**Research Method**

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| --- | --- | --- | --- | --- | --- |
| **Prerequisites:**No | **Theory: 1****Practical: 1** | **Course type:** Major: Common | **Number of course: 2****Number of hours: 48** | **Row:01** | **Research Method** |
| **Practical Supplementary Training: Yes No** Science trip Workshop Laboratory Seminar  |

**Course Objective:** Familiarity with the various stages of research and its methods and conduct a sample research to prepare for the dissertation.

**Outline:**

**Theory:**

Philosophical Principles and Research Approach, Aristotelian Logic, Logic of Iranian-Islamic Scholars, Cause and Effect, Approach of Opinions and Opinions in Research, External (Mal al-Haland), Ferdowsi (Introduction to Shahnameh and Introduction to Shahnameh Abu Mansouri), Ibn Khaldun, Abu Saeed Abu al-Khair, Aristotle, Descartes, Hegel, Basic Concepts in Research, Problem and Question Expression, Variable Hypothesis and Hypothesis, Adjective and Parameter, Quantitative and Qualitative Argument, Index and Criteria of Statistical Argument and Interrogation, Subject and Types of Subject and Depth in Research, Analytical and Descriptive Research , Types of research, basic, applied, study, research and development, research in natural sciences and social sciences, contractual (field) research, differences in the effectiveness of evaluation (evaluation), economic research, social research, techniques and tools, quantitative and qualitative problem , Transition from quantity to quality, assessment in research, production of information and thought, techniques and statistical methods, application of statistics in research, types of statistical analysis and inference, statistical tests, correlation and regression, statistics and mathematics, sampling methods (experimental design) , Types of variables and parameters, formal, relative, distance, sequential, quantitative, qualitative, discrete, continuous, continuous, disturbing variables, two-value and multi-value variables, measurement scales and measures, experimental design T in Agriculture and Natural Resources, Methods of Collecting and Recording Information (Fisheries, Experimental Resources and Documents, Field, Contract ...), Principles of Writing.

**Practical:** Develop a proposal, write an article, compile a statistical plan, summarize a book

**Assessment Method (Percent):**

|  |  |  |  |
| --- | --- | --- | --- |
| Project / Work | End of semester exam | Mid-Term Exam | Continues assessment |
| 30 | 50 | 10 | 10 |

**References:**

1) Mir Mohammadi Meybodi, Seyed Ali Mohammad (1998). Research Methods in Biological Sciences with Emphasis on Agriculture, Isfahan University Jihad Publishing, 254 pages.
2) Mesdaghi, Mansour. (1998). Statistical Methods in Agricultural and Natural Resources Research, Gorgan University of Agricultural Sciences and Natural Resources Publications, 288 pages
3) Khajeh Nouri, Abbas Gholi. (2013). Research Method, Tehran University Press, 224 pages
4) Khajeh Nouri, Abbas Gholi. (2000). Advanced Statistics and Biometrics, University of Tehran, 476 pages.2- Thomas, G, B., Weir, M, D., Hass, J., $ Giordono, F, R. (2010). Thomas Calculus Early transcendental, Pearson.

**River Engineering**

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| --- | --- | --- | --- | --- | --- |
| **Prerequisites:**No | **Theory: 1****Practical: 1** | **Course type:** Major: Common | **Number of course: 2****Number of hours: 48** | **Row:02** | **River Engineering** |
| **Practical Supplementary Training: Yes No** Science trip Workshop Laboratory Seminar  |

**Course Objective:** Planning, design, implementation and operation of various operations to improve the condition of the river in order to make better use of it.

**Outline:**

**Theory:**

Introduction - Paleohydrology River Engineering Objectives - Meanders and Its Transformation - Water Level Profile and Its Determination Methods - Sediment Estimation Models in Rivers - Protective Methods (Blue - Wall of Currency Levels and Its Calculations) River-Visit river reorganization projects-River morphology: Different river classifications-River flow equations: Flow continuity equation, Navier-Stokes-Nimrokh equations Vertical velocity and its changes in rivers-Shear stress and changes It in rivers-Resistance to flow and bed shapes-Rivers of rivers in river engineering-Side erosion processes and creating shortcuts-Carrying sediments in rivers-Types of models in river engineering-Principles of river reorganization: Objectives, regulation, stabilization and Route modification, classification of river flow regulation operations, types of side stabilization methods and route modification: veneers, longitudinal and transverse walls (water breakers): classification of water breakers-Structural design principles of stabilization and river salts.

