**MSc Degree: Environmental Science and Engineering**

**Environmental Pollution**

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| **First Semester**  | **Second Semester** |
| **Course Row** | **Course Title** | **Course code** | **Credit Number** | **Theoretical** | **Practical** | **Course Row** | **Course Title** | **Course code** | **Credit Number** | **Theoretical** | **Practical** |
| 1 | Research Methods | 60-24-075 | 2 | 2 | - | 4 | Advanced remote sensing | 60-24-189 | 2 | 1 | 1 |
| 2 | Advanced statistical methods | 60-24-188 | 2 | 2 | - | 19 | Air pollution monitoring and control | 60-24-156 | 2 | 2 | - |
| 3 | Geographic information system | 60-24-145 | 2 | 1 | 1 | 15 | Environmental pollution monitoring | 60-24-154 | 2 | 2 | - |
| 51 | Marine pollution | 60-24-191 | 2 | 2 | - | 16 | Industrial pollution | 60-24-190 | 2 | 2 | - |
| 52 | Waste recycling | 60-24-183 | 2 | 2 | - | 53 | Advance soil and water pollution | 60-24-184 | 2 | 2 | - |
| 21 | Environmental Biogeochemistry | 60-24-158 | 2 | 2 | - | 17 | Site selection and design of landfill | 60-24-085 | 2 | 2 | - |
| 5 | Climate change impact assessment | 60-24-164 | 2 | 2 | - |  | - | - | - | - | - |
|  | Total Score in semester | 14 | 13 | 1 |  | Total Score in semester | 12 | 11 | 1 |

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| **Third Semester**  |  **Forth Semester** |
| **Course Row** | **Course Title** | **Course code** | **Credit Number** | **Theoretical** | **Practical** | **Course Row** | **Course Title** | **Course code** | **Credit Number** | **Theoretical** | **Practical** |
| 6 | Thesis | 60-24-023 | 6 | - | 6 | 6 | Thesis | 60-24-023 | 6 | - | 6 |
|  | Total Score in semester | 6 | - | 6 |  | Total Score in semester | 6 | - | 6 |

