5.4. Interactions of GW & SW in Streams, Lakes, and Wetlands

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:

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

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RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. McWhorter, D.B. and Sunada, D.K. (2010), *Ground-Water Hydrology and Hydraulics, Water Resources* Pubns; Reprint edition.
2. Cushman, J. H. and Tartakovsky, D. M. (2016) *The Handbook of Groundwater Engineering* (Boca Raton: CRC Press, 07 Nov 2016), accessed 07 Dec 2020, Routledge Handbooks Online.
3. Guthrie. M. (2018). *Ground and Surface Water Hydrology*, Larsen and Keller Education ISBN-13: 978-1635496949.
4. Winter, Thomas C., Harvey, J.W. Franke, O. L. and Alley, W. M (1998) *Ground water and surface water:* a single resource. Vol. 1139. DIANE Publishing Inc.
5. Pringle, C.M. and Triska, J. F. (2000) in *Streams and Ground Waters*, Elsevier Publishers

HYD 308 GROUNDWATER AND SURFACE WATER INTERACTIONS (LAB) (01 Credit hr)

PRE-REQUISITE: HYD-305 Soil and Water Conservation

LEARNING OUTCOMES

Following are the learning outcomes of the course:

- Students will learn about Flow nets and seepage analysis
- Students will be trained about spread sheet and models applications to investigate ground and surface water interaction
- Student will learn identification of ground and surface water interaction

CONTENTS

This course provides deep learning of surface and ground water interaction and its significance with reference to hydrology and water resources management.

PRACTICAL

Unit-1 Flow Nets and Seepage Analysis

1.1. Development and interpretations of flow nets
1.2. Interpretation of equipotential lines
1.3. Analysis of flow lines
1.4. Seepage analysis

Unit-II Use of Spread Sheets and Models for Ground and Surface water Interaction

2.1. Excel based 1-D spreadsheet models.
2.2. Pitman Model
2.3. Computer Applications to investigate ground and surface water interaction
2.4. Applications of Geospatial techniques

Unit-III: Identification of Ground and Surface Water Interaction

1.1. Study and identification of groundwater surface water interaction along a stream.

TEACHING – LEARNING STRATEGIES

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

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- homework
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- short tests, quizzes etc.

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4. Winter, Thomas C., Harvey, J.W. Franke, O. L. and Alley, W. M (1998) *Ground water and surface water:* a single resource. Vol. 1139. DIANE Publishing Inc.
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HYD 309 HYDRO INFORMATICS (03 credit hrs)

PRE-REQUISITE: HYD-203 Applications in GIS and Remote Sensing

LEARNING OUTCOMES

Following are the learning outcomes of the course:

- Student will learn about Data and the Data Life Cycle
- Student will learn about Databases and Data Models
- Student will learn about Visualization, Transformations, Analysis, and Modeling
- Student will learn about Soft Computing

CONTENTS

Unit-1 Data and the Data Life Cycle

1.1. Describe the data life cycle
1.2. Determine the dimensionality of a dataset, including the scale triplet of support, spacing and extent
1.3. Create basic programs for data collection using data loggers and, environmental sensors
1.4. Generate metadata and describe datasets to support data sharing
1.5. Discover and access data from major data sources

Unit-II Databases and Data Models

2.1. Store, retrieve, and use data from important data models used in Hydrology such as, ArcHydro, NetCDF, and the Observations Data Model (ODM)
2.2. Develop data models to represent, organize, and store data
2.3. Design and use relational databases to organize, store, and manipulate data
2.4. Query, aggregate, and pivot data using Structured Query Language (SQL), Excel, R, and other software systems

Unit-III: Visualization, Transformations, Analysis, and Modeling

3.1. Create reproducible data visualizations
3.2. Write and execute computer code to automate difficult and repetitive data related tasks manipulate data and transform it across file systems, flat files, databases, programming languages, etc.
3.3. Retrieve and use data from Web services
3.4. Organize data in a variety of platforms and systems common in hydrology and engineering

Unit-IV: Soft Computing

4.1. Soft computing,
4.2. Data mining
4.3. Artificial neural network
4.4. Genetic algorithms
4.5. Fuzzy logics

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. Kumar, P. (2005), *Hydroinformatics: Data Integrative Approaches in Computation, Analysis, and Modeling*, CRC Press, 552 p.
2. Grayson, R. and Blöschl, G. (2000), *Spatial Patterns in Catchment Hydrology: Observations and Modelling*, Cambridge University Press, Cambridge.
3. Tomer, S.K. (2012), *Python in Hydrology*, Grean Tea Press, Indian Institute of Science,147p. Full PDF text available at http://www.greenteapress.com/pythonhydro/pythonhydro.html (Links to an external site.)

HYD-309: HYDRO INFORMATICS (LAB) (01 Credit hr)

PRE-REQUISITE: HYD-203 Applications in GIS and Remote Sensing

LEARNING OUTCOMES

Following are the learning outcomes of the course:

- Student will learn about Data and the Data Life Cycle
- Student will learn about Databases and Data Models
- Student will learn about Visualization, Transformations, Analysis, and Modeling
- Student will learn about Soft Computing

CONTENTS

Unit-1 Data and the Data Life Cycle

1.1. Practical Skills related to data management and life cycle assessment

Unit-II Databases and Data Models

2.1. Practical related to Database and Data Models

Unit-III: Visualization, Transformations, Analysis, and Modeling

3.1. Data Transformation and Modeling
3.2. Data models common in hydrology and engineering

Unit-IV: Soft Computing

4.1. Soft computing,
4.2. Data mining
4.3. Artificial neural network
4.4. Genetic algorithms
4.5. Fuzzy logics

TEACHING – LEARNING STRATEGIES

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

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HYD 310 IRRIGATION II (THEORY) (03 Credit hrs)

PRE-REQUISITE: HYD-205 Irrigation (I)

LEARNING OUTCOMES:

- This course will provide an introduction to the Pressurized irrigation systems to the students.
- The students will learn about the Drip Irrigation system.
- They will have the knowledge about Hydraulics of Flow Regime
- The Fertilization process used with drip system will be introduced to them.
- The students will get used to Drip Design Procedure.
- The students will be equipped with the Design of Pipe Network system.
- They will become conversant with Sprinkler Irrigation & its importance in local environment.