**Practical:** Visit river reorganization projects and its beaches.

**Assessment Method (Percent):**

|  |  |  |  |
| --- | --- | --- | --- |
| Project / Work | End of semester exam | Mid-Term Exam | Continues assessment |
| - | 60 | 60 | 20 |

**References:**

1) Taluri, Abdul Rasool (1383). Preliminary Principles of River Organizational Engineering, Soil Conservation and Watershed Management Research Center Publications, 490 pages.

2) Nik Sefat, Gholamreza and Danandeh Mehr, Ali. (2010). Principles of River Engineering, Diba Gran Publications, Tehran, 268 pages.

3) Salavati Dezfuli, Abdul Amir and Mohseni Sarovi, Mohsen. (1997) Effects of road construction in river areas: Considerations of hydraulic and environmental design, guidance, education and design, Gorgan University of Agricultural Sciences and Natural Resources Publications, 256 pages.

4)Przedwojski, B., Blazejcwski, R. and Pilarczyk, K.W. (1995). River Training Techniques:Fundamentals, Techniques and applications. Balkema, The Netherlands Press, 686 pages.

5)Jansen, P.Ph, van Bendegom, L. van den Berg, J., de Vries, M. and Zanen, A. (1994). Principles of River engineering; The Non- Tidel Alluvial River. Delftse Uitgevers Maatschappij press.608 pages.

6)Julien,P.Y.(2002). River Mechanics. Cambridge University Press,375 pages.

7)Varma,C.V.J., Saxena, K.R. and Rao,M.K.(1989,1994) . River Behaviour, Management and Training. Cetral Board of Imigation and Power,Publ. No. 2004, Vol.l(1989),Vol.ll(1994).New Delhi,500 pages.

**Integrated Watershed management**

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| --- | --- | --- | --- | --- | --- |
| **Prerequisites:**No | **Theory: 1****Practical: 1** | **Course type:** Major: Common | **Number of course: 2****Number of hours: 48** | **Row:03** | **Integrated****Watershed****management** |
| **Practical Supplementary Training: Yes No** Science trip Workshop Laboratory Seminar  |

**Course Objective:** Management and analysis of the watershed and reviewing issues and problems and providing solutions.

**Outline:**

**Theory:**

Basic Concepts of Watershed Management - Adaptive Management of Watersheds - Sustainable Management of Watersheds - Packaging Management of Watersheds - Good Management of Watersheds - Participatory Management of Watersheds Based on Decision Support System - Designing the Conceptual Framework of Land Management Watershed - Hydrology and watershed management - Mountain watershed management - Human resources, water and land management - Multifunctional use in watershed management - Climate change and its effects on watershed management - Tactical and strategic in watershed management - Global watershed management in relation to the quality and quantity of drinking water - Evaluation, monitoring and modeling of watersheds - Comprehensive management of watersheds and its role in advancing project management goals - Investigating the management structure of watershed projects - Management of watershed ecosystems - Investigating the issues and problems of comprehensive management of watersheds.

**Practical:** Field visit of watershed management projects and presentation of technical report of strengths and weaknesses, limitations and potentials related to watersheds using methods such as SWOT and ....

**Assessment Method (Percent):**

|  |  |  |  |
| --- | --- | --- | --- |
| Project / Work | End of semester exam | Mid-Term Exam | Continues assessment |
| 30 | 50 | 10 | 10 |

**References:**

1) Mohseni Sarvi, Mohsen and Mortezaei Farizandi, Qasem. (2015). Comprehensive management of watersheds, University of Tehran Press. 260 pages
2) Mohseni Sarvi, Mohsen and Rostami, Nooruddin (2012). Management of watersheds: topics and attitudes, Tehran University Press. 188 pages

3) Gonenc, I.E., Wolflin, J.P. and Russo. R.C. (2014). Sustainable Watershed Management. Publisher CRC. 230 Pages.