**MSc Courses: Environmental Pollution**

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| Topic/Headlines | Total Units | Semester | Title |
| Research definition and various types of it, literature review for research, introducing search engines and information databases for scientific research, presenting an applicable software for research documentation, skills of preparing scientific proposal and its details (including explanation of the problem and its importance, defining the research objectives, hypothesis and material and methods required to conduct the research work), planning and implementation of stages of a research work (literature review, material and methods, data collection, implantation of the experiments), statistical principles (including variables, sampling, statistical population, statistical analysis of data) parameters of deviation, distribution, signification, regression, correlation, non-parametric statistics, proposal and manuscript preparation, grammatical principals and concerns.  | 2 | 1 | Research Methodology |
| • Course Introduction• Fundamental concepts of statistics• Parametric and non-parametric statistics• Data preparing 1: Scatter plot, Q-Q plot, Box plot• Data preparing 2: Normality test, Variances Homogeneity test, Independence assumption• Concepts of Hypothesis testing• One sample tests about a population mean• Comparing two populations/sample means: independent and paired populations/samples• Principles of analysis of variances (ANOVA)• Experimental designs: CRD• Experimental design: RCBD, Relative efficiency• Experimental design: LS• Experimental design: Factorial• Simple Correlation and partial correlation• Linear and nonlinear regression• Validation of regression models: Holdout cross validation, Leave one out cross validation, K-fold cross validation• Introduction to PCA | 2 | 1 | Advanced Statistical Methods |
| GIS definitions, History, Applications in natural resources and the environment, Baes of GIS, Data importing in GIS environment, Spatial and descriptive data, Presentation model of geographical data, Advantage and disadvantage of raster data, Advantage and disadvantage of vector data, Data quality and their assessment, Rater analysis in GIS environment.Familiarity with the environment of a GIS software, Introducing the importing data, Data management in GIS software, Importing data into software, Editing, Saving, Presenting of information layers, Create the digital elevation model, Slope, Aspect, Digitizing the Arial photo, Rater analysis | 2 | 1 | Geographical Information |
| Satellite image types, Correction types (Atmospheric, geometric, Radiometric), Preprocessing and image processing, Survey of environmental indexes using satellite image, Sampling in remote sensing, Classification types, Classification using advance methods, Accuracy assessment, Spectral classification, Classification analysis, Thermal remote sensing, Application of thermal remote sensing in environmental sciences, Environmental pollutions survey using remote sensing, Application of active remote sensing in environmental sciences, Application of statistics in remote sensing, Application of remote sensing in aquatics and terrestrial ecosystems, Application of remote sensing in biodiversity and habitats, Integrated of remote sensing and GIS, Familiarity with the satellite data types, Preprocessing, corrections and classifications of satellite images and familiarity with a remote sensing software  | 2 | 2 | Advanced Remote Sensing |
| Review of the greenhouse gases effects on recent climatic changes and paleoclimatology, review of the climatic changes effects on environmental, Basic concepts of global climate: Radiation, Solar Energy, Atmospheric Circulation, Oceanic Circulation, Physical Process of Climate and Atmospheric Physics, Introducing climatic models and classification of climatic models, Relationships between land cover, snow, ice, vegetation cover with atmospheric-oceanic oscillations, mathematic and statistical modelling of climatic changes, downscaling and prediction of changes, trend analysis of climatic variables and detection of climatic changes, introducing data banks and how to prepare data, applications of downscaled atmospheric information, modelling extreme events such as drought, Flood, Strom, Modelling rising sea water levels, Climatic Scenarios of IPCC, GCMs, Introducing LarsWG, SDSM, HadCM3, RCM, ECHO-G, ClimGen, Applications of Satellite Maps in monitoring climatic changes, Relationships between Climatic changes and Dust storm, Evaluating of climatic changes effects on land ecosystems, Coastal and Marine ecosystems, mammals, Birds, Aquatic, Invertebrates, Evaluating climatic changes effects on health and human health  | 2 | 1 | Climate Change Impact Assessment |
| Carrying out a research project in the relevant field which has been approved in accordance with the rules of the department of education and the university and the results are compiled in the dissertation to be defended in the presence of the jury. | 6 | 3&4 | Thesis |
| Importance of monitoring and detection of pollutants in the environment, different sampling methods, random sampling method, systematic sampling method with random starting point and stratified method, familiarity with sampling equipment in the aquatic ecosystems (core sampler for deep sediment), surface sediment sampler (grab van vin and Ekman), water sampler from different deeps (Nansen), sampling methods from fishes and shells according to the EPA protocol, samples preparation method, different standard methods for extraction of organic and inorganic pollutants (digestion methods for heavy metals analysis, organic pollutant extraction by soxhlet extractor, cold extraction and ultrasonic, PLE), classification of pollution detection methods in samples (organic and inorganic), introducing atomic absorption methods (FAAS and GFAAS), chromatography (Gas and liquids), organic carbon detection methods (Furnace, Walkley Block method and TOC analyzer), evaluation of accuracy and precision of analytical methods, introducing of standards and reference materials for analysis of heavy metals and petroleum pollutant in water and soil, evaluation of QA/QC in the environmental samples.Sampling, heavy metal extraction by digestion block and microwave, organic pollutant extraction by soxhlet extractor, detection of heavy metals by atomic absorption instrument, detection of petroleum hydrocarbons and some organic pollutant by gas chromatography (GC) | 2 | 2 | Environmental Pollution Monitoring |
| Introduction and history of industrial development, social and economic impacts of industrial development, classification of industries, industrial area, the role of industries in the environmental pollutions, types of industrial pollutants, different industrial pollutants including iron and steel industries, oil and gas industries, petrochemical industries, powerhouse, mining industries, nuclear industries, food industries, leathering industries, textile and etc. control and prevention strategies for industrial pollutants, pollution prevention, benefits and limitations of program implementation in pollution prevention for industries, pollution prevention technologies (operation improvement, recycling in production line, exchange in the process, replacement of products and materials, separation of materials), introducing and application of environmental management standards (ISO14000), risk assessment, life cycle evaluation and environmental labeling for reducing and prevention of industrial pollution, industrial pollutants monitoring, emission listing, estimation methods for emission rate of pollutant from industries, Self-emergence of industries in terms of pollution, introducing of TANK, ALOHA, … models for evaluation of pollution emission and their pollution dangers from industries, select a specific topic related to the lesson and present it in class by students, scientific visits from industries. | 2 | 2 | Industrial Pollution |
| Landfill importance, definition of sanitary landfill and its characteristics, designing and preparation of land fill sites (land requirement, access road, equipments), geo-membranes, various types of landfills, environmental aspects of landfill sites, systems for pollutions monitoring of the landfills, controlling swage and gas leakages, landfill site requirements (sanitation, topography, hydrology, geology, access to cover materials, neighboring urban and industrial zones, access road, distances, climate, wind direction, drainage, costs, public acceptance, future land use), landfill liners and their characteristics, common mistakes in landfill site selection, multi criteria decision making and geographical information system for landfill site selection, fuzzy logics, sewage/leakage volumetric estimation in a landfill, covering methods of landfill. | 2 | 2 | Selection and Design of Landfill |
| A review on air pollutants and their classification and effects, methods of air pollutants monitoring, online monitoring, biological monitoring of air pollutants, site selection of monitoring station, methods and apparatus for measuring particulate matters and gaseous pollutants, calculation and estimation of diffusion factors for air pollutants, tracing the origin of air pollutants, methods to control particulate materials (cyclones, electrostatic filters, textile filters), absorption processes to control air pollutants, photo-catalysts and their roles on controlling air pollutants, biological methods to control air pollutions (bio-filters, bio-reactors and …), management of air pollutants in urban and industrial zones, visiting air pollution monitoring stations.  | 2 | 2 | Air Pollution Monitoring and Control |
| Introduction, a review on principle and concept of chemistry and biogeochemistry, history of biogeochemistry, earth systems, lithosphere, atmosphere, hydrosphere, ecosphere, continental biogeochemical cycles, marine biogeochemical cycles, mankind influences on biogeochemical cycles of elements, carbon cycle, nitrogen cycle, phosphorous cycle, sulfur cycle, cycle of elements and environmental changes, land uses and cycle of elements, soil erosion, acid rain in marine and continental ecosystems, eutrophication, climate change and biogeochemical cycles, seminar presentation by the graduate students. | 2 | 1 | Environmental Biogeochemistry |
| Introduction to the environmental pollutants, recognize marine environment features, marine water quality changes process, the source of marine pollution, oxygen demand wastes, environmental and sanitary impacts of waste water and sludge discharge to marine, eutrophication and red tide, destruction of corals, biologic toxins (DSP, PSP, NSP), cyanobacteria (blue-green algae) and its toxins, marine oil pollution, destiny and effects oil pollution in marine, methods of cleaning up marine and coastal oil pollution, halogenated hydrocarbons, heavy metals in the marine, mercury and methyl mercury in the marine, effects of tin components in the marine environment, radioactive pollutant in the marine environment, effects of agriculture and aquaculture in marine water environment, regional and international laws and conventions on marine pollution, investigate the status of Mazandaran sea and Persian Gulf pollution. | 2 | 1 | Marine Pollution |
| Introduction to solid waste, classification and specifications of solid waste, concepts and components of integrated solid waste management, introducing of reduction methods in source, reuse, recycling and composting, thermal energy recovery process, biological energy recovery process, landfill, mechanical-biological process (MBT), importance and role of recycling in the solid waste management system, development and performance of waste recycling, recycled products market, motivate people's participation in waste separation and recycling, environmental and economic aspects of recycling industries of glass, iron and steel, aluminum, plastic, papers, recycling of industrial wastes, recycling industries situation in Iran, new findings in waste management (such as microbial fuel cells, and their application in landfill leachate management), scientific visit to recycling industries. | 2 | 1 | Waste Recycling |
| A review on principles and concepts of chemistry (concentration, activity, gas laws), introducing fate and transportation of pollutants in soil and water environment, mass flow mechanisms, transportation and dispersion of pollutants, hydraulic equations related to pollutants transportation, in soil and water resources, physical and chemical absorption, isotherms and kinetic models of absorption and their applications, micro-organisms' role in soil and water environments and their contaminations, introducing some software related to modern technologies for purification and treatment of contaminated soil and water. | 2 | 2 | Advanced Soil and Water Contamination |