SCHOOL OF ENVIRONMENTAL AND EARTH SCIENCES

'A' Grade
NAAC Re-Accredited
(3rd Cycle)

KAVAYITRI BAHINABAI CHAUDHARI NORTH MAHARASHTRA UNIVERSITY, JALGAON

REVISED SYLLABUS

(With CGPA System)

For

M. Sc. (Environmental Sciences)

w. e. f.

2018-2019

SCHOOL OF ENVIRONMENTAL AND EARTH SCIENCES
Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon

SEMESTERWISE DISTRIBUTION OF COURSES

M.Sc. (Environmental Science)

SEMESTER - I

EES-101: Environmental Science: An Interdisciplinary Approach.

EES-102: Ecology and Environment.

EES-103: Environmental Chemistry.

EES-104: Practical Course on Environmental Chemistry.

EES-105: Practical Course on Ecosystem.

EES-106: Tutorial 1

SEMESTER - II

EES-202: Air and Noise Pollution.

EES-202: Water Pollution.

EES-203: Terrestrial Pollution.

EES-204: Practical Course on Air and Noise Pollution.

EES 205: Practical Course on water and Terrestrial Pollution.

EES-206: Tutorial 2

SEMESTER – III

EES-301: Remote Sensing and Computer Application. **(CBCS)**

OR

Gg -302: Fundamental of Remote Sensing. **(CBCS)**

OR

GS -303: Remote sensing and GIS **(CBCS)**

EES-302: Environmental Monitoring for EIA.

EES-303: Pollution Control and Waste Management.

EES-304: Practical Course on Environmental Monitoring.

EES-305: Practical Course on Pollution Control and Waste Management.

EES-306: Seminar 1

SEMESTER – IV

EES-401: Industrial Safety, Hygiene and Toxicology.

EES-402: Environmental Policies and Legislation.

EES-403: Nature Conservation and Environmental Management.

EES-404: Practical Course on Industrial Visits.

EES-405: Practical Course on Research Dissertation.

EES-406: Seminar 2

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COURSE STRUCTURE WITH CREDIT

M.Sc. (Environmental Science)

	Course	Marks	Hrs./Week	Credit	Total
Semester I	EES-101	100	04	04	21
	EES-102	100	04	04	
	EES-103	100	04	04	
	EES-104	100	08	04	
	EES-105	100	08	04	
	EES-106	40	01	01	
Semester II	EES-201	100	04	04	21
	EES-202	100	04	04	
	EES-203	100	04	04	
	EES-204	100	08	04	
	EES-205	100	08	04	
	EES-206	40	01	01	
Semester III	EES-301	100	04	04	21
	EES-302	100	04	04	
	EES-303	100	04	04	
	EES-304	100	08	04	
	EES-305	100	08	04	
	EES-306	40	01	01	
Semester IV	EES-401	100	04	04	21
	EES-402	100	04	04	
	EES-403	100	04	04	
	EES-404	100	08	04	
	EES-405	100	08	04	
	EES-406	40	01	01	

Grand Total: 84

EES-101: ENVIRONMENTAL SCIENCES: AN INTERDISCIPLINARY APPROACH

Basic issues in environmental sciences: Definition, principles and scope of environmental science, human population growth, urbanization, sustainability and carrying capacity, Environmental Problems of India: Over population, Food, Health, Energy and Environmental security, negative side of green revolution. **(07)**

Earth as a system: Environmental unity, earth and life, earth as an eco-system, changes and equilibrium in systems, mass and energy transfer across various interfaces, material balance, first and second law of thermodynamics, heat transfer process. **(08)**

Environmental geo-science and geo-chemistry: Basic environmental problems, geo-science factors in environmental planning, Environmental geo-science- fundamental concepts (i) short term geological hazards- floods, landslides, earthquakes, volcanoes (ii) Long term hazards- erosion, desertification, urbanization. Concept of major trace elements and REE classification of trace elements, mobility of trace elements, biogeochemical factors in environmental health. **(08)**

Urban environment, waste management and sustaining living resources: City as a system, influence of city life on city planning and environment, concept of waste disposal. Food and resources supply and environment, ecological perspective on agriculture forestry, sources of food, soil and agriculture. **(10)**

Effects of agriculture on environment: Effects of fertilizers on agriculture, pest control and agro-chemicals, integrated pest management, undesirable effects of irrigation. **(08)**

Minerals, environment and environmental economics: Importance of minerals in environment, agriculture, industry and life, resources and reserves, procurement methods and disposal. Importance of environmental economics, use of desirable resources vis-a-vis sustainability, minimization of pollution, cost benefit analysis (CBA), policy instruments. **(07)**

Recommended Books:

1. Environmental Sciences, Daniel Botkin and Edward Keller, John Wiley and Sons, New York (1997).
2. Environmental Science, Eldon D. Enger and Bradley F. Smith, WCB Publishers, Boston (1995).
3. Forests in India, Dr. A. K. Jain Vorha Publication, Allahabad (1989).
4. Advances of Environmental Science and Technology, Nileema Rajvaidya APH Publishing House, Delhi (1989)
5. T.D. Bishwas & S. K. Mukharji, A.J.B. of Soil Sciences, Tata Mc-graw hill pub. Co. Ltd. New Delhi. (II Edition 1997)

EES-102: ENVIRONMENT AND ECOLOGY

Introduction to ecology: Scope, basic concepts in ecology, levels of ecology, First and second law of thermodynamics, autecology and synecology and applied ecology, environmental complexes, interaction of ecological factors. **(07)**

Abiotic factors: Light, temperature, precipitation (rainfall), humidity. Atmosphere – gases and wind, atmospheric gases, wind factor and fire factor-

(i) Topographic factor (Physiographic) – height and direction of mountain steepness of slopes and exposure of slopes.

(ii) Edaphic factor – Importance, formation of soil, factors affecting on soil formation, soil composition, soil profile, soil erosion and soil conservation.

(iii) Ecological Adaptations – Ecological groups of plants and ecological adaptations (i) Hydrophytes (ii) Mesophytes (iii) Xerophytes (iv) Halophytes.
Ecological adaptations in animals. **(12)**

Biotic factors:

(i) Population ecology – Population characteristics, population growth curves, law of population growth, biotic potential, natality, mortality, age structure.

(ii) Ecosystem-Introduction, kinds of ecosystem, structure and function of ecosystem, ecological energetics, energy flow in ecosystem, energy flow models, food chain and food webs, pyramids of energy, biomass and numbers.

Major ecosystems – pond, grassland, forest, desert, cropland etc. productivity of different ecosystems, Ecological problems, Biogeochemical cycles in ecosystems-carbon, nitrogen, sulfur and phosphorous.

(iii) Community ecology – Evaluation, origin, structure, composition and development of community, species diversities in communities, ecotones and the concept of edge effect, ecological niche. **(16)**

Systems ecology and ecosystem modeling: Development of environmental modeling, scope, types, state of art. **(06)**

Biodiversity: Concept of biodiversity, types of biodiversity, major biomes distribution. **(02)**

Ecological succession: Mechanism of succession, course of succession, types and trends of succession, climax concept in succession, succession and chemical cycling. **(05)**

Recommended Books:

1. K.C. Agrawal, Environmental Biology, Agro-Botanical publishers, Bikaner. (1993)
2. E.P.Odum, Fundamentals of Ecology Revised edition (1995)
3. P.S.Verma, V.K.Agrawal, Environmental Ecology S. Chand & Co., New Delhi.(1998)
4. P.D.Sharma, Ecology & Environment, Rastogi Publications, Meerat.(VII Edi.2000)
5. Eldon D. Enger and Bradley F. Smith, Environmental Sciences, WBC publishers, Boston. (1995)
6. Daniel Botkin and Edward Keller, Environmental Sciences, John wiley & Sons, New York. (1997)
7. R.K. Dixit, Environment, Forest Ecology and Man, Rastogi publication, New Delhi. (1997)
8. S. E. Jorgeson et al, Handbook of Environmental and Ecological Modeling, Levis Publications, New York. (1995)

EES-103: ENVIRONMENTAL CHEMISTRY

Fundamentals of environmental chemistry: Concept and scope of environmental chemistry, stoichiometry, Gibb's energy, redox potential, chemical potential, chemical equillibria, acid-base reaction, solubility products, solubility of gases in water, definition of environmental term. **(10)**

Atmospheric chemistry: Atmosphere- composition, structure, heat balance, chemical composition of air (classification of elements, chemical speciation, particles, ions and radicals in atmosphere), chemical processes for formation of inorganic and organic particulate matter, thermo chemical and photochemical reactions in the atmosphere, oxygen and ozone chemistry. **(06)**

Soil chemistry: Lithosphere- formation of the earth, zonal structure of the earth and its composition, composition of the earth as a whole, differentiation of elements. Soil and agricultural, nature and composition of soil, acid-base and ion-exchange reaction in soil, macronutrients in soil, NPK in soil, micronutrients in soil. **(08)**

Chemistry of water and aquatic system: Hydrosphere- characteristic, characteristic and structure of the ocean, snow and ice, fresh water system. Properties of water and their significance, characteristic of water bodies, alkalinity, acidity, calcium and other metals in water, sedimentation, coagulation, organic pollutants in sewage, soaps, oil and detergents, pesticides in water, their classification, radio-nuclide in water. **(10)**

Analytical environmental data: Basic concept and definition, true results, error, types of error, accuracy, precision and standard deviation **(02)**

Instrumental techniques in environmental analysis (principle, Instrumentation merits and demerits of techniques): Neutron activation analysis, isotope dilution analysis, colorimetry, spectrophotometry, atomic absorption spectrophotometry, flame photometry, gas chromatography, high performance liquid chromatography, ion exchange chromatography and polarography **(12)**

Recommended Books:

1. A. K. De Environmental Chemistry,. Wiley Eastern Ltd, New Delhi (2001).
2. G. S. Sodhi, Fundamental concepts of Environmental Chemistry, Narosa Publishing House, New Delhi (2002).
3. F.W. Field and P.J. Haines, Environmental Analytical Chemistry, Blackwell Science Ltd. USA (2000).
4. Physicochemical examination of water, sewage and industrial effluent, Pragati prakashan, Meerut, (1996).
5. Standard Methods for the examination of Water and Wastewater, 19th Edn, American Public Health Association (1995).

EES 104: Practical Course on Environmental Chemistry

1. Studies on the concept of morality, normality and buffers solutions
2. Calibration of pH and conductivity meter and their applications
3. Studies on the principles, component & working operation of colorimeter and spectrophotometer.
4. Study on the principle, component & working operation of flame photometer and its applications.
5. Determination the turbidity of given sample by using Turbidity meter.
6. Study on principle and working operation of Potentiometer and its application in estimation of chloride in water sample.
7. Analysis of total dissolved & suspended solids from water.
8. Study on physical characteristics of soil.
9. Determination of organic matter by Walkley and Black method from soil.
10. Estimation of dissolved oxygen by Winkler's method.
11. Determination of bicarbonate and carbonate alkalinity of water.
12. Determination of temporary & permanent hardness of water.
13. Demonstration of HPLC for pesticides analysis.
14. Demonstration of Atomic Absorption Spectroscopy for heavy metal analysis.
15. To determine a) λ max of the solution of KMnO4 b) Verify Beer's law and find out the concentration of unknown solution by spectrophotometer.
16. To determine the concentration of iron in water sample by spectrophotometric method.

EES 105: Practical Course on Eco-system

1. Microscopy- a) Use of compound microscopy
   b) Calibration of microscopy
2. Staining techniques - a) Monochrome staining
   b) Negative staining
   c) Gram staining
   d) Special staining methods
3. Slide culture techniques for examination of fungi / actinomycetes
4. To study the biotic components of a pond ecosystem
5. To compare the biomass and net primary productivity of ungrazed & grazed grassland.
6. To determine the minimum size of the quadrat by 'Species Area Curve' method.
7. To determine the minimum number of quadrates to be laid down in the field under study.
8. Estimation of total viable counts in water and soil samples.
9. Preparation and sterilization of microbial media.
10. Estimation phosphatic fertilizers by colorimetric analysis.
11. Estimation of sucrose from sugar industry effluent.
12. Estimation of protein from leather industry effluent.
13. Vegetation studies by line and belt transact method & their analysis.
14. Assessment of phyto and zooplankton in fresh water bodies

EES-201: AIR AND NOISE POLLUTION

Air pollution: Definition, natural and man-made sources of air pollution, stationary and mobile sources, primary and secondary pollutants, global background concentrations, macro and micro methodological influences, transport and diffusion of pollutants, emission and ambient standards, local regional and global criteria for effects of air pollution, vehicular pollution and urban air quality. **(06)**

Air pollutants: Sulfur oxides (SO_x); nitrogen oxides (NO_x), carbon monoxide, total suspended particulate matter, respirable particulates, photo-chemical oxidants, specific pollutants (Hydrogen sulphide, particulate fluoride, formaldehyde and volatile organic compounds), chemical composition of SPM and RSP for toxic trace metals like Pb, Cd, Hg, Ni and Cr. Importance of inorganic ionic composition like SO_4, Cl, NH_4, Na, K, Ca, Mg and organic acids in aerosols and precipitations, photochemical smog, peroxy acyl nitrates (PAN), benzo-α-pyrene (BAP) formations, atmospheric sinks. **(12)**