4) Ramkumar, M., Kumaraswamy, K. and Mohanraj, R. (2015). Environmental Management of River Basin Ecosystem. Publisher Springer Intemational Publishing.761 Pages.

5) Alcott, E. (2013). Natural and engineered solutions for drinking water supplies: lessons from the northeastern United States and directions for global watershed management. Publisher CRC Press.279 Pages.

6) Brooks, K.N., Ffolliott, P.F. andMagner, J.A. (2012). Hydrology and the Management of Watersheds, Fourth Edition. Publisher Wiley-Blackwell. 545 Pages.

7) Krecek, J., Haigh, M., Hofer, Th. And Kubin, E. (2012). Management of Mountain Watersheds.Publisher Springer Netherlands.269 Pages.

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9) Gregersen, H., Ffolliott, P. and Brooke, K. (2007). Integrated Watershed Management: Connecting People to their Land and Water. Publisher CABI.215 Pages.

10) Bruins, R.J.F, and Heberling, M.T. (2004). Economics and Ecological Risk Assessment Applications to Watershed Management. Publisher CRC Press.472Pages.

11) Davenport, T.E. (2002) The Watershed Project Management Guide. Publisher CRC Press. 295 Pages.

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**Quaternary Formations**

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| --- | --- | --- | --- | --- | --- |
| **Prerequisites:**No | **Theory: 1****Practical: 1** | **Course type:** Major: Common | **Number of course: 2****Number of hour: 48** | **Row:04** | **Quaternary****Formations**  |
| **Practical Supplementary Training: Yes No** Science trip Workshop Laboratory Seminar  |

**Course Objective:** Familiarity of students with Quaternary processes in Iran and the world.

**Outline:**

**Theory:**

Introduction, Definition of temporal stratigraphic units, Stone stratigraphy and formation units, Importance of Iranian geological zones in quaternary studies, Stone characteristics and pre-Quaternary formations affecting quaternary phenomena in Iran Color mixes and marinas of Iran, erosion and sedimentation of pre-Quaternary formations of Iran as the origin of Quaternary materials of Iran, Quaternary phenomena of the world, Climate change of Iran Quaternary, glacial and interglacial periods of the world (Alps, Northern Europe, USA) and Phenomena of continental and mountainous glaciation (alpine), global changes in sea and ocean water levels (eustasis) and changes in isostasis and their causes, marine kingdoms (Mediterranean, Baltic, North Caspian), magnetic events, mountaineering events, evidence of change Quaternary Climate (Sedimentological Evidence, Geomorphological Evidence, Oceanic Sediment Survey, Drought Subjects including Refrigerators, Lessons and Pollution, Causes of Quaternary Climate Change, Iranian Quaternary Phenomena, Iran's Situation in Refrigeration and Intercontinental Periods, Sedimentation Processes, Soil erosion and formation in Quaternary Iran, glacial processes, process O volcanism, processes of mass movements (landslides ...), glacier-wind processes and Iranian laces, river and cone-forming processes, study of Taleghan and Iran barracks, study of cone-breakers and their application, morphotectonics Tehran region and its alluvial sediments, wind processes and origin of sand sand hill sediments, lake processes and desert Quaternary desert sediments of Iran (desert, desert and disaster areas of Iran) and climate change in them, marine processes and coastal and marine sediments, determining age Quaternary deposits, methods for determining the relative age in Quaternary (magnetic stratigraphy, morphological stratification, stratigraphic ash, arachnology, stratigraphic soil, stratigraphic climate, archeological method), methods for determining the absolute age in Quaternary (radiocarbon, radiometry) Thermal or optical, amino acid, beryllium method, uranium collection method), the practical importance of quaternary application, application of cognate quaternary formations in renewable natural resources, erosion and sedimentation of quaternary deposits (water and wind erosion), ability to use quaternary lands ( Vegetation, soil formation, flood distribution and artificial feeding, groundwater storage and water quality assessment T, dam construction, road construction, construction and urban planning and geotechnical characteristics of Quaternary deposits, disposal of nuclear waste)

**- Practical:** Visiting various quaternary facilities in Iran, Taleghan barracks, Jajrud barracks, conifers around Tehran and Karaj, sampling Taleghan barracks and other barracks in Iran, checking the sediments of the barracks in the laboratory, examining the world's glacial phenomena and other phenomena Quaternary Iran in aerial photographs and topographic maps, study of the sex and physical characteristics of quaternary formations in relation to soil characteristics and how to use them.

**Assessment Method (Percent):**

|  |  |  |  |
| --- | --- | --- | --- |
| Project / Work | End of semester exam | Mid-Term Exam | Continues assessment |
|  40 | 20 | - | 20 |

**References:**

1) Ahmadi, Hassan and Feyznia, Sadat (2012). Quaternary period constructions (theoretical and practical bases in natural resources). Tehran University Press, 557 pages.
2) Feyznia, Sadat. (1992). Buildings of the Fourth Era, Master's Thesis in Watershed Management, Department of Rehabilitation of Dry and Mountainous Areas, Faculty of Natural Resources, University of Tehran, 208 pages
3) Journal of Science, University of Tehran (1988) Special Issue of the First Iranian Quaternary Symposium, Volume 17, Numbers 3 and 4, Fall and Winter 1988, 67 Pages
4) Mahmoudi, Faraj A ... (1367). Evolution of Iran's roughness in Quaternary, Journal of Geographical Research, Geography Institute, No. 22, Pages 5 to 43
5) Motamed, Ahmad. (1997). Quaternary (Geology of the Fourth Era), Tehran University Press, No. 2332, 328 pages.

6) Catt, J.A. (1998). Quaternery geology for scientists and engineers, Ellis Harwood series in Applied Geology, Hatsed Press, John wiley & sons, 340 pages
7) Forster, A., Culshaw, M.G., Cripps, J.C., Little, J.A., and Moon, C.F (1991) .Quatemary engineering geology, Geological Society, Engineering Geology, Special Publication no. Geological Society, London, 725 pages.
8) Gale, S.J. and Hoare, P.G. (1991). Quatemary sediments, petrographic methods for the study of unlithified rocks, Halted Press, John wiley & sons, 323 pages.
9) Rachocki, A.H. and Charch, M. (1990). Alluvial fans, a field approach, John, Wiley & sons, 391 pages.
10) Rengers, N. (1994). Engineering geology of Quatemary sediments, Balkema press, 370 pages.

**Erosion and Sediment models**

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| --- | --- | --- | --- | --- | --- |
| **Prerequisites:**No | **Theory: 1****Practical: 1** | **Course type:** Major: Common | **Number of course: 2****Number of hours: 48** | **Row:05** | **Erosion and** **Sediment models**  |
| **Practical Supplementary Training: Yes No** Science trip Workshop Laboratory Seminar  |

**Course Objective:** Familiarity with new concepts of erosion (blue and wind) along with how to measure them and identify the types of methods and models available for estimating erosion.

**Outline:**

**Theory:**

Introduction and expression of new concepts in erosion and erosion, recycling and sediment transfer, sediment balance, role of spatial scales on processes and sediment production, classification of erosion types, types of methods in estimating erosion, model definition and simulation, importance and Performance of models, different modeling steps and features used to evaluate the model, calibration, validation, validation of different types of classification in erosion models, introduction of different types of sediment measurement curves, sedimentation graphs, sedimentation detection method, detectors, statistical methods And evaluating the results of the origin, introducing the basic, deterministic, probabilistic, probabilistic, distributive, species, and concepts governing them. Hydraulic concepts of current affecting erosion and basic physical models, relationships governing basic physics models in small watersheds. Dimensional analysis method in soil erosion modeling. Introducing USLE Family Soil Erosion Models Family models of WP, components, implementation method and desired considerations in Iran. Introduction of models used in trench refining (EGEM). Wind erosion (effective factors, estimation models and their types). Reviewing and summarizing erosion models. Location Results from the implementation of models in erosion management.

**Practical:** Methods used to measure and estimate erosion (tools, experimental models and methods). Calculation of erosion indices (EI30, Damak, Hudson, Modified fornies, dumb). Preparation of erosion maps and its temporal and spatial changes. Methods of preparing sediment measurement curves, one-line, two-line, correction coefficients, middle limits of categories, combination of monthly and daily discharge, Dubai class, teaching how to implement RUSLE3d, SATEEC, WEPP models. Visit a rainwater lab or paired areas and erosion plots.

**Assessment Method (Percent):**

|  |  |  |  |
| --- | --- | --- | --- |
| Project / Work | End of semester exam | Mid-Term Exam | Continues assessment |
| 50 | 30 | - | 20 |

**References**:

1) Refahi, Hosseinghli. (1394). Water erosion and its control, University of Tehran Press. 674 pages.

2) Anderson, M.G. (1988). Modelling erosion on hillslopes, in: Modelling Geomorphological Systems. Wiley and Sons, 287-308

3)Morgan, R.P.C (2005). Soil erosion and conservation. Blackwell Publishing, Oxford, 304 pages.

**Urban Watershed**

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| --- | --- | --- | --- | --- | --- |
| **Prerequisites:**No | **Theory: 1****Practical: 1** | **Course type:** Major: Common | **Number of course: 2****Number of hours: 48** | **Row:06** | **Urban Watershed** |
| **Practical Supplementary Training: Yes No** Science trip Workshop Laboratory Seminar  |

**Course Objective:** Urban watershed management for sustainable development.

**Outline:**

**Theory:**

Reservoir approach in urban management - Geology and groundwater and surface water in the watershed area - Water cycle in urban hydrology - Drainage of surface water - Assessing the surface environment of urban watershed - Human health and ecology of urban watershed - Urban watershed mapping - Restrictions Urban watershed mapping - Surface hazards in watersheds such as pollution and environmental changes - Factors affecting water, soil and plant change in urban watershed - Reviewable functions in the field of sustainable development of urban watershed - Erosion and sedimentation in the city - High and low intensity floods in the urban watershed - estimate of runoff - time to focus on urban watersheds - Dubai peak and basic water in urban watersheds - effective factors in success and failure in urban watersheds - land appearance and planning in areas Urban watershed - Human impact on hydrology and geomorphology of urban areas - The impact of urban development on land use change - Natural disasters in urban watersheds - Comprehensive approach to urban rainfall management - Best Management Practices or BMP approach in urban watershed - Provide management framework in Urban watershed.

**Practical:** Provide a report on watershed management in Iran or abroad.

**Assessment Method (Percent):**

|  |  |  |  |
| --- | --- | --- | --- |
| Project / Work | End of semester exam | Mid-Term Exam | Continues assessment |
| 20 | 50 | 15 | 15 |

**References**:

1)Kaufman, M.M., Rogers, D.T. and Murray, K.S. (2011). Urban watersheds: geology, contamination and sustainable development. CRC Press. 547 Pages.

2)Wigmosta, M.S. and Burges S.J. (2001). Land Use and Watersheds: Human Influence on Hydrology and Geomorphology in Urban and Forest Areas. American Geophysical Union Publication, 228 Pages.

3)Field, R, Struck, S.D., Tafuri, A, N., Ports, M.A., Clar, M., Clark, Sh. And Rushton, B. (2004). Bmp Technologies in Urban Watersheds: Current and Future Directions. American Society of Civil Engineers Publishing, 324 pages.

4)United States Soil Conservation Service. (1986). Urban hydrology for small watersheds. Technical release, no. 55. Engineering Division Soil Conservation Service.163 Pages.

**Flood Management Control**

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| --- | --- | --- | --- | --- | --- |
| **Prerequisites:**No | **Theory: 1****Practical: 1** | **Course type:** Major: Common | **Number of course: 2****Number of hours: 48** | **Row:2-1** | **Flood Management** **Control**  |
| **Practical Supplementary Training: Yes No** Science trip Workshop Laboratory Seminar  |

**Course Objective:** Familiarity with different methods of non-structural management (flood insurance, flood warning, land use management, watershed management, ...) and structural (flood diversion, die, flood dam, ...) flood control and flood risk management, Flood Plain Management - Introducing methods of strengthening houses and anti-flooding facilities and residential areas in urban and rural watersheds, various methods of flood forecasting and warning.

**Outline:**

**Theory:**

Definition of floods and their types - Risks and damages caused by floods in the world and Iran - Study of watershed (physical, climatic and biological) - Flood hydrology - Flood flow in rivers and reservoirs - Analysis of statistics and flood forecasting - Models Different flood estimates - study of cargo materials (suspended - barcode) - Prevention: watershed management (domain correction operations - increase vegetation) - Sedimentation dams - Reservoir dams - Delay dams - Protective walls - Flood floods - Flood distribution - Flood diversion - Soil and concrete wall design - Economic justification of flood control plans - Flood risk management - Flood plain planning - Flood flood zoning models - Software used in flood control - Flood warning methods - Application of systems Experts and hydrological models in flood forecasting and warning, emergency evacuation, flood insurance and flood control facilities.

**Practical:** Visit a flood control project, present a class seminar and participate in a workshop (if possible).

**Assessment Method (Percent):**

|  |  |  |  |
| --- | --- | --- | --- |
| Project / Work | End of semester exam | Mid-Term Exam | Continues assessment |
| 30 | 40 | 20 | 10 |

**References**:

1) Kowsar, Seyed Ahang. (1995) Introduction to flood control and their operation. Publications of the Forest and Rangeland Research Institute of the country. 538 pages

2) SNGash, translated by Ghodsian, Massoud. (1998) Flood control and drainage engineering, Tarbiat Modares University Press, 404 pages.

3) National Irrigation and Drainage Committee of Iran (2000). Guide to non-structural methods of flood management, Publications of the National Committee for Irrigation and Drainage of Iran 315 pages.

4) Islamian, Seyed Saeedo Soltani Kopai, Saeed (2002). Flood frequency analysis, Ardakan Publications, 344 pages.

5) Mahdavi, Mohammad. (2002). Applied Hydrology, Volumes 1 and 2, Tehran University Press, 360 pages.

6) Proverbs, D. and Soetanto, R. (2008) Flood damaged property. John Wiley & Sons press. 240 pages.

7) Elevated Residential Structures. (1996). Federal Emergency Management Agency-54. Washington press. 198 pages.

8) Han, D. (2011). Flood Risk Assessment and Management. Bentham Science Publishers. 152 pages.

9) Han, D., Davis, J., Hu, Z., Lan, G., Maren, E. and Twyman, C. (2002). Design Studies on Flood-Proof House. Project Flood-Proof House, Sponsored by ICE R&D Enabling Fund, University of Bristol, 37 pages.

10) Beven, K. and Carling, P. (1989). Floods; hydrological, sedimentological and geomorphological implication, John Wiley and stone press, 290 pages.

11) Smith, K. and Ward, R. (1998). Floods; Physical processes and human impacts. John Wiley and stone press, 394 pages.

**Flood forecast and Warning Models**

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| --- | --- | --- | --- | --- | --- |
| **Prerequisites:**No | **Theory: 2** | **Course type:** Major: Subdiscipline | **Number of course: 2****Number of hours: 32** | **Row:2-2** | **Flood forecast and Warning Models** |
| **Practical Supplementary Training: Yes No** Science trip Workshop Laboratory Seminar  |

**Course Objective:** Investigating the types of flood prediction models and systems in Iran and the world and the techniques for reducing flood risks through forecasting techniques.

**Outline:**

**Theory:**

Introduction to Hydrology Forecasting - Expectations of Flood Warning Forecasting System - Flood Forecasting Systems in the World - Flood Forecasting Systems in Iran - Information Needed for Hydrological Forecasting - Flood Forecasting Models and Monitoring Networks - Techniques Optimism - Flood forecasting and rapid warning organization - Flood forecasting and water resources management - Flood zoning plans - Flood forecasting and warning equipment - Operational management.

**Practical:** Conceptual design project of flood forecasting and warning system.

**Assessment Method (Percent):**

|  |  |  |  |
| --- | --- | --- | --- |
| Project / Work | End of semester exam | Mid-Term Exam | Continues assessment |
| 30 | 50 | 20 | 10 |

**References**:

1) Heidari, Ali and Emami, Kamran. (2005). Flood forecasting and warning. Publications of the National Drainage Committee of Iran. 272 pages.

2) flood forecasting and early warning (2013). Integrated flood management tools series, Associated Program on Flood Management.84 Pages.

**River hydraulic and sediment**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Prerequisites:**No | **Theory: 1****Practical: 1** | **Course type:** Major: Subdiscipline | **Number of course: 2****Number of hours: 48** | **Row:2-3** | **River hydraulic and sediment** |
| **Practical Supplementary Training: Yes No** Science trip Workshop Laboratory Seminar  |

**Course Objective:** Communicate between river processes and sediments.

**Outline:**

**Theory:**

Reminder of the hydrodynamic basics of open canals, sedimentation resources in watersheds, analysis of sedimentary particle motion threshold (Shields diagram), shear stress analysis and resistance to non-uniform flow in rivers including fast and slow currents, analysis of meander rivers phenomenon ( Meandering, and sediment transfer in the lateral direction of the river, Dominant discharge and bank full discharge analysis, permanent and non-permanent currents in rivers, sediment transfer and bed load mechanism, suspended load and total load in river Coarse and fine grains, analysis of the basics of designing sustainable canals in sandy and sandy beds, regime theory and limit hypothesis, organism forming very tooth-shaped, talc, anthelmintic, pond and sand dunes based on turbulent flow structure, fixed bed models And animated; Drainage analysis in water structures, river flow control structures, river dynamics, river wall protection and river flow path stabilization.

**Practical:** Measurement of sediment and suspended load values and establishing a relationship between the factors influencing sediment production and river morphology change.

**Assessment Method (Percent):**

|  |  |  |  |
| --- | --- | --- | --- |
| Project / Work | End of semester exam | Mid-Term Exam | Continues assessment |
| 30 | 40 | 20 | 10 |

**References**:

1. Graf, W.H. (1998). Hydraulics of Sediment Transport, 4th Printing Edition, Water Resources Publication. 524 pages.

**Numerical calculation**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Prerequisites:**No | **Theory: 2** | **Course type:** Major: Subdiscipline | **Number of course: 2****Number of hours: 32** | **Row:2-4** | **Numerical calculation** |
| **Practical Supplementary Training: Yes No** Science trip Workshop Laboratory Seminar  |

**Course Objective:** Strengthening the computational basis of students in the field of processes in the watershed, such as rivers, erosion and sedimentation, etc.

 **Outline:**

**Theory:**

Introduction - Absolute and Relative Error - Main Resources Error - Error Four Main Operations - Error Calculating Formulas and Functions - Numerical Solution of Equations - Numerical Methods of Equation Solving - Introducing and Finding Out - Taylor expansion method - matrices and solving linear and nonlinear equation devices - Determining special values of matrices - Minimum squares method - Solving exercises.

**Practical:** No.

**Assessment Method (Percent):**

|  |  |  |  |
| --- | --- | --- | --- |
| Project / Work | End of semester exam | Mid-Term Exam | Continues assessment |
| - | 80 | 10 | 10 |

**References**:

1. Nikokar, Massoud and Darvishi, Mohammad Taghi (2013). Numerical Calculations, Basic Science Development Publications. Print 25. 345 pages.

**River mechanic**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Prerequisites:**No | **Theory: 1****Practical: 1** | **Course type:** Major: Subdiscipline | **Number of course: 2****Number of hours: 48** | **Row:2-5** | **River mechanic** |
| **Practical Supplementary Training: Yes No** Science trip Workshop Laboratory Seminar  |

**Course Objective:** Investigating the kinematic and dynamic processes of rivers.

**Outline:**

**Theory:**

Introduction of river mechanics - physical properties and equations - properties of water - sedimentary properties - kinematic properties of river flow - survival of mass - equations of motion - lines of energy hydraulic slopes - rainfall - surface runoff - soil erosion losses - sediment source and load - river flow - Sediment transfer in rivers - River flow coherence equation - Size and motion equations - River flood waves - Flood flow detection - Particle and channel stability - Stable hydraulic geometry - River winding - Reduction and increase of river bed balance - Coast stability And side stabilization - river flow control structures - river bank engineering - flood control in the river - bridge base waterfall - multi-dimensional river models - surface waves and saline wedges in the estuary of the river.

**Practical:** Solve equations.

**Assessment Method (Percent):**

|  |  |  |  |
| --- | --- | --- | --- |
| Project / Work | End of semester exam | Mid-Term Exam | Continues assessment |
| 15 | 50 | 20 | 15 |

**References**:

1) Jafarzadeh, Mohammad Reza (1391). River mechanics. Ferdowsi University of Mashhad Publications 547 pages.

2) Hosseini, Seyed Mahmoud and Abrishami, Jalil. (1393). Hydraulic open channels. Twenty-third edition. Imam Reza University Press. 605 pages.

**Flood plain Management**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Prerequisites:**No | **Theory: 2** | **Course type:** Elective: Subdiscipline | **Number of course: 2****Number of hours: 32** | **Row:6-2** | **Flood plain Management** |
| **Practical Supplementary Training: Yes No** Science trip Workshop Laboratory Seminar  |

**Course Objective:** Management of floodplains using the necessary structural and non-structural measures.

**Outline:**

**Theory:**

Basics and History of Flood Management - Hydrology of flood plain - flood routing in river and plain - flood zoning and river guidance - estimate of erosion and sedimentation due to flooding and the impact of flood on river morphology Comprehensive floods - structural and non-structural measures to reduce the effects of floods in floodplain plains - flood river arrangements in various areas such as: city, plain, mountains and coast.

**Practical:** Case study.

**Assessment Method (Percent):**

|  |  |  |  |
| --- | --- | --- | --- |
| Project / Work | End of semester exam | Mid-Term Exam | Continues assessment |
| - | 50 | 30 | 20 |

**References**:

1) Bozorg Haddad, Omid, Blori Yazdali, Yasman and the troubled Parisa Sadat (2013). Engineering and management of water systems. Publisher. 460 pages.

2) Rezaei Moghadam, Mohammad Hossein and Saghafi, Mehdi. (2008). Rivers and floodplains. Page Publishing.486 pages.

3) Qudsian, Massoud (1378). Flood control and drainage engineering. Tarbiat Modares University Press. 404 pages.

**Ecohydrology**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Prerequisites:**No | **Theory: 1****Practical: 1** | **Course type:** Elective: Subdiscipline | **Number of course: 2****Number of hours: 48** | **Row:6-4** | **Ecohydrology** |
| **Practical Supplementary Training: Yes No** Science trip Workshop Laboratory Seminar  |

**Course Objective:** Recognition and modeling of ecological and hydrological processes.

**Outline:**

**Theory:**

Eco-hydrology and its concepts - Eco-hydrology in arid and semi-arid regions - The role of climate change in eco-hydrology - The role of eco-hydrology in the nitrogen cycle - Eco-hydrology and ecosystem - Balance between community demand and the ability of eco-hydrological processes Land and its effects on hydrological cycles - land use and its effects on aquatic ecosystem cycles - modeling in ecohydrology - hydroecology and ecohydrology - processes and responses in ecohydrology - land and groundwater resources - components of aquatic ecosystems - flood ecosystems and - Eco-hydrology modeling for limited water resources management - Improving the quality of water resources using eco-hydrological processes - Understanding current eco-hydrological processes and its future prospects - Simulation of several hydro-ecological-eco-hydrological systems in the watershed.

**Practical:** Echohydrology simulation of a watershed.

**Assessment Method (Percent):**

|  |  |  |  |
| --- | --- | --- | --- |
| Project / Work | End of semester exam | Mid-Term Exam | Continues assessment |
| 30 | 50 | 10 | 10 |

**References**:

1) Chicharo, L., Muller, F., Fohrer, N. (2015). Ecosystem Services and River Basin Ecohydrology. Publisher Springer Netherlands. 341 Pages.

2) Harper,M. A. Zalewski, M. (2008). Ecohydrology; processes, models and case studies; an approach to the sustainable management of water resources. Publisher CABI. 402 pages.

3) Wood, P, J., Hannah, D. M. and Sadler, J. P. (2008). Hydroecology and Ecohydrology; past. Present and Future. Publisher Wiley.466 ages.

4) Falkenmark, and Rockstrom, J. (2004). Balancing Water for Humans and Nature; The New approach in Ecohdrology.Publisher Routledge. 268 Pages.

5) D Odorico. P. and Porporato, A. (2006). Dryland Ecohydrology. Publisher Springer. 348 Pages.