CONTENTS

Unit-1 Drip Introduction

1.1. Introduction
1.2. Histories and Development
1.3. Components of Drip Irrigation System
1.4. Types of Drip System
1.5. Advantages and Disadvantages
1.6. Evaluation and Futuristic Approach of Drip Irrigation in Pakistan

Unit-II Hydraulics of Flow Regime

2.1. Reynolds Number
2.2. Darcy-Weisbach Equation
2.3. Hazen-William Formula
2.4. Hydraulic Characteristics of Distributors
2.5. Manufacturing Variation of Distributors
2.6. Irrigation Uniformity and Efficiency

Unit-III: Drip Design Procedure

3.1. Crop Water Requirements
3.2. Water Distribution in Soils and Wetting Pattern
3.3. Selection of Number of Distributors per Plant
3.4. System Capacity
3.5. Questions & Problems

Unit-IV: Design of Pipe Network

4.1. Hydraulic Formulae/Head Losses in Pipes
4.2. Lateral Design
4.3. Sub-main Design
4.4. Design Charts
4.5. Main Line Design
4.6. Farm Drip System Design Examples

Unit-V: Fertilization

5.1. Introduction
5.2. Fertilizers in Drip Fertigation
5.3. Drip Fertigation Systems
5.4. Rate of Fertilizer Application

Unit-VI Sprinkler Irrigation

6.1. History of Sprinkler Irrigation
6.2. Advantage and Limitations of Sprinkler Irrigation
6.3. Scope of Sprinkler Irrigation in Pakistan
6.4. Type of Sprinkler System and Components
6.5. Design of Sprinkler Irrigation System

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

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

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2. Choudhary, M. R. (2009). *A Text Book of Irrigation and Drainage Practices for Agriculture*. University of Agriculture, Faisalabad.
3. Kahlown, M. A. and Majeed. A. (2004). *Pakistan Water Resources Development and Management*. Pakistan Council of Research in Water Resources, Ministry of Science and Technology, Government of Pakistan.
4. Micheal, A. M. (2003). *Irrigation Theory and Practices*. Vikas Publishing House (Pvt), New Delhi.
5. Keller, J. (2001). *Sprinkle and Trickle Irrigation*. Blackburn Press, New Jersey, USA.
6. Phocaides, A. (2007). *Handbook on Pressurized Irrigation Techniques*. Food and Agriculture Organization of the United Nations, Rome.
7. Bliesner, R. D. and Keller, J. (2001). *Sprinkle and Trickle Irrigation*. Van Nostrand Reinhold.

HYD-310 IRRIGATION II (LAB) (01 Credit hr)

PRE-REQUISITE: HYD-205 Irrigation (I)

LEARNING OUTCOMES:

- This course will provide an introduction to the Computation of reference crop evapotranspiration (ETo).
- The students will learn about the Determination of Crop water requirement.
- They will have the knowledge about the Use of computer models for the determination of crop water requirement and irrigation scheduling,
- The Determination of Irrigation requirements, leaching requirements and irrigation scheduling will be performed by the students.
- The students will perform hands on training on Design of sprinkle irrigation system.
- The students will be equipped with the Design of trickle irrigation system.

CONTENTS

Unit-1

1.1. Computation of reference crop evapotranspiration (ETo)

Unit-II

2.1. Determination of Crop water requirement (etc).

Unit-III:

3.1. Determination of Irrigation requirements, leaching requirements and irrigation scheduling

Unit-IV:

4.1. Use of computer model (Crop water) for determination of crop water requirement and irrigation scheduling

Unit-V:

5.1. Design of sprinkle irrigation system, selection of sprinklers, and evaluation of sprinkler system

Unit-VI

6.1. Design of trickle irrigation system, selection of proper emitter and evaluation of drip irrigation system; design of low head pipeline

Unit-VII:

7.1. Visit to a sprinkler and trickle irrigation project site, Layout and design of sprinkler and drip irrigation systems, evaluation of the systems

Unit-VIII

8.1. Field demonstration of sprinkler and drip irrigation systems,
8.2. Use of software Wetup, IRRICAD etc.

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- short tests, quizzes etc.

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3. Kahlown, M. A. and Majeed. A. (2004). *Pakistan Water Resources Development and Management*. Pakistan Council of Research in Water Resources, Ministry of Science and Technology, Government of Pakistan.
4. Micheal, A. M. (2003). *Irrigation Theory and Practices*. Vikas Publishing House (Pvt), New Delhi.
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7. Bliesner, R. D. and Keller, J. (2001). *Sprinkle and Trickle Irrigation*. Van Nostrand Reinhold.

HYD-311 HYDROLOGICAL FIELD STUDIES II (01 Credit Hrs)

PRE-REQUISITE: HYD-212 Urban Hydrology

HYDROLOGICAL MEASUREMENTS

Study of urban drainage, urban water problems, 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.

4th YEAR, SEVENTH SEMESTER				
Sr. #	**Code**	**Course Title**	**Course Type**	**Credit Hours**
1.	HQ-07	Translation of Holy Quran	Compulsory	Non Credit
2.	HYD-401	Water Resources Laws and Transboundary Issues	Compulsory	02
3.	HYD-402	Advance Fluid Mechanics	Foundation	02+1
4.	HYD-403	Drainage Engineering	Foundation	02+1
5.	HYD-404	Watershed Management	Elective	03
6.	HYD-405	Advances in GIS and Remote Sensing	General	2+1
7.	HYD-406	Groundwater Modeling	Major	2+1
Total Credit hrs Semester-VII				**17**

HQ-07: TRANSLATION OF HOLY QURAN (Non Credit)

PRE-REQUISITE: HQ-06 Translation of Holy Quran

COURSE OUTLINE

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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.

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HYD-401 WATER RESOURCES LAWS AND TRANSBOUNDARY ISSUES (02 Credit hrs)

PRE-REQUISITE: HYD-210 Integrated Water Resources Management

LEARNING OUTCOMES

Following are the learning outcomes of the course:

- Students will be trained with Water Laws and Transboundary Issues
- Student will learn International River systems and Global issues
- Student will learn water conflicts and management
- Student will be trained about water scarcity issues
- Student will learn economic perspective of water infrastructure
- Student will learn hydro politics and United Nation (UN) Conventions
- Student will learn international river basin agreements

CONTENTS

This course provides of global water resource problems, laws and transboundary issues.

Unit-1 Water Laws and Transboundary Issues

1.1. Water Laws and Transboundary Issues
1.2. Introduction to international water law
1.3. The Evolution of the International Regulation on Fresh Water Resources
1.4. The Principles of the Law on Transboundary Water Resources I
1.5. The Principles of the Law on Transboundary Water Resources II
1.6. Prevention and Resolution of Water-Related Disputes

Unit-II International River Systems and Global Issues

2.1. International rivers system (selected)
2.2. Rivers systems and transboundary issues of south Asia
2.3. The World Bank, Global Water Partnership
2.4. United Nations (UN)
2.5. International water policy
2.6. Global water issues

Unit-III: Water Conflicts and Management

3.1. Water and resource conflict theories,
3.2. Organization of the course,
3.3. Introduction to basic principles and the problem of transboundary waters,
3.4. The conflict-environment position
3.5. The natural resource curse theory applied to water,
3.6. Water as a catalyst for cooperation, Systematic ways of thinking about water conflict and cooperation
3.7. Type of evidence used for systematic analyses

Unit-IV: Water Scarcity Issues

4.1. Transboundary Freshwater Dispute Database (TFDD) and other river basin event data
4.2. Quantitative assessments of conflict and cooperation; and challenges
4.3. Water and scarcity: definitions and dimensions of depletion
4.4. Concepts of water scarcity (and relevance to well-being and conflict processes)
4.5. Models of resource use and depletion
4.6. Scarcity in the future

Unit-V: Economic Perspective of Water Infrastructure

5.1. Climate, technology and adaptation
5.2. Water infrastructure, development and well-being
5.3. Investments in water resources: drivers or correlates of economic development

5.4. What do we know about the impacts of infrastructure?
5.5. Linking water resources to health and well-being, Economic perspectives
5.6. The challenging economics of water, Benefit-sharing
5.7. Virtual" water, trade, and general equilibrium, Water and security

Unit-VI: Hydro politics and UN Conventions

1.1. Hydro politics and securitization
1.2. The effects of water variability and disasters
1.3. International legal frameworks for dealing with water and institutional perspectives,
1.4. International water law
1.5. Helsinki rules and UN Convention

Unit-VII: International River Basin Agreements

7.1. Noteworthy river basin agreements and institutions,
7.2. Management of commons property resources and institutional resilience,
7.3. Water competition,
7.4. Political economy
7.5. Power asymmetries, issue salience, negotiation,
7.6. Internal politics and discourse
7.7. Game theory Weeks Student presentations and discussions.
7.8. Indus water treaty and transboundary issues of Pakistan.

TEACHING – LEARNING STRATEGIES

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

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- short tests, quizzes etc.

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RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Wu, X. and Whittington, D. (2006). *Incentive compatibility and conflict resolution in international river basins: A case study of the Nile Basin* Water Resources Research 42, W02417, doi:10.1029/2005WR004238, 2006.
2. Olmstead, S. & Sigman, H. (2015). "*Damming the Commons: An Empirical Analysis of International Cooperation and Conflict in Dam Location*."Journal of the Association of Environmental and Resource Economists 2(4): 497-526.
3. Wolf, A., Stahl, K., Macomber, M. (2003). *Conflict and Cooperation within International River Basins: The Importance of Institutional Capacity*. Water Resources Update. Pp.1-6.
4. Ostrom, E. (1999). *"Revisiting the Commons: Local Lessons, Global Challenges*." Science 284 (5412), 278-282. 5.
5. Deets, S. (2009). "*Constituting Interests and Identities in a Two-Level Game: Understanding the Gabcikovo-Nagymaros Dam Conflict*." Foreign Policy Analysis 5: 37- 56. 6.
6. PCA Press Release (2013). *"Indus Waters Kishenganga Arbitration* (Pakistan v. India)" Permanent Court of Arbitration.
7. Burke, M.; S. Hsiang; & Miguel, E. (2015). "*Climate and conflict*." Annual Review of Economics 7:577-617.
8. Guariso, A. & Rogall, T. (2015). "*Rainfall inequality, political power, and ethnic conflict in Africa*." Working Paper.
9. Rijsberman, F. (2006). "*Water scarcity: Fact or fiction*?" Agricultural Water Management 80: 5-22.
10. Kumar, M.D. (2018) *Water Policy Science and Politics*, Elsevier Publishers

HYD 402 ADVANCE FLUID MECHANICS (THEORY) (02 Credit hrs)

PRE-REQUISITE: HYD-307 Open Channel Hydraulics

LEARNING OUTCOMES:

- This course will provide an introduction to the fluid dynamics & hydraulic machinery to the students.
- The students will learn about the Flow Systems.
- They will have the knowledge about Control Structures used in fluid dynamics.
- The students will get used to Storage Structures & dimensional analysis.
- The students will be equipped with the Pumps its types & their Uses.

CONTENTS

Unit-1 Introduction

1.1. Introduction of fluid dynamics
1.2. Flow control systems
1.3. Characteristics of flow control system
1.4. Characteristics of flow control
1.5. Hydraulics of flow control
1.6. Flow control concept

Unit-II Flow Systems

2.1. Pipe flow system
2.2. Water distribution analysis,
2.3. Design, construction and maintenance of irrigation channels

Unit-III: Control Structures

3.1. Design of discharge control
3.2. Structures; Design of surface and underground pipe line systems
3.3. Design of Channels
3.4. Construction and maintenance of irrigation canals

Unit-IV: Storage Structures

4.1. Design of storage structures
4.2. construction and maintenance of small irrigation water storage structures.

Unit-V: Pumps Types & Uses

5.1. Principles, types, operations, performance and maintenance of irrigation pumps
5.2. Total pumping head
5.3. Study of characteristics curves for different pumps

Unit-VI: Selection Criteria

6.1. Pump selection
6.2. Power unit selection
6.3. Economic aspects of irrigation pumping machinery

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

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

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1. Kay, M. (2008). *Practical Hydraulics*. Taylor & Francis, Abingdon, UK.
2. Douglas, J. F. J. M. Gasiorek, J. A. Swaffield and Lynne B. Jack. (2005). *Fluid Mechanics.* Pearson Education Limited, Edinburgh, UK.
3. Khurmi, R.S. (2012). *Textbook of Hydraulics and Fluid Mechanics*. Chand & Co Ltd., India
4. Subramanya, K. (2008). *Flow in Open Channels*. Tata McGraw-Hill.
5. Akan, A. O. (2006). *Open Channel Hydraulics*. Butterworth-Heinemann, Burlington, MA, USA.

HYD 402 ADVANCE FLUID MECHANICS (LAB) (01 Credit hr)

PRE-REQUISITE: HYD-307 Open Channel Hydraulics

LEARNING OUTCOME:

- This course will provide an introduction to the demonstration of various parts of Hydraulic Bench.
- The students will learn about the experimental study of laminar and turbulent Flow.
- They will have the knowledge about measurement of drag on a small sphere.
- The verification of Bernoulli's theorem will be performed by the students.
- The students will get used to calibration of Orifices by various methods.
- The students will be equipped with the calibration of venturi meter.
- They will become conversant with calibration of. rectangular and triangular notch

CONTENTS

Unit-1

1.1. Demonstration of various parts of Hydraulic Bench

Unit-II

2.1. Experimental study of laminar and turbulent Flow.

Unit-III:

3.1. Measurement of Drag on a small sphere.

Unit-IV:

4.1. Calibration of Orifices by Various Methods

Unit-V:

5.1. Calibration of Venturi meter

Unit-VI:

6.1. Calibration of. Rectangular and Triangular Notch

Unit-VII:

7.1. Verification of Bernoulli's theorem

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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HYD 403 DRAINAGE ENGINEERING (THEORY) (02 Credit hrs)

PRE-REQUISITE: HYD-302 Water Resources System Analysis

LEARNING OUTCOMES:

- This course will provide an in depth knowledge of Surface and Subsurface drainage systems.
- This course will introduce the students to the Rainfall process and its Relationship to Drainage.
- The students will learn about the phenomena of Flow of Water through Soil.
- They will have the knowledge about the Surface Drainage Systems.
- The students will get used to Sub-Surface Drainage Systems.
- The students will be equipped with the Vertical Drainage System.

CONTENTS

Unit-1 Introduction

1.1. Waterlogging and salinity, their causes and remedial measures
1.2. Need for drainage
1.3. Purpose of drainage; benefits of drainage
1.4. Effect of poor drainage on soil and plant
1.5. Drainage problems in Pakistan.
1.6. Sources of excess water; relationship of irrigation and drainage.

Unit-II Rainfall and its Relationship to Drainage

2.1. Mean rainfall over a basin or watershed
2.2. Frequency of rainfall
2.3. Characteristics of storm
2.4. Time of concentration
2.5. The time of overland flow
2.6. Different formulas for estimating runoff

Unit-III: Flow of Water through Soil

3.1. Occurrence of ground water
3.2. Saturated and unsaturated flow
3.3. Flow of water through soil
3.4. Measurement of hydraulic head
3.5. Capillary flow above the water table
3.6. Critical water table depth measurement of hydraulic conductivity
3.7. Soil salinity control; leaching requirements

Unit-IV: Surface Drainage Systems

4.1. Surface drainage methods for flat lands and sloping lands
4.2. Surface drain design
4.3. Construction of surface drains
4.4. Maintenance of surface drains

Unit-V: Subsurface Drainage System

5.1. Types of subsurface drainage layouts
5.2. Interceptor drain; relief drains; mole drains
5.3. Material for subsurface drainage system
5.4. Design process for subsurface drainage system
5.5. Drainage coefficients; drain spacing formula
5.6. Hooghoudt's formula for steady state
5.7. Determination of design depth and pipe diameter; layout and patterns
5.8. The pipe; and the envelope materials, outlets, installation, maintenance

Unit-VI: Vertical Drainage System

6.1. Factors affecting the feasibility of drainage wells
6.2. Layout of drainage well systems
6.3. Problems associated with vertical drainage
6.4. Causes of failure of tubewell drainage in Pakistan
6.5. Well configuration, design consideration, maintenance, urban drainage system,
6.6. Principle and practices. Drainage, method of drainage, runoff components and soil moisture retardation.
6.7. Renovation of drainage system, sub-surface drainage design.
6.8. Drain capacity, slope and size. Layout of systems. Interceptor drains, canal design.

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 TEXT BOOKS / SUGGESTED READINGS

1. Smedema, L. K. Vlotman, W. F. Rycroft. D. W. (2020). *Modern Land Drainage: Planning, Design and Management of Agricultural Drainage Systems*. 2nd edition, Taylor & Francis. ISBN 9780367458775
2. Gupta S.A. (2019). *Drainage engineering: principles and practice*, Scientific Publishers ISBN: 9789388172028
3. Micheal, A. M. and Bhattacharya. A. K. (2003). *Land Drainage: Principles Methods and Application*. Konark Publishers Pvt Ltd, India. ISBN: 8122006558
4. Siddiqui, I. H. (2003). *Irrigation and Drainage Engineering*. Oxford University Press, ISBN: 9780195473568
5. Waller P, Yitayew M. (2015) *Irrigation and Drainage Engineering*, Springer ISBN-13: 9783319056982

HYD 403 DRAINAGE ENGINEERING (LAB) (01 Credit hr)

PRE-REQUISITE: HYD-302 Water Resources System Analysis

LEARNING OUTCOMES:

- This course will provide an introduction to the Measurement of seepage losses.
- The students will learn about the Auger hole method; constant and inverted auger hole method.
- They will have the knowledge about Field determination of hydraulic conductivity.
- The Calculation of drain spacing will be performed by the students.
- The students will get used to Computation of leaching requirement and drainage coefficient of a drainage basin.

CONTENTS

Unit-1

1.1. Measurement of seepage losses

Unit-II

2.1. Measurement of ground water table

Unit-III:

3.1. Auger hole method; constant and inverted auger hole method

Unit-IV:

4.1. Field determination of hydraulic conductivity

Unit-V:

5.1. Calculating drain spacing

Unit-VI:

6.1. Computation of leaching requirement and drainage coefficient of a drainage basin.

Unit-VII:

7.1. Field trip to subsurface drainage scheme

Unit-8

8.1. Practical examples of urban drainage design.

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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HYD 404 WATERSHED MANAGEMENT (03 credit hrs)

PRE-REQUISITE: HYD-210 Integrated Water Resources Management

LEARNING OUTCOMES

Following are the learning outcomes of the course:

- Student will learn about Watershed Management
- Student will learn about Technological Applications to Watershed Management
- Student will learn about Soil Water Conservation
- Student will learn about Agronomic Practices
- Student will learn about Reducing Losses from Watershed

CONTENTS

This course will provide an insight learning of watershed problems, solution, management and long term planning.

THEORY

Unit-1 Watershed Management

1.1. Introduction: importance and role of watershed management
1.2. Issues and constraints in watershed management
1.3. Socio-technical approaches for development
1.4. Sustainable integrated watershed management
1.5. Surveys in selected watersheds.

Unit-II Technological Applications to Watershed Management

2.1. Appropriate Technology and Practices
2.2. Rehabilitation of degraded land
2.3. Agroforestry systems and practices
2.4. Bio-engineering practices for soil and water conservation
2.5. Land slide control in upland watersheds
2.6. Bio-technology of natural resource management

Unit-III: Soil Water Conservation

3.1. Soil erosion
3.2. Soil and water conservation.
3.3. Water Harvesting Practices
3.4. Micro-catchment development in local, regional and global Level
3.5. Catchment area ratio and grid spacing
3.6. Land development techniques
3.7. Reducing runoff losses

Unit-IV: Agronomic Practices

4.1. Agronomic practices
4.2. Land surface modification,
4.3. Contour bonding
4.4. Contour trenches
4.5. Hillside conduit system

Unit-V: Reducing Losses from Watershed

5.1. Reducing evaporation losses
5.2. Reducing losses from reservoirs
5.3. Forcing deep water penetration
5.4. Reducing deep percolation losses
5.5. Chemical treatment
5.6. Anti-transparent; RS/GIS applications in watershed management

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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RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Heathcote I. W. (2009). *Integrated Watershed Management*, John Wiley & Sons. Inc.
2. Beheim, E., Rajwar, G. S. Haigh, M. Krecek, J. (2010). *Integrated Watershed Management: Perspectives and Problems.* Capital Publishing Company, Springer.
3. Gregersen, H. Folliott, P. F and Brookes. K. (2008). *Integrated Watershed Management*: Connecting People to their Land and Water. Cabi Publishing.

HYD-405 ADVANCES IN GIS AND REMOTE SENSING (THEORY) (02 Credit hrs)

PRE-REQUISITE: HYD-203 Applications of GIS and Remote Sensing

LEARNING OUTCOMES

Following are the learning outcomes of the course:

- Student will learn about Data Processing and Application of GIS and Remote Sensing
- Student will learn about Use of Scripting Languages in Hydrology
- Student will learn about Multi Criteria Decision Analysis (MCDA)
- Student will learn about Applications of GIS and Remote Sensing in Hydrology
- Student will learn about Flood analysis using GIS and Remote Sensing

Contents

Remote sensing and GIS theories, satellites systems, image interpretation, and applications in hydrology. Practical performance of advances in GIS and remote sensing.

Theory

Unit-1 Data Processing and Application of GIS and Remote Sensing

1.1. Preprocessing data for model uses
1.2. Application of GIS for data preprocessing
1.3. Remote sensing in GIS and Remote sensing
1.4. Data Tabulation
1.5. conversion
1.6. projection
1.7. catchment delineation
1.8. Use of OSGEO software (Quantum GIS, GDAL)

Unit-II Use of Scripting Languages in Hydrology

2.1. Using scripts (shell and Python) to batch process datasets
2.2. High resolution DEM generation
2.3. Pre and Post flood damage assessment
2.4. Using Earth observation satellite data and DEM
2.5. Spatio-temporal analysis for water quality assessment
2.6. Python scripts to calculate a water surface profile for wetland decision making

Unit-III: Multi Criteria Decision Analysis (MCDA)

3.1. Analytical Hierarchy process for Weight calculation,
3.2. Dam site selection using Multi Criteria analysis (MCDA)
3.3. Computation and assessment of water balance

Unit-IV: Applications of GIS and Remote Sensing in Hydrology

4.1. Retrieval of hydro-metrological parameters using remote sensing
4.2. Integration in hydrological models with GIS and Remote Sensing
4.3. Mapping and monitoring snow cover, glaciers, and surface water
4.4. Snow-glacier melt analysis using GIS and Remote Sensing
4.5. Applications of GIS and Remote Sensing to rainfall-runoff models
4.6. Surface runoff computation using rainfall – runoff modeling

Unit-V: Flood analysis using GIS and Remote Sensing

5.1. Hydrological modeling approach using GIS and Remote Sensing
5.2. Flood analysis using geospatial techniques
5.3. Design flood computation using geospatial techniques

5.4. Flood forecasting and Modeling
5.5. Groundwater and urban hydrological/hydrodynamic modeling studies
5.6. Geo-spatial data creation, integration and assimilation for flood simulation in 1/2 D HD models

TEACHING – LEARNING STRATEGIES

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

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

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

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2. Heywood, i., Cornelius, A. and Carver, S. (2006). *An introduction to Geographical Information Systems*. 3rd ed.Perason Education Limited.
3. Aspinall, R., (2003). *Modelling land use change with generalized linear models-a multi-model analysis of change between 1860 and 2000 in Gallatin Valley, Montana*. Journal of Environmental Management 73-91.
4. Jansen, M., Judas, M.E. and Saborowski, J. (2002). *Spatial Modelling in Forest Ecology and management- A Case Study*. Springer 223.
5. Kohsaca, H. (2001). *Applications of GIS to urban planning and management: Problems facing Japanese local governments.* Geojournal, 52: 271-280
6. Michael, Z. (1999). *Modeling Our World: The ESRI Guide to Geodatabase Design*. ESRI Press, 216 pp.

HYD 405 ADVANCES IN GIS AND REMOTE SENSING (LAB) (01 Credit hr)

PRE-REQUISITE: HYD-203 Applications of GIS and Remote Sensing

LEARNING OUTCOMES

Following are the learning outcomes of the course:

- Student will learn about Use of Advance GIS Software
- Student will learn about Use of QGIS and Google Earth Engine
- Student will learn about Use of Scripting Languages

CONTENTS

Remote sensing and GIS theories, satellites systems, image interpretation, and applications in hydrology. Practical performance of advances in GIS and remote sensing.

PRACTICAL

Unit-1 Use of Advance GIS Software

Use of Software like

1.1. OSGEO
1.2. Quantum GIS
1.3. GDAL

Unit-II Use of QGIS and Google Earth Engine

2.1. QGIS
2.2. Google earth engine

Unit-III: Use of Scripting Languages

3.1. using scripts (shell and Python) to execute water resources and modeling applications.

TEACHING – LEARNING STRATEGIES

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

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HYD 406 GROUNDWATER MODELING (THEORY) (02 Credit hrs)

PRE-REQUISITE: HYD-308 Ground Water and Surface Water Interaction

LEARNING OUTCOMES

Following are the learning outcomes of the course:

- Student will learn about damental Concepts of Ground Water Modeling
- Student will learn about Steady and Unsteady Flow of Ground Water
- Student will learn about Ground Water Modeling Structure its Types
- Student will learn about Transient Flow
- Student will learn about Solute Transport Modeling

CONTENTS

Groundwater Modeling, Flow Modelling, Salute transport Modelling, Numerical Models, Transient Models, Flow nets.

THEORY

Unit-1 Fundamental Concepts of Ground Water Modeling

1.1. Basic concepts of groundwater modeling
1.2. Systems analysis and Models
1.3. Equations of numerical methods
1.4. Governing equations of ground water modeling
1.5. Derivation of governing equations

Unit-II Steady and Unsteady Flow of Ground Water

2.1. Steady state ground water flow
2.2. Unsteady state ground water flow
2.3. Solution methods for groundwater modeling.
2.4. Regional groundwater flow

Unit-III: Ground Water Modeling Structure its Types

3.1. The conceptual model and grid design
3.2. Types of ground water models
3.3. Ground water modeling layers
3.4. Types of grids
3.5. Data needs for ground water modeling
3.6. Assigning parameter values, types of boundaries,
3.7. Simulation boundaries, sources and sinks: injection and pumping wells
3.8. Finite difference models
3.9. Finite element models

Unit-IV: Transient Flow

4.1. Transient simulating
4.2. Model execution and the calibration process
4.3. Contaminant Transport
4.4. Advection, Dispersion & Diffusion, Adsorption, Boundary conditions

Unit-V: Solute Transport Modeling

5.1. Solute Transport Modeling,
5.2. Transport Models
5.3. Solution methods

5.4. Sequence of running of transport models
5.5. Limitations of models

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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2. Jani, J. (2011). *A GIS-based Method for Groundwater Modelling*. University of Sheffield.
3. Howard S. W, Simon A. M. and Li. X. (2010). *Groundwater Modelling in Arid and Semi-Arid Areas*. Cambridge University Press.
4. Wang, H.F and Anderson, M.P. (1995) *Introduction to Groundwater Modeling*. AP Academic Press, Inc.
5. Todd, D.K., and Mays, L.W., (2008) *Groundwater Hydrology*, 3rd edition, Wiley.

HYD 406 GROUNDWATER MODELING (LAB) (01 credit hr)

PRE-REQUISITE: HYD-308 Ground Water and Surface Water Interaction

LEARNING OUTCOMES

Following are the learning outcomes of the course:

- Student will learn about Ground Water Modeling
- Student will learn about Development of Steady and Transient Flow
- Student will learn about Practical Performance of Ground Water Models

CONTENTS

PRACTICAL

Unit-1 Ground Water Modeling

1.1. Introduction to Groundwater Modeling Code (MODFLOW)
1.2. Introduction to different Groundwater Modeling Software's. and its GUI's

Unit-II Development of Steady and Transient Flow

2.1. Development of a Steady state groundwater flow model.
2.2. Development of a Transient groundwater flow model.

Unit-III: Practical Performance of Ground Water Models

3.1. Practical performance of MODEFLOW
3.2. Practical Performance of MT3DMS

TEACHING – LEARNING STRATEGIES

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

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- hands-on-activities,
- Short tests, quizzes etc.

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4th YEAR, EIGHTH SEMESTER				
Sr. #	**Code**	**Course Title**	**Course Type**	**Credit Hours**
1.	HQ-08	Translation of Holy Quran	Compulsory	01
2.	HYD-408	Reservoir Design and Operation	Foundation	03+1
3.	HYD-409	Sustainable Water Resources Development	Elective	03
4.	HYD-410	Environmental Issues in Water Resources	General	03
5.	HYD-411	Thesis / Viva Voce Examination	Major	06
		Total Credit hrs Semester-VIII		**17**

HQ-08: TRANSLATION OF HOLY QURAN (01 Credit hr

PRE-REQUISITE: HQ-07

COURSE OUTLINE

سورة الذريات تا سورة الناس

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

ASSESSMENT AND EXAMINATIONS:

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HYD-408 RESERVOIR DESIGN AND OPERATION (THEORY) (03 credit hours)

PRE-REQUISITE: HYD-301 Surface Water Hydrology

LEARNING OUTCOMES

Following are the learning outcomes of the course:

- Student will learn about Reservoir Classification and Capacity
- Student will learn about Reservoir Simulation
- Student will learn about Flood Routing
- Student will learn about Computer Application to Reservoir Operation
- Student will learn about Reservoir Economics and optimization

CONTENTS

Introduction to the principles and practices of reservoir operation and design

THEORY

Unit-1 Reservoir Classification and Capacity

1.1. Classification of reservoirs
1.2. Methods to determine water availability for reservoir design
1.3. Methods to determine capacity of reservoir
1.4. Ripple mass curve analysis
1.5. Sequent peak analysis

Unit-II Reservoir Simulation

2.1. Simulation, optimization method to determine reservoir capacity
2.2. Stochastic methods in determination of reservoir capacity.
2.3. Concept of probability of failure in reservoir operation.
2.4. Reservoir operation studies using simulation
2.5. system analysis techniques for reservoir operation
2.6. Conjunctive use of reservoirs.

Unit-III: Flood Routing

3.1. Flood control procedure by reservoir operations.
3.2. Flood routing through a reservoir
3.3. Level pool method
3.4. Muskingum method
3.5. Muskingum-Cung method
3.6. Runk-Kutta Methods

Unit-IV: Computer Application to Reservoir Operation

4.1. Application of computer methods for reservoir operation and design.
4.2. Review of widely used computer model for reservoir design and operation
4.3. Application of R language for reservoir operation and design

Unit-V: Reservoir Economics and optimization

5.1. Basic concept economics
5.2. Cost benefits ratios analysis for reservoir operation
5.3. Optimization of reservoir demand and supply
5.4. Linear programming for reservoir operation
5.5. Dynamic programming for reservoir operation

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,
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ASSESSMENT AND EXAMINATIONS:

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RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

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2. Singh, V. P. (2017) *Handbook of Applied Hydrology, Second Edition*, McGraw-Hill Education
3. Eagleson, P.S. (1970) *Dynamic Hydrology*, McGraw-Hill, Inc., New York.
4. Kumar, D. (2011) *Watershed Modeling and Management*: A Concise Approach VDM Verlag Dr. Müller ISBN-13: 978-3639371482
5. Westervelt, J. (2001) Simulation Modeling for Watershed Management 2001st Edition Springer ISBN-13: 978-0387988931
6. Eslamian, S. (2014) *Handbook of Engineering Hydrology*: Modeling, Climate Change, and Variability (Volume 1) 1st Edition CRC Press ISBN-13: 978-1466552463
7. Subramanya, K.G. (2008) *Engineering Hydrology* 3rd Edition, McGraw-Hill, Inc.

HYD-408 RESERVOIR DESIGN AND OPERATION (LAB) (01 Credit hr)

PRE-REQUISITE: HYD-301 Surface Water Hydrology

LEARNING OUTCOMES

Following are the learning outcomes of the course:

- Student will learn about Practical Reservoir Capacity
- Student will learn about Computer Application

CONTENTS

PRACTICAL

Unit-1 Practical Reservoir Capacity

1.1. Practical aspects regarding capacity of reservoir
1.2. Ripple mass curve analysis
1.3. Sequent peak analysis
1.4. Simulation, optimization methods

Unit-II Computer Application

2.1. application of computer methods and models for reservoir operation and design
2.2. Linear Programming
2.3. Dynamic Programming

TEACHING – LEARNING STRATEGIES

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

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

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- homework
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- 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. Viessman, Jr., W., Lewis, G.L. and Knapp, J.W. (1989) *Introduction to Hydrology*, Harper and Row, New York
2. Singh, V. P. (2017) *Handbook of Applied Hydrology, Second Edition*, McGraw-Hill Education
3. Eagleson, P.S. (1970) *Dynamic Hydrology*, McGraw-Hill, Inc., New York.
4. Kumar, D. (2011) *Watershed Modeling and Management*: A Concise Approach VDM Verlag Dr. Müller ISBN-13: 978-3639371482
5. Westervelt, J. (2001) Simulation Modeling for Watershed Management 2001st Edition Springer ISBN-13: 978-0387988931
6. Eslamian, S. (2014) *Handbook of Engineering Hydrology*: Modeling, Climate Change, and Variability (Volume 1) 1st Edition CRC Press ISBN-13: 978-1466552463
7. Subramanya, K.G. (2008) *Engineering Hydrology* 3rd Edition, McGraw-Hill, Inc.

HYD-409 SUSTAINABLE WATER RESOURCES DEVELOPMENT (03 Credit hrs)

PRE-REQUISITE: HYD-404 Watershed Management

LEARNING OUTCOMES

Following are the learning outcomes of the course:

- demonstrate critical thinking about sustainable water systems.
- engage with major policy issues and concepts including water regulation, governance, and the water-energy-food nexus.
- discuss theoretical and substantive areas of water management for different human and natural uses.
- articulate methods used in evaluating sustainable water systems such as modeling, demand and supply management and water accounting.
- employ tools to evaluate real world case studies.

CONTENTS

Unit-1 Human and Water

1.1. concepts of sustainable water resources development
1.2. what we are doing today
1.3. future water resources availability
1.4. ethical water utilization
1.5. overexploitation of water resources

Unit-II Sustainable development and water

2.1. Indigenous perspectives on water
2.2. Balancing diverse needs for water
2.3. Environment
2.4. ecosystem services,
2.5. the human right to water

Unit-III: Water Foot Prints

3.1. Water Foot-Print and Accounting
3.2. Integrated Water Resources Management
3.3. Agricultural water use

Unit-IV: Management of Water Resources

4.1. Water use
4.2. Water reuses
4.3. stewardship within the industrial sector
4.4. efficient water resources design
4.5. why, what and how to manage water resources
4.6. concept of environmental water management
4.7. water allocation and water scheduling problems

Unit-V: Water Governance

5.1. Water governance,
5.2. legislation and law
5.3. Water pricing and privatization
5.4. understanding trade-offs

Unit-VI: Global Efforts

6.1. Think Globally: Act Locally on water resources
6.2. Manware on water resource management
6.3. Local water organizations; WAPDA, IRRIGATION WASA etc
6.4. World water organizations; UN, GWP, WWC, etc.

Unit-VII: Hydro-politics

7.1. International water disputes
7.2. Local water disputes
7.3. Water sharing among provinces pros and cons
7.4. Indus Water treaty
7.5. Selected Case studies

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 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.

RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Hoekstra, A. Y. (2000). *Appreciation of water: four perspectives. Water Policy* 1(6): 605-622.
2. UN Water (2013). *UN-Water Analytical Brief Water Security and the Global Water Agenda* – 4-page Summary for Decision Makers.
3. Kubota, N.K. Setiawan, J. Indra, B. (2016) "*Sustainable Water Management New Perspectives, Design, and Practices*" Springer ISBN 978-981-10-1204-4
4. Rong, S. and Li, F. (2019) *Sustainable Development of Water and Environment Proceedings of the ICSDWE* Springer ISBN 978-3-030-16729-5
5. Ghosh, M. K. and Roy (2011) *Sustainable Development Environment, Energy and Water Resources* CRC Press ISBN 9781439888254
6. Farolfi, S. Perret, S. Hassan, R. (2013) *Water Governance for Sustainable Development Approaches and Lessons from Developing and Transitional Countries* Routledg, ISBN 9780415852029

HYD-410 ENVIRONMENTAL ISSUES IN WATER RESOURCES (03 Credit hrs)

PRE-REQUISITE: HYD-308 Ground Water and Surface Water Interaction

LEARNING OUTCOMES

Following are the learning outcomes of the course:

- Student will learn about Basic Concept of Environment
- Student will be trained about Components of Environment
- Student will learn about Environmental Challenges
- Student will learn about Global Environmental Issues
- Student will learn about Pollution and its Control
- Student will learn about Pollution and its Control
- Student will learn about Energy and Economics of Environment

CONTENTS

Unit-1 Basic Concept of Environment

1.1. Introduction to environmental issues
1.2. basic concepts, environment
1.3. History, nature and scope of Environmental Science
1.4. Environmental Sciences and its contribution to society.
1.5. physical, ecological, socio-economic, ethical, philosophical aspects of Environment

Unit-II Components of Environment

2.1. Major components of environment:
2.2. Physico-chemical Components of environment
2.3. Biological components of environment
2.4. Social, and their relationships with various environmental factors
2.5. Human environment and its problems
2.6. global, national, regional aspects of environment

Unit-III: Environmental Challenges

3.1. Environmental challenges for sustainable development
3.2. Current and future trends in population growth
3.3. Environmental pollution
3.4. Development in industry and agriculture
3.5. Urbanization, poverty and resource depletion

Unit-IV: Global Environmental Issues

4.1. Why Environmental Education? Across the
4.2. Globe-Environmental Issues,
4.3. Cultural Changes,
4.4. Population Dynamics and Control,
4.5. Ecosystems, Air Pollution and
4.6. Global Warming
4.7. Ozone Depletion
4.8. Acid Rain, Solutions
4.9. Water Pollution; Rivers, Lakes, Groundwater, Solutions
4.10. Ultimate Global Problems of Deforestation and loss of Biodiversity
4.11. Mangroves and their disappearance
4.12. Solid and Hazardous Waste
4.13. Food Resources and World Hunger

Unit-V: Pollution and its Control

5.1. Soil Pollution

5.2. Fertilizers, Pesticides and their harmful effects on environment
5.3. Pest Control, Social Environment
5.4. Common Drug in Pakistan: Heroin and Alcohol, Nicotine etc.
5.5. Women and Environment, Chipko Movement, Chance and catastrophes
5.6. Air pollution (outdoor and indoor),
5.7. Treating wastes
5.8. Sustainable Development, Environment of Cities
5.9. Noise and Noise pollution
5.10. Water supply use and management

Unit-VI: Energy and Economics of Environment

6.1. Energy concepts in environment,
6.2. Fossil Fuels (oil, natural gas and coal)
6.3. Alternate Energy and Environment (wind, solar etc.)
6.4. Nuclear energy and Environment, Mining and Environment
6.5. Environmental economics
6.6. Environmental health and toxicology

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
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RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Montgomery, C. (2005) *Environmental Geology*. McGraw-Hill.
2. Nebel, BJ & Wright, R. (2004) *Environmental Science: Toward a Sustainable Future*. Prentice-Hall.
3. Miller G.T. (2005) *Living in the Environment: Principles, Connections, and Solutions*. Belmont, Calif.: Brooks/Cole (14th International student edition)
4. Wright, R.T. (2005) *Environmental Science - toward a Sustainable Future.* (9th International Edition), Pearson Education International, Prentice Hall Publishers.
5. Botkin, D.B. and Keller, E.A. (2007). *Environmental Science: Earth as a Living Planet*. 6th and 12th Ed., John Wiley & Sons.
6. McKinney, M.L., Schoch, R.M. & Yonavjak, L. (2007). *Environmental Science: systems and solutions*. 4th Ed., Jones & Bartlett Publishers.
7. Wright, R.T. and Nebel, B.J. (2007). *Environmental Science: Toward a Sustainable Future*. 10th Ed., Pearson Educational.
8. Miller, G. (2002). *Environmental Science: Working with the Earth*. Thomson Learning.

HYD-411 THESIS / VIVA VOCE EXAMINATION (06 Credit hrs)

PRE-REQUISITE: F.Sc. or equivalent

Dissertation (Viva Voice Examination)