Global air pollution problems: Green house effect (green house gases: CO_2, CH_4, N_2O, CFC's, water vapor concentration, alternatives for CFC's, fire extinguishers), global warming and climate change, ozone layer depletion (ozone depleting processes, ozone hole, environmental effects and strategies for ozone layer protection), acid rain. **(07)**

Effects of air pollution and air monitoring instruments: Human health, plants, animals and microbes, archeological monuments and aesthetics, Orsat apparatus, high volume air sampler and source monitors. **(06)**

Air pollution meteorology: Wind speed, direction and their vertical profiles, turbulence (mechanical and thermal), atmospheric stability characteristics and classes, Plume behavior, effects of micrometeorology on point source emission, wind-valley effects, land/sea breeze-effects, heat island effect, mixing height-boundary layer definition, temperature inversions, factors affecting on dispersion of air pollutants, micrometeorological instruments. **(09)**

Noise pollution: Properties of sound waves, sound pressure and sound level measures, sound level meters, definition of noise, industrial community noise factors, effects of noise on human beings, hearing mechanism, audiometric tests, damage - risk criteria, effects on human performance, noise rating systems, noise standards and guidelines, permissible noise levels for occupational exposures, noise pollution control and abatement measures. **(10)**

Recommended Books:

1. Magill, Holden and Ackdey, Air Pollution Hand Book, Mc-Graw Hill, New Delhi (1998)
2. R. K. Trivedi & P. K. Goel, An Introduction to Air Pollution, Techno Science Publications, Jaipur (1995)
3. C.S.Rao, Environmental Pollution Control Engineering, New Age International Publication New Delhi (2001)
4. A. Sharma & A. Roychaudhari, The Deadly Story of Vehicular Pollution in India, CSE New Delhi (1996)
5. Wahi S.K., Agnihotri A. K., and Sharma J.S.,Environmental Management, Willey Eastern Ltd., New Delhi. (1992)

6. G. N. Pandey, and G.C. Carney, Master Gillbert M., Introduction to Environmental Engineering and Science, Prentice Hall, New Delhi (2000).
7. E. Robart Alley and Associates, Air Pollution Control Hand-book, Mc-Graw Hill, New Delhi (1998)

EES-202: WATER POLLUTION

Characteristics of water and wastewater: Physical, chemical, and biological characteristics of water and wastewater, physiochemical and bacteriological sampling and analysis of water quality, quality standards, (BIS, WHO, CPCB and US Environmental Protection Agency), water quality indices: definition, types, applications and significance, water quality for industrial and bathing purpose, prevention and control of water pollution, sewage treatment plant. **(08)**

Sources of water pollution: Point and non-point sources of water pollution: urban, industrial, agricultural and natural waters, interaction in aquatic system, nature of sources-stationary, intermittent, continuous and mobile, sources of marine pollution, criteria for disposal of pollutants in marine ecosystem, coastal management. **(08)**

Pollution potential of industrial effluents (Process, sources and characteristics): Effluent characteristics- (temperature, exit velocity, concentration and volume). Nuclear/thermal power stations, agriculture, sugar, food processing, chemical, tanneries, pulp and paper, oil and petroleum, textile and electroplating industries. **(10)**

Water resources and environment: Phytoplankton, zooplankton and macrophytes in aquatic ecosystem, global water balance, ice sheets and fluctuations of sea levels, origin and composition of sea water, types of water: surface, ground water, brackish and marine water, human use of surface and ground water, exploration of ground water, ground water table, aquifers, design, construction and maintenance of wells and infiltration galleries. **(07)**

Consequences of water pollution: Biological uptake of pollutants and their effects on land, vegetation, animals and human health, bio-deterioration, bioaccumulation, bio-magnification and eutrophication, infectious microbial agents in water system and their consequences on human health. **(10)**

Specific pollutants in aquatic system: Specific pollutants and their speciation, behavior, toxicity and detoxification of pollutants. (Heavy metals, pesticides, fertilizers and radioactive materials). **(05)**

Recommended Books:

1. Gerard Kiely, Environmental Engineering Vol. I, II,& III Liptak, Tata McGraw Hill, New Delhi.(1998)
2. A.K. De, Environmental Chemistry. 2nd edn., 1990, Wiley Eastern Ltd., New Delhi.
3. Nancy J. Sell, Industrial Pollution Control, John Willey and Sons, Inc., New York (1992)
4. S.S. Dara, A Text Book of Environmental Chemistry and Pollution Control, S. Chand, and Co. Ltd., New Delhi. (1995)
5. P. K. Goal and K. P. Sharma, Environmental Guidelines and Standards in India, Techno science Pub. Jaipur, India (1996)
6. G. R. Pathade, and G. K. Goal, Environmental Pollution and Management of Waste Water by Microbial Techniques, A. B.D. Pub. Jaipur India (2001)

7. S. N. Jogdand, Environmental Biotechnology (Industrial Pollution Management) Himalaya Pub. House Delhi. (1995)

EES-203: TERRESTRIAL POLLUTION

Composition of solid wastes: Nature & composition of solid wastes- Ashes, slags, agro residues, industrial wastes, sewage treatment sludges, grits, debris, dirt, masonry, garbage, rubbish, trash, dead animals, abandoned vehicles, bulky wastes, special wastes or hazardous wastes. **(08)**

Sources of solid waste: Classification of solid wastes- Urban and rural, agricultural and industrial, construction and demolition, Hazardous or special wastes- Chemical wastes, Biomedical wastes, Nuclear wastes, Explosive wastes. (**08)**

Collection, transportation and characterization of solid wastes: Collection of wastes- Waste storage devices, Collection system parameters, Collection equipments, Collection methods, Transportation equipments; Transfer stations; Processing of solid wastes; General, physical, chemical and biological properties of solid wastes, Bulkiness, Combustibility, Solubility & Perishability of solid wastes; Solid wastes and disease vectors. **(08)**

Effects of solid wastes: Social and aesthetic impacts of terrestrial pollution; Occupational and community health hazards; Interaction of terrestrial pollution with air and water pollution; Agricultural land and its effects on environment; Effects of mining and transportation activities; Cost of terrestrial pollution. **(08)**

Pollution from production methods: Pollution from oil, coal, wood and agro-residues burning; Pollution from food industries, chemical manufacturing industries, agro-industries, petroleum refineries & metal plants; Environmental effects of nuclear, thermal and hydel power production methods. **(08)**

Management of solid wastes: Physical methods- Open dumping, sanitary landfill, ocean dumping & incineration; Chemical methods- Pyrolysis & Gasification; Biological methods- Composting and vermicomposting; Energy recovery from solid wastes; 3-R strategy of solid waste management; Integrated Waste Management (IWM); Management of hazardous wastes- Neutralization, oxidation, encapsulation, incineration, secure landfill & deep well injection. **(08)**

Recommended Books:

1. A. D. Bhide and B.B. Sundersen, Solid Waste Management in Developed Countries, INSDOC, New Delhi (1983)
2. Sinha R. K., Sinha A. K., Saxena V. S., A Book on Waste Management, INA, Shri publishers, Jaipur (2000)
3. Robert A. Corbitt, Standard Handbook of Environmental Engineering, Mc-Graw Hill, (1989)
4. E. D. Enger, B.F. Smith, Environmental Science - a study of interrelationships. 5th Edn. W.C.B. Publ., London. (1995)

5. D. Botkin and E. Keller, Environmental Science - Earth as a Living Planet. John Wiley and Sons, Inc., New York, (1997)

EES-204: PRACTICAL COURSE ON AIR AND NOISE POLLUTION

1. Study of micrometeorological equipments.
2. To study principle, components and working operation of respirable dust sampler.
3. To study principle, components and working operation of stack monitoring kit.
4. Determination of NOx from ambient air.
5. Determination of SOx from ambient air.
6. Determination of RPM & TSPM from ambient air.
7. Construction of windrose and study of wind profiles.
8. Measurement of noise levels.
9. Evaluation of impact of refuse on physical parameters of soil quality.
10. Evaluation of impact of refuse on chemical parameters of soil quality.
11. Determination of CO2 & O2 by Orsat apparatus.
12. Analysis of physical parameters of solid waste.
13. Analysis of chemical characteristics of solid waste.
14. Determination of pollution load through leachate of solid waste dump.
15. Estimation of dust falls by slide and beaker method.

EES- 205: PRACTICAL COURSE ON WATER POLLUTION

1. Estimation of chlorides in water sample by Mohr's method.
2. Estimation of residual chlorine in water sample by iodometric method.
3. Estimation of sulphate in water sample by turbidimetric method.
4. Estimation of sulphite in water sample by titrimetric Method.
5. Estimation of ferric and ferrous iron present in water.
6. Estimation of chromium in water.
7. Estimation of nitrate in water.
8. Determination of Chemical Oxygen Demand (COD) in waste water.
9. Determination of Biological Oxygen Demand. (BOD) of a waste water.
10. Determination of Most Probable Number (MPN) in water.
11. Determination of total acidity and CO2 in water.
12. Determination of total bacterial and fungal count from garbage piles in housing
13. colonies.
14. Determination of oil/grease in water.
15. Determination of Inorganic Phosphorus in water.

EES-301: REMOTE SENSING AND COMPUTER APPLICATIONS

Introduction to remote sensing: Definition, Historical perspective, Electromagnetic radiations(EMR), EMR spectrum, EMR quantities, Radiation laws, Black body and real body radiation, Hemispheric reflectance, Transmittance, Absorbance, Application of remote sensing in environmental studies. **(04)**

Interaction of electromagnetic radiation (EMR) and remote sensing: With earth surface: reflection, transmission, spectral signatures. With the atmosphere: scattering, absorption, refraction, Types of remote sensing, necessity, importance and scope of remote sensing, Characteristics of remote sensing,
Platforms and orbits: ground based, air borne, space borne
Orbits: geostationary satellites and polar-orbiting satellites
Sensors: MSS and TM scanners in landsat series, HRV scanners in spot series, LISS, PAN and WiFS scanners in IRS series **10)**

Aerial photography: Definition, Photogrammetry, Flight lines of vertical aerial photography, Types of aerial photography, Types of films, Measurements of heights and slopes from aerial photographs, Aerial photo interpretation. Differences between aerial photography and remote sensing. **(09)**

Application of remote sensing in environmental studies: Land use / land cover; Wastelands; Forest, Forest fires; Water resources, Disasters; Wildlife habitat, Vegetation. **(05)**

Computer and statistical applications: 1. Fundamental of statistics: Collection of Data, classification and tabulation, Diagrammatic representation. Measures of central tendencies: Introduction, arithmetic mean, median mode characteristic of good average. Measure of dispersion: Introduction, measures of studying variation, Range, standard deviation, variance, mean deviation, coefficient of variation.
2. Some probability distributions: binomial, Poisson and normal distribution
3. Applied statistics: Review of Descriptive statistics, Correlation analysis, Regression analysis: Introduction, simple linear regression, fitting of regression line, ANOVA. **(10)**

Geographical information system (GIS): GIS: definition, capabilities and advantages, History of GIS, Objectives of GIS, Elements of GIS, Data model: Raster and vector data model, Data structures: relational, hierachical and network data structures, Overview of GIS softwares, Use of GIS in environmental management **(10)**

Recommended Books:

1. Principles of Remote Sensing: A.N. Patel and S. Singh, Scientific Publishers (India), Jodhpur (1999).
2. Remote Sensing of the Environment: J.R.Jensen, Pearson Education Inc, Delhi(2003).
3. Remote Sensing for Environment and Forest Management: A. Mehrotra and R.K. Suri, Indus Publishing Co., New Delhi (1994).
4. Remote Sensing for Large Wildfires: E. Chuvieco, Springer, New York (1999).
5. Introduction to Geographic Information System: Chang, Kang-tang, Tata McGraw Hill, New Delhi (2002).
6. Geographic Information System: R.Ram Mohan Rao and A. Sharieff, Rawat Publication, New Delhi, (2002).

7. Environmental Science Methods, Haynes, R. (1982) Chapman & Hall, London
8. Business Mathematics and statistics, Vittal R. R. (1986) Murgham Publications.

EES-302: ENVIRONMENTAL MONITORING FOR EIA

Environmental impact assessment (EIA): Definition of EIA and EIS, Environmental inventory, Concepts, scope and objectives of EIA; National Environmental Policy Act (NEPA, 1969); EIA guidelines-1994 (Notification of Government of India), Procedure to review report of Environmental impact assessment. **(05)**

Impact assessment methodologies: Definition and concept of impact; Types of impacts (Negative & Positive: Primary & Secondary; Reversible and Irreversible; Tangible and Intangible); Impact identification; Methods for impact identification: Matrices, networks and checklists, Advantage & disadvantages of EIA methodologies. **(08)**

Components of EIA: Environmental Setting; Baseline data; Prediction and evaluation of impacts; Environmental management plan and monitoring, Baseline information, Prediction, evaluation and mitigation of impacts on socio-economic, air water, soil and noise environment. **(14)**

Public participation in EIA: Decision making, Public participation in environmental decision making, Objectives and techniques for public participation, Advantages and disadvantages of public participation. **(04)**

Preparation and writing of EIA: For water resources, Dams and irrigation projects; Mining and Infrastructural projects etc. **(06)**

