KERALA TECHNOLOGICAL UNIVERSITY

Master of Technology

Curriculum, Syllabus and Course Plan

Cluster *: 9*

Branch *: Civil Engineering*

Stream *: Environmental Engineering*

Year *: 2015*

No: of Credits *: 68*

COURSE OBJECTIVE

The main objective in offering this course to the students pursuing post graduate in Environmental Engineering is to provide them with an ability to apply knowledge of mathematics, science, and engineering and to comprehensively understand the significant environmental issues currently impacting global society. A student completing this course shall have a good knowledge and understanding of professional and ethical responsibility, an ability to communicate effectively by using their quantitative and critical thinking skills to find an appropriate engineering solution. Thus in a wider aspect, the course will be a molding opportunity for the student to explore and improve knowledge in the field.

COURSE OUTCOME

The field of Environmental Engineering is gaining wide importance worldwide especially in modern concepts of Green Technology, waste minimization, disposal and management which is essential to maintain an ecological balance between human beings and the environment. On completion of this course, the student is expected to acquire knowledge in both technical and practical aspects of the application of Environmental Engineering in the present scenario.

SEMESTER 1

Examination Slot	Course Number	Subject	L-T-P	Internal marks	End Semester Examination		Credits
					Marks	Duration (hours)	
A	09CE6211	Applied Statistics	4-0-0	40	60	3	4
B	09CE6221	Environmental Chemistry and Microbiology	4-0-0	40	60	3	4
C	09CE6231	Physicochemical methods in Environmental Engineering	4-0-0	40	60	3	4
D	09CE6241	Solid and Hazardous Waste Management	3-0-0	40	60	3	3
E		Elective	3-0-0	40	60	3	3
	09CE6251	Research Methodology	0-2-0	100	0	0	2
	09CE6261	Seminar		100	0	0	2
	09CE6271	Environmental Quality Measurement Laboratory	0-0-2	100	0	0	1
		TOTAL	**18-2-2**	**500**	**300**		**23**

TOTAL CONTACT HOURS: 22

TOTAL CREDITS: 23

Elective

09CE6215 Industrial Water Pollution Control and Waste Management

09CE6225 Analytical Methods for Environmental Monitoring

09CE6235 Transport of Water and Waste Water

SEMESTER 2

Examination Slot	Course Number	Subject	L-T-P	Internal marks	End Semester Examination		Credits
					Marks	Duration (hours)	
A	09CE6212	Biological Methods in Environmental Engineering	3-1-0	40	60	3	4
B	09CE6222	Air Quality Management and Meteorology	3-0-0	40	60	3	3
C	09CE6232	Environmental Impact Assessment	3-0-0	40	60	3	3
D		Elective I	3-0-0	40	60	3	3
E		Elective II	3-0-0	40	60	3	3
	09CE6262	Mini Project	0-0-4	100			2
	09CE6272	Environmental Microbiology and Engineering Laboratory	0-0-2	100			1
		TOTAL	**15-1-6**	**400**	**300**		**19**

TOTAL CONTACT HOURS: 22

TOTAL CREDITS: 19

Elective I

09CE6266 Environmental Geology

09CE6276 Environmental Biotechnology

09CE6286 Numerical Methods

Elective II

09CE6218Advanced Hydrology and Water Resource Engineering

09CE6228Global Climatic changes and Disaster Management

09CE6238Water Pollution Control and Stream Sanitation

SEMESTER 3

Examination Slot	Course Number	Subject	L-T-P	Internal marks	End Semester Examination		Credits
					Marks	Duration (hours)	
A		Elective III	3-0-0	40	60	3	3
B		Elective IV	3-0-0	40	60	3	3
	09CE7263	Seminar	0-0-2	100	0	0	2
	09CE7283	Project (Phase I)	0-0-12	50	0	0	6
		TOTAL	**6-0-14**	**230**	**120**		**14**

TOTAL CONTACT HOURS: 20

TOTAL CREDITS: 14

Elective III

09CE6217 Remote Sensing and GIS

09CE6227 Environmental System Analysis

09CE6237Groundwater Contamination and Pollution Transport

Elective IV

09CE6267 Planning and Design of Environmental Facilities

09CE6277 Bioremediation Principle and Applications

09CE6287 Environmental Systems Modelling

SEMESTER 4

Examination Slot	Course Number	Subject	L-T-P	Internal marks	End Semester Examination		Credits
					Marks	Duration (hours)	
	09CE 7284	Project (Phase II)	0-0-21	70	30	0	12
		TOTAL	**0-0-21**	**70**	**30**		**12**

TOTAL CONTACT HOURS: 21

TOTAL CREDITS: 12

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6211	Applied Statistics	4-0-0	4	2015

Course Objective

To enable the students apply statistics in various areas of Environmental Engineering like sampling and analysis, stochastic modeling etc.

Syllabus

Probability Distributions-Sampling techniques- Regression and correlation- Statistical inference-Applications-Time Series Models

Expected Outcome

Upon successful completion of this course, the student will have basic knowledge in mathematics which is essential for higher studies and research in engineering.

References

1. *Fundamentals of Mathematical Statistic, Gupta.S.C. and Kapoor.V.K, , Sultan Chand and Sons, 1978.*
2. *Probability, Statistics and Decision for Civil Engineers, Benjamin, Jack.R and Comell.C, Allin, Mc-Graw Hill.*
3. *Traffic Engineering and Transport Planning, Kadiyali.L.R , Khanna Publishers.*
4. *Traffic Systems analysis for Engineers and Planners, Wohl, Martin and Martin, Brian.V, Mc-Graw Hill.*
5. *Probability and Statistics for Engineers (6th edition), Richard.A. Johnson: Miller and Freunds, Pearson.*
6. 6. *Fundamentals of Statistics, Elhance.*

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6211	Applied Statistics	4-0-0	4	2015

Module	Contents	Hours Allotted	% of marks in End Semester Examination
I	Probability Distributions: Probability mass functions and probability density function, mean and variance. Binomial, Poisson, Exponential, Gamma, Lognormal and normal distribution: Fitting of the distributions.	10	20
II	Sampling techniques: Simple random sampling, stratified sampling, systematic sampling, sample size determination- application in Environmental Engineering	7	25
FIRST INTERNAL EXAMINATION			
II	Regression and correlation: Linear Regression and correlation, multiple correlation coefficient, standard error of estimate, curvilinear regression- Applications.	7	
III	Statistical inference: Intervals estimation, Confidence interval for mean, variances and regression coefficients. Sampling Distribution, Test of significance of (i) Means (ii) Mean of two samples (iii) Proportions (iv) Variance (v) Two variances (vi) Two observed correlation coefficients (Fishers' z-transformation), (vii) Paired T-test (viii) Regression coefficients (ix) Chi-square test of goodness of fit, Skewness and Kurtosis tests.	16	30
SECOND INTERNAL EXAMINATION			

IV	Applications: Analysis of variance (i) Completely randomized designs (ii) Randomized block designs. Latin squares. Grecco Latin square design. Factorial experiments. Graphical presentation techniques. Time Series Models: Components of time series-smoothing- Measuring forecasting accuracy-Testing of ARIMA Models.	12	25
END SEMESTER EXAMINATION			

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 60 marks

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6221	Environmental Chemistry and Microbiology	4-0-0	4	2015

Course Objective

To bring into focus those aspects of chemistry and microbiology that are particularly valuable for solving environmental problems like water and wastewater analysis

Syllabus

Types of chemical reactions-Fundamentals of surface and colloidal chemistry - Mass transfer and transport of impurities in water and air -Chemistry of water and waste water -Microorganisms – Classification- applications in environmental engineering- Microbial metabolism and growth Distribution of microorganisms in natural water- Microbiology of wastewater treatment processes

Expected Outcome

Upon successful completion of this course, the student will be thorough with the fundamental concepts of environmental chemistry and microbiology which will be useful for further application in experimental works and research.

References

1. *Chemistry for Environmental Engineering, Clair N.Sawyer, Pery L.McCarty - Mc Graw Hill*
2. *Standard methods for the examination of water and waste water ,APHA*
3. *Pollution and health (Wiley Eastern Ltd),P. K. Ray*
4. *Environmental Chemