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 5th to 8th Semester of BS Hydrology and Water Resources Management (HWRM) in Replacement of MA/M.Sc Program at the College of Earth and Environmental Sciences as well as affiliated Colleges w.e.f. the Academic Session, 2021 and onward.

The Revised Syllabi and Courses of Reading for 5th to 8th Semester of BS Hydrology and Water Resources Management (HWRM) in Replacement of MA/M.Sc is attached herewith as Annexure 'A'.

Sd/-
REGISTRAR

Admin. Block,
Quaid-i-Azam Campus,
Lahore.
No. D/ 7671 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. All the Principals of the affiliated Colleges
4. Controller of Examinations
5. Director, IT for placement at the website
6. Admin Officer (Statutes)
7. Secretary to the Vice-Chancellor.
8. PS to the Registrar.
9. Assistant Syllabus.

Assistant Registrar (Academic)
for Registrar

COLLEGE OF EARTH AND ENVIRONMENTAL SCIENCES
UNIVERSITY OF THE PUNJAB, LAHORE

Courses & Syllabi
5th – 8th Semester of BS Hydrology and Water Resources Management
in Replacement of MA / M.Sc. program at University affiliated Colleges

Program Title: **BS Hydrology and Water Resources Management**

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

Faculty: **Geosciences**

01. Categorization of Courses as per HEC Recommendation and Difference

Semester	Courses	Category (Credit Hours)					
		Compulsory	Foundation	General	Major	Elective	Semester Load
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	**25**	**7**	**6**	**05**	**05**	**02**	**69**

02. Scheme of Studies / Semester –Wise Workload

Sr. #	Code	Course Title	Course Type	Prerequisite	Credit Hours
Semester V					
1.	HQ-05	Translation of Holy Quran	Compulsory	Associate Degree (Science), B.Sc. or equivalent	Non Credit
2.	HYD-301	Surface Water Hydrology	Major	Associate Degree (Science), B.Sc. or equivalent	02+1
3.	HYD-302	Water Resources System Analysis	Foundation	Associate Degree (Science), B.Sc. or equivalent	02+1
4.	HYD-303	Applied Soil Mechanics	General	Associate Degree (Science), B.Sc. or equivalent	02+1
5.	HYD-304	Hydrochemistry and Pollution Control	General	Associate Degree (Science), B.Sc. or equivalent	03+1
6.	HYD-305	Soil and Water Conservation	General	Associate Degree (Science), B.Sc. or equivalent	03
Total Credit hrs Semester-V					**16**
Semester VI					
7.	HQ-06	Translation of Holy Quran	Compulsory	HQ-05	01
8.	HYD-306	Advance Mathematics in Hydrology	Compulsory	Associate Degree (Science), B.Sc. or equivalent	03
9.	HYD-307	Open Channel Hydraulics	Foundation	HYD-302	03
10.	HYD-308	Ground water and Surface water Interactions	Foundation	HYD-305	02+1
11.	HYD-309	Hydro-informatics	Major	Associate Degree (Science), B.Sc. or equivalent	03+1
12.	HYD-310	Irrigation-II	Major	Associate Degree (Science), B.Sc. or equivalent	03+1
13.	HYD-311	Hydrological Field Studies-II	Compulsory	Associate Degree (Science), B.Sc. or equivalent	01
Total Credit hrs Semester-VI					**19**

Sr. #	Code	Course Title	Course Type	Prerequisite	Credit Hours
Semester VII					
14.	HQ-07	Translation of Holy Quran	Compulsory	HQ-06	Non Credit
15.	HYD-401	Water Resources Laws and Transboundary Issues	Compulsory	Associate Degree (Science), B.Sc. or equivalent	02
16.	HYD-402	Advance Fluid Mechanics	Foundation	HYD-307	02+1
17.	HYD-403	Drainage Engineering	Foundation	HYD-302	02+1
18.	HYD-404	Watershed Management	Elective	Associate Degree (Science), B.Sc. or equivalent	03
19.	HYD-405	Advances in GIS and Remote Sensing	General	Associate Degree (Science), B.Sc. or equivalent	2+1
20.	HYD-406	Groundwater Modeling	Major	HYD-308	2+1
Total Credit hrs Semester-VII					**17**
Semester VIII					
21.	HQ-08	Translation of Holy Quran	Compulsory	HQ-07	01
22.	HYD-408	Reservoir Design and Operation	Foundation	HYD-301	03+1
23.	HYD-409	Sustainable Water Resources Development	Elective	HYD-404	03
24.	HYD-410	Environmental Issues in Water Resources	General	HYD-308	03
25.	HYD-411	Thesis / Viva Voce Examination	Major	--	06
Total Credit hrs Semester-VIII					**17**
Grand Total (V+VI+VII+VIII):					**69**

03. Award of Degree

02 Year BS degree (5^{th} to 8^{th} Semesters) 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.

04. NOC from Professional Councils (if applicable)

Not Applicable

05. 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**

06. Present Student Teacher Ratio in the Department

447: 19= (1:23)

07. Scheme of Study/Semester Wise Workload

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: Associate Degree (Science), B.Sc. or equivalent

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:

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

PRE-REQUISITE: Associate Degree (Science), B.Sc. or equivalent

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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- homework
- attitude and behavior,
- 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. 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: Associate Degree (Science), B.Sc. or equivalent

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

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

PRE-REQUISITE: Associate Degree (Science), B.Sc. or equivalent

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.

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. Evangelos, B. (2018). *Hydrology and Water Resources System Analysis.* CRC Press. Taylor & Francis Group.
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: Associate Degree (Science), B.Sc. or equivalent

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

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

PRE-REQUISITE: Associate Degree (Science), B.Sc. or equivalent

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

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. 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: Associate Degree (Science), B.Sc. or equivalent

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

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. 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: Associate Degree (Science), B.Sc. or equivalent

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

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- 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. 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: Associate Degree (Science), B.Sc. or equivalent

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:

1.1 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.

ASSESSMENT AND EXAMINATIONS:

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HYD 305 SOIL AND WATER CONSERVATION (03 Credit hrs)

PRE-REQUISITE: Associate Degree (Science), B.Sc. or equivalent

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

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

- classroom participation,
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- 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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HYD-306: ADVANCE MATHEMATICS IN HYDROLOGY (03 Credit hrs)

PRE-REQUISITE: Associate Degree (Science), B.Sc. or equivalent

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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- 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,
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- homework
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- short tests, quizzes etc.

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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

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

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

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HYD 309 HYDRO INFORMATICS (03 credit hrs)

PRE-REQUISITE: Associate Degree (Science), B.Sc. or equivalent

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
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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. 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

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

PRE-REQUISITE: Associate Degree (Science), B.Sc. or equivalent

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

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1. Ali, M. H. (2011). *Practices of Irrigation & On-Farm Water Management*: Volume 2. Springer, USA.
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: Associate Degree (Science), B.Sc. or equivalent

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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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.
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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: Associate Degree (Science), B.Sc. or equivalent

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

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

PRE-REQUISITE: Associate Degree (Science), B.Sc. or equivalent

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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- homework
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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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- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,

- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS

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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,
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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.

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

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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

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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HYD 404 WATERSHED MANAGEMENT (03 credit hrs)

PRE-REQUISITE: Associate Degree (Science), B.Sc. or equivalent

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

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

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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: Associate Degree (Science), B.Sc. or equivalent

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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- 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: Associate Degree (Science), B.Sc. or equivalent

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,
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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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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:

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- homework
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- 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

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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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- homework
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- short tests, quizzes etc.

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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

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- classroom participation,
- attendance, assignments and presentation,
- homework
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ASSESSMENT AND EXAMINATIONS:

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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)