Environmental auditing: Notification and guidelines for Environmental audit; Scope, applicability and objective of environmental audit; procedure of environmental auditing; Water, raw material and energy balance; Hazardous waste audit, Safety audit; Applicability of statutory environmental audit statement. **(11)**

Recommended Books:

1. Environment Impact Assessment: Larry W. Canter, Mc-Graw Hill Inc., New York (1996).
2. Introduction of Environmental Impact Assessment: John Glassion, Rikay Therival and A. Chadwick, UGC Press Ltd., London (1994).
3. Methods of Environmental Impact Assessment: Peter Morris, Ricky Therivel, UGC Press Limited, London (1994).
4. Environmental Impact Assessment & Management: Daya Publishing House, New Delhi (1998).
5. Using Environmental Management system to improve profits: B. Pearson, BFP Little and M. J. Brierley, Graham & Thotrman, Kluwer Academic Publisher Group, London(1992).
6. A monograph on Environmental Audit: The Institute of cost and works Accounts of India, New Delhi (1994)
7. Handbook of Environmental Impact Assessment (Vol. I): Judith Petts, Blackwell Science, USA (1999).

8. Handbook of Environmental Impact Assessment (Vol. II): Judith Petts, Blackwell Science, USA (1999).

EES-303: POLLUTION CONTROL AND WASTE MANAGEMENT

Primary wastewater treatment: Necessity of wastewater treatment; Municipal & Industrial Wastewaters; Flow diagram of wastewater treatment plant; General design aspects of wastewater treatment plant; Preliminary treatments- Screen chamber, Grit basin, Skimming tank & Detritus tank; Primary treatments- Sedimentation, Primary clarifier & Final clarifier. **(06)**

Secondary wastewater treatment: Introduction to secondary treatment; Trickling filter & Biological tower; Activated sludge process & its modifications; Low cost treatments- Sand filter, Contact bed, Rotating biological contactor, Septic tank, Oxidation pond and Lagoons. **(06)**

Tertiary wastewater treatment: Introduction to tertiary treatment; Tertiary treatments- Chemical precipitation, Nitrification & denitrification, membrane filtration, reverse osmosis, ion exchange & electro-dialysis; Effluent disinfection- Chlorination, UV irradiation & Ozonation; Concept of Common Effluent Treatment Plant (CETP); Wastewater treatment for industries such as Petroleum refining, Fertilizer, Pesticide, Pulp and paper & Textile. **(14)**

Sludge treatment: Origin & properties of sludges-primary-secondary, organic-inorganic & compressible-noncompressible; Thickening, Conditioning, Dewatering, Filtration, Digestion & Drying of sludges; Sludge disposal. **(06)**

Solid waste management: SWM techniques- Land filling, Incineration, Pyrolysis, Composting & Biogas generation; Recycling & 3-R strategy; Integrated waste management; Hazardous waste management. **(08)**

Air and noise pollution control: Control of particulate matters- Gravity settling chamber, Cyclone separator, Bag filter & Electrostatic precipitator; Control of gaseous pollutants- Scrubbing, Adsorption & Combustion; Noise pollution control- At source, During transmission & At receptor. **(08)**

Recommended Books:

1. Waste Water Engineering: Metcalf & Eddy, Tata Mc-Graw Hill Publishers, III Edition (1995)
2. Water Supply and Sanitary Engineering: S. C. Rangwala, Charotar publishing house, Anand (1992)
3. Water and Wastewater Technology: Mark J Hammer & Mark J Hammer Jr., Prentice Hall of India, IV Edition (2002)
4. Environmental Pollution Control Engineering: C.S.Rao,New Age International (P) Ltd. (1991)
5. Sewage Disposal and Air pollution engineering: S. K. Garg, Khanna publishers,

New Delhi (1998)
6. Air Pollution and Control: Mowli and Subbayya, Divyajyoti Prakashan, Jodhpur (1989)
7. Air Pollution: V.P. Kudesia, Pragati Prakashan, New Delhi (1997)
8. Noise Pollution and Management: G. Gaur, Sarup and Sons, New Delhi (1997)

EES-304: PRACTICAL COURSE ON ENVIRONMENTAL MONITORING

1. To analyze auto exhaust for PUC
2. Interpretation of aerial photographs.
3. Use of GIS software for environment studies
4. Determination of height of the object in aerial photographs
5. Interpretation of satellite images
6. Study of energy plants.
7. Impact of air pollution on photo density flux of plant leaves.
8. To study the impact of flood on ecology.
9. To estimate the effect of exhaust gases on chlorophyll content in different plants.
10. Determination energy content of biomass.
11. Assessment of urban / Industrial forestry.
12. Computations of measures of central tendency Viz: mean, mode, median etc. and graphical representation of data through histogram, dot plot, box plot
13. Computation/calculation of measures of dispersion for datasets based on environmental experiments viz: soil testing, air temperature, bacteria analysis, water wasted data, green house/ watershed managements etc.
14. Computation/calculation of correlation for datasets based on environmental experiments, viz: scatter plot for bivariate data, fitting of regression lines, ANOVA, calculation of R2.

EES-305: PRACTICAL COURSE ON POLLUTION CONTROL AND WASTE MANAGEMENT

1. To determine the ambient air quality in industrial belt.
2. Study on noise and dust pollution in flourmills.
3. To evaluate the impact of traffic density on mix environment.
4. To study the effluent characteristics of pulp and paper industry.
5. To study pollution potential of dairy effluent.
6. Analysis of textile mill effluent.
7. Estimation of MLSS, MLVSS from the sewage.
8. Determination of chlorine demand for drinking water.
9. To study environmental status of thermal power plant.
10. To draw the flow chart for industrial effluent treatment.
11. Design of settling tank.
12. Design of aeration tank.
13. To compare the impact of chemical pesticides vis-à-vis bio-pesticides on micro flora.
14. To examine the effect of chemical v/s bio-fertilisers on root ramification and plant growth.

EES 401: Industrial Safety, Hygiene and Toxicology

Industrial safety: History and development of safety movement; Safety legislation, Acts and Rules; Safety standards and codes, Safety policy; Safety organization and responsibilities and authorities of different levels; Accidents- Sequence theory, Causes & Prevention, Plant safety inspections, Job safety Analysis and Investigation of accidents, Safety committee- Role & Formation; Safety awareness programme- Motivation, Education and Training; Total loss control concept; Productivity, Quality, Reliability and Safety (PQRS) theory. **(10)**

Risk assessment and management: Checklist procedure; Preliminary hazard analysis; What if analysis; Failure mode effect analysis; Hazard and Operability (HAZOP) studies; Hazard analysis techniques-Fault tree & Event tree analysis; DOW index; Risk estimation and management; On-site and Off-site emergency preparedness. **(04)**

Specific hazards: Identification of hazard; Categorization methods for elimination of hazard; Mechanical hazards- Machine guarding, Safety with hand tools/ portable power tools, Pressure vessel hazards and their control; Safety in material handling; Safety with storage of materials; Electrical hazards- classification, Safe work practices; Chemical hazards- Laboratory safety, Bulk handling of chemicals; Fire and explosion hazards- Fire detection, Prevention, Control & extinguishments. **(10)**

Industrial hygiene: Principles of industrial hygiene; Environmental stresses- Physical, Chemical, Biological and Ergonomic stresses; Physical stresses- Heat, Heat balance, Health effects, WBGT index & Control measures, Gases under high pressure; Chemical stresses- Chemical agents, IS/UN classification, Flammables, Explosives, Irritants, Oxidants, Asphyxiants, Anaesthetics, Toxic & Carcinogenic chemicals; Air sampling and evaluation methods, Occupational exposure limits, Engineering control measures. **(10)**

Elementary industrial toxicology: Introduction; Definitions; Environmental agents causing public concern; Factors affecting toxicity; LD_{50}- Definition and uses, Dose response curve, Extrapolation of animal studies results to human, Probit factor; Carcinogenesis- Initiation, Promotion and Progression, Chemicals carcinogenesis, Threshold limit value (TLV); Morphological, functional and biochemical changes in Acute and Chronic exposures. **(08)**

Occupational health: WHO definition of health, Concept of occupational health; History of occupational health; Occupational and work-related diseases; Prevention of occupational diseases, Occupational health service; Personal protective equipments- Respiratory and Non-respiratory. **(06)**

Recommended Books:

1. Industrial Safety and pollution control handbook: National Safety Council and Associate publishers Pvt. Ltd, Hyderabad (1993).
2. Handbook of Environmental Health and Safety: Herman Koren and Michel Bisesi, Jaico Publishing House, Delhi (1999).
3. Environmental Toxicology and Chemistry: Donald G. Crosby , Oxford University Press, USA (1998).
4. Handbook of Environmental Risk Assessment and Management: Peter Calow, Blackwell Science Ltd. USA (1998).
5. Principals of Environmental Toxicology: Ian C. Shaw and John Chadwick, Taylor and Francis, USA (1998).
6. The Factories Act-1948, Government Printing Press, Civil lines, Delhi (1994).
7. Risk Assessment and Environmental Management: D. Kofi Asvite- Dualy, John Willey & Sons, West Sussex, England (1998).

8. Introduction to Environmental Engineering & Science: Gilbert M. M., Pearson Education, Singapore (2004).

EES-402: ENVIRONMENTAL POLICIES AND LEGISLATION

Environmental policy: Population, industrialization and urbanization policies of GOI, International and Government of India's policies in the protection of environment; Environment action plan (EAP); Making of environmental laws; implementing the laws. National Forest Policy, 1989, National Water Policy, 2002. **(07)**

Policy statement for abatement of pollution: Introduction, problems, objectives and future directions; Critical polluted areas and their standards; Constitutional provision regarding Environmental Protection (article 48 and 58 A) **(07)**

Leading case studies: The Environmental concern in India, Silent valley; Sardar Sarovar; Tehri Dam and Chipko Movement. **(04)**

Global environmental awareness and action plan: Stockholm Conference (UNCHE); Montreal Protocol; UN conference on environment and development, Rio (UNCED) Summit; Population conference, Cairo and climatic change conference, Kyoto; International union for conservation of nature and natural resources (IUCN); UN environmental programmers (UNEP); World-wide fund for nature (WWF). **(10)**

Environmental laws in India: The Factories Act,1948 and Amendment thereof, The Water (prevention and control of pollution) Act,1974; The Forest (conservation) Act,1980; The Air (prevention and control of pollution) Act,1981; The Environment (protection) Act,1986, Public Liability Insurance Act,1991, The Wildlife (protection) Act,1972. **(12)**

Environmental rules in India: Hazardous Waste (management and handling) Rules,1989; Rules framed under industrial waste; Biomedical waste management rules; Noise and Environmental Pollution under Motor Vehicles Rules,1989; Noise Pollution (regulation and control) Rules, 2000; Coastal Zone Regulation,1991. **(08)**

Recommended Books:

1. Environmental Governance -The Global Challenge: Lamont, C., Affiliated East-West Press Pvt. Ltd, New Delhi (1998).
2. A Text book in Environmental Sciences: Subramanian, Narosa Publishing House, New Delhi (2000).
3. Environment and Pollution Law Manual: Mohanty S. K., Universal Law Publishing Co-Pvt. Ltd., New Delhi (2000).
4. Labour and Industrial Law: Sing, A, K. and Agrawal R. K., Pioneer Printers, Agra (2000).
5. Environmental Policies: Sinha P. C., Anmol Publications Pvt. Ltd, New Delhi (1998).
6. Environmental Geography: Savindra Singh, Prayag Pustak Bhawan, Allahabad (2002).
7. Climate Change in Asia and Brazil: James G. Speth and Mohaned EL-Ashry, TERI, New Delhi (1994).
8. Environmental Guidelines and Standards in India: Goel P. K and Sharma K. P, Techno Science Publications, Jaipur (1996).

9. Commentaries on water and air pollution law: Lal, Universal Publication, New Delhi(1992).
10. Earth Summit, Vol. I & II: Bhaskar Rao, Universal Publication, New Delhi (1996).

EES-403: Nature Conservation and Environmental Management

Biodiversity conservation: Causes for loss of biodiversity, Biodiversity Hot spot, Strategies for biodiversity conservation, National park, Sanctuaries, biosphere reserve, Gene Pool, Listing of endangered and threatened species, Convention on Biodiversity (CBD) **(10)**

Conservation of resources: Natural resources and its classification ; Mineral resources- use of minerals, mineral exploration and extraction, environmental impacts of mineral extraction, Wild life resources; conservation measures, necessity for conservation, Wild life research in India; Forest resource; importance, Forest conservation, Water resources; worldwide distribution and uses of water, sources of water, Managing of water resources, Environmental impact of resource exploitation, Wasteland reclamation, Wetland; Definition, types, characteristic, Benefits, Watershed management- approach and prioritization of watershed, principle of influencing operation, Rain water harvesting Definition, techniques, methods for groundwater recharge. **(16)**

Environment Biotechnology: Vermiculture technology- Role of earthworm, process of vermin-composting, applications; Bio-fertilizer technology- Definition, classification importance, prospects; Fermentation Technology- Bioreactor, Overview of the fermentation process, Bioreactor design, materials of the bioreactor. **(06)**

Non-conventional energy sources and their programs in India: Biogas, Wind Mill (wind farm, Advantages and limitation, wind energy), Solar energy (SPV, ST), Geothermal energy, Nuclear energy (Nuclear reactor, Status of Nuclear power, Cost befit analysis) Hydro power (small hydel project), Tidal power. **(06)**

ISO 14000: Definition, Standards (14001), TC-207, EMAR and EMAS, TAG. ISO 9000, ISO 14001, Relation between ISO 14001 and ISO 9000, Certification, Accreditation and Registration, Preparation for ISO 14000. **(04)**

Environmental Education: Concept, Definition, History, Objectives, Teacher training program, Environmental aspects need to be highlighted in EE, EE at various levels, Role of NGO's in EE. **(06)**

Recommended Books:

1. Biodiversity: K. C. Agrawal, Agro Botanical Publishers, New Delhi, India (1996),
2. Environmental Biology: S. N. Prasad, Campus Books International, New Delhi (2000),
3. Fundamentals of Biotechnology: S. S. Purohit and S. K. Mathur, Agro Botanical Publishers, New Delhi, India. (1990).
4. Environmental Biology: K. C. Agrawal, Agro Botanical Publisher, New Delhi, India. (1993).
5. Compendium of Environmental Statistics: Central Statistical Organization, Dept. of State. Ministry of Planning and Programme Implementation, Govt. of India. (1997).
6. Environment Pollution and Development: Prof. Chandra Pal, Mittal Publications, New Delhi (1999).
7. Environmental Guidelines and Standards in India: P. K. Goel and K. P. Sharma, Techno science Publications, Jaipur, (1996).
8. Global Environmental Chemistry: D. C. Parashar, C. Sharma and A. P. Mitra, Narosa Publishing House (1998).

9. Environmental Challenges and the Universities: AIN (1994).
10. Environment and Development: I. S. Grover and A. K. Thukval, Scientific Publishers, Jodhpur (1998).
11. Principles of Environmental Biology – P.K.G. Nair, Himalaya Pub. House, Delhi.
12. Elements of Biotechnology – P. K. Gupta, Rastorgi Publication, Meerut.

EES -404: PRACTICAL COURSE ON INDUSTRIAL VISITS

Industrial visits: Sugar, Distillery, Dairy, Foundry, Textile, Pulp and Paper, Pharmaceutical, Chemical, Food Processing Agrochemical, Fertilizer, etc. Writing of report on the local industrial visits and long tour report.

Case study on EIA: Any one case study from the followings: Mining, Hydel, Irrigation and Thermal Power Plant

EES -405: PRACTICAL COURSE ON RESEARCH DISSERTATION

Dissertation topic on environmental protection and nature conservation. The students are expected to study the local environmental problems related to the following aspects during their dissertation.

a. Urban environmental problems.
b. Quality of water resources.
c. Watershed management.
d. Biodiversity.
e. Reclamation of problematic soil.
f. Bioremediation.
g. Health effects of pollution.
h. Environmental and socio-economic impacts of various human activities.

SCHOOL OF ENVIRONMENTAL AND EARTH SCIENCES
Kavayitri Bahinabai Chaudhari Maharashtra University, Jalgaon

Model for implementation of the

Credit-Grade based Performance and Assessment (CGPA) system

M.Sc. course

In tune with the concept and suggestions of the UGC and NAAC, technological advancement and social needs and to make the teaching effective and meaningful, School of Environmental and Earth Sciences has been permitted to adopt Credit-Grade based Performance and Assessment (CGPA) system from the academic year 2009-2010 for the course M.Sc. (Environmental Science) being run in the school. The modalities and operational details of the credit system shall be as follows.

A. Features of the CGPA System:

1. Master's degree course, M. Sc being run in School would be of 84 credits each.
2. One credit for the theory course shall be of the one clock hour per week running for 15 weeks. Thus, each theory course of 4 h per week teaching shall be of 4 credits.
3. Four credits for each practical course shall be awarded to the 8 h of laboratory exercise per week for a semester. As per the guidelines of the work load, each batch for practical course shall consist of 10-12 students and each batch shall perform the laboratory exercise twice in a week. Thus, each practical course shall be of 8 h laboratory exercise per week with 4 credits.
4. Four credits shall be awarded to the Project course, which will commence from III Semester and the final work and report will be completed during IV Semester. The marks and the credits will be allotted in IV Semester.
5. Two credits, one each in first two semesters (i.e. for Semester I and II) have been allocated for the Tutorials/Home assignments. Besides, for every theory course one Take Home Assignments of 40 marks each shall be conducted. Average marks of all the home assignment in the given semester will be considered. No grade will be given for the tutorial. However, the completion of the credit for the tutorial shall be compulsory.
6. Two credits, one each in the III and IV semesters have been allocated for the Seminar. There shall be one seminar per student. Marks out of 40 will be allocated per semester for this as per break up given below in (g). No grade will be given for the seminar. However, the completion of the credit for the seminar shall be compulsory.

7. Every student shall complete 84 credits in a minimum of four semesters. All Semesters will have 21 credits each.
8. Academic calendar showing dates of commencement and end of teaching, internal assessment tests and term end examination shall be duly notified before commencement of each semester every year by the School.

B. Evaluation of the student:

(a) The evaluation of the student shall be divided into two parts viz. **Internal Assessment** and **Term End Examination (semester end examination)** with a weightage in the ratio of 40:60, as approved by the committee.

(b) Standard of passing –

(i) There shall not be pass or fail for the internal assessment. However, the attendance for the internal assessment shall be compulsory.

(ii) Minimum marks for passing the Term End Examination in theory/practical/project course shall be 40%.

(iii) Minimum marks for passing the theory/practical/project course (i.e. sum of the marks obtained in internal and term end examination) shall be 40%.

(c) The distribution of marks for each theory paper of 4 credits at term (Semester) end examination and for continuous internal assessment (Minor tests), as approved by the committee shall be as follows:

Theory Examination	Maximum marks
Internal assessment	40
Term end examination	60
Total marks	100

(d) The distribution of marks for each laboratory course of 4 credits at term (Semester) end examination and for continuous internal assessment (Minor tests), as approved by the committee shall be as follows:

Practical Examination	Maximum marks
Internal assessment	40
Term end examination	60
Total marks	100

(e) The Project course will commence from III Semester and the final work and report will be completed during IV Semester. The marks and the credits will be allotted in IV Semester. The distribution of marks for Project course of 4 credits at term (Semester) end examination and for continuous internal assessment (Minor tests), as approved by the committee shall be as follows:

Practical Examination	Maximum marks
Internal assessment	40

Heads	Marks	Evaluating Authority
Marks for journal	10	Concerned practical incharge
Experimental work carried by	20	

Term end examination	60
Total marks	100

(f) Internal Assessment:

(i) Internal assessment for each course would be continuous and dates for each internal test/practical test will be pre-notified in the time table for teaching or placed separately as a part of time table.

(ii) Each subject teacher shall coordinate this activity and maintain the record of the internal tests conducted.

(iii) Internal assessment for each course shall be of 40 marks.

(iv) There shall not be pass or fail for the internal assessment. However, the attendance for the internal assessment shall be compulsory.

For Theory Courses:

(i) Two internal tests for each theory course comprising of 4 credits shall be conducted by the subject teacher.

(ii) Each test shall be of 20 marks.

(iii) The marks for each test shall be displayed on notice board within seven days of conducting the test.

(iv) It is mandatory to show the answer sheets of all tests to the students.

For Practical Courses:

The internal assessment for the practical courses will be based on the following 03 heads:

Heads	Marks	Evaluating Authority
Performance of the student in the collection of reference material for project work and punctuality	10	Concerned Project guide
Experimental work carried out by the student	20	
Viva-voce	10	
Total marks	40	

student		
Viva-voce	10	
Total marks	40	

For Project course

(i) The Project course will commence from III Semester and the final work and report will be completed during IV Semester.

(ii) Every student has to undertake a project of interest. The project may be related to a theoretical analysis, an experimental investigation, a proto-type design, a new correlation and analysis of data, fabrication and setup new equipment. Ordinarily, the Project Co-ordinator shall be chosen by the student depending on his/her subject interest. The project co-ordinator assigns the topic for the project and the work is done uniformly during both the semesters of the final year.

(iii) The marks and the credits will be allotted in IV Semester.

(iv) On the basis of marks obtained in Seminar, the marks out of 40 will be given for the Seminar.

For Tutorial:

(i) Two credits based on Tutorial component, one each in I and II semesters will constitute the compulsory part.

(ii) For every theory course one Take Home Assignments of 40 marks each shall be given.

(iii) The evaluation will be based on following two heads:

Head	Marks	Evaluating Authority
Take Home Assignment	40	Concerned subject teacher

(iv) On the basis of marks in Tutorials for theory courses, the average will be calculated and the marks out of 40 shall be awarded for the Tutorial.

For Seminar:

(i) Two credits based on Seminar component, one each in the III and IV semesters will constitute the compulsory part.

(ii) Each student shall deliver one seminar per semester and there will be a continuous evaluation of the seminar.

(iii) The evaluation will be based on following four heads:

Heads	Marks	Evaluating Authority
collection of reference material for seminar	10	Concerned course teacher
Content of the seminar	20	
Performance in seminar/presentation	10	
Total marks	40	

iv) On the basis of marks obtained in Seminar, the marks out of 40 will be given for the Seminar.

g) Term end examination:

(i) The term end examination for 60 marks per course would be held about a week after completion of teaching for the semester.

(ii) The term end examination of maximum marks 60 and its assessment work shall be conducted by the School from the academic year 2009-10 under the academic flexibility granted to the School by the University.

For Theory Courses:

(i) Examination pattern shall be 60+40.

(ii) Each theory paper of 60 marks shall be of the three hours duration.

For Practical Courses:

(i) The term end practical examination shall be of 60 marks and it is of duration 06 h.

(ii) There shall be two examiners for the practical examination out of which one examiner shall be from the other University/Institute.

For Project course

(i) The project report should be submitted by the prescribed date. Submission of the project cannot be postponed beyond the date specified in the calendar.

(ii) Students should submit 2 bound typed copies of Project Report to the department. A student who is unable to complete his/her Project may be awarded 'X' grade and he/she will be required to register for the next Semester and pay the fees under following circumstances:
Exceptional circumstances beyond students / supervisor control
Medical grounds

(iii) There shall be two examiners for the evaluation of Project, out of which one examiner shall be from the other University/Institute.

(iv) The examiners shall evaluate the report and an oral examination shall be conducted. The assessment of the project work is done on the following basis-

Heads	Marks	Evaluating Authority
Performance of the student in the presentation of the project work and report	10	Panel of examiners
Experimental work carried out by the student	40	
Viva-voce	10	
Total marks	60	

C. Grades :

(i) Marks for each course would be converted to grades as shown in Table 1.

Table 1: Conversion of marks to grades in credit system

Marks obtained	Grade	Grade Points
90-100	A+	10
80-89	A	9
70-79	B+	8
60-69	B	7

55-59	C+	6
45-54	C	5
40-44	D	4
39 and less	F	0

(ii) The grade point will be given on the total marks (sum of mark obtained in internal assessment and term end examination) obtained in the said subject.

(iii) A student who fails in a course (i.e. He scores less than 24 out of 60 marks in the Term End Examination or less than 40 out 100 marks) shall be given F grade. Student with F grade in course would be granted credit for that course but not the grade for that course and shall have to clear the concerned course within 1.5 year from appearing for first time in the concerned paper.

(v) The **total grade points earned in each course** shall be calculated as –

Grade points obtained (vide Table-1) X Credits for the course

Maximum grade points that can be earned in a semester are 200.

(vi) **Semester Grade Point Average (SGPA)** –

The performance of a student in a semester is indicated by a number called SGPA. SGPA is the weighted average of the grade points obtained in all courses registered by the student during the semester. It shall be calculated as follows-

$$SGPA = \frac{\sum_{i=1}^{n} C_i p_i}{\sum_{i=1}^{n} C_i}$$

where Ci = the number of credits earned in the i'th course of a semester for which SGPA is to be calculated **(Audit credits should not be included).**

pi = grade point earned in the i'th course

i = 1,2,3,……n represent the number of courses in which a student is registered in the concerned semester.

That is,

$$SGPA = \frac{Total\ earned\ grade\ points\ for\ the\ semester}{Total\ credits\ for\ the\ semester}$$

The SGPA is rounded upto one decimal places.

(vii) **Final result** – Up to date assessment of the overall performance of a student from the time of his/her first registration is obtained by calculating a number called Cumulative Grade Point Average (CGPA), which is weighted average of the grade points obtained in all courses registered by the student since he/she entered the School/Department.

$$CGPA = \frac{\sum_{j=1}^{m} C_j p_j}{\sum_{j=1}^{m} C_j}$$

where Cj = the number of credits earned in the jth course up to the semester for which CGPA is to be calculated

pj = grade point earned in the jth course. A letter grade lower than D (i.e. grade point < 4) in a course shall not be taken into consideration for the calculation of CGPA.

j = 1,2,3……m represent the number of courses in which a student is registered up to the semester for which the CGPA is to be calculated.

The CGPA is rounded upto one decimal places.

(viii) The final grade earned shall be as per Table 2 given below-

Table-2

CGPA	Grade
8.0-10	A+
7.0-7.9	A
6.0-6.9	B+
5.5-5.9	B
4.5-5.4	C+
4.0-4.4	C
0 -3.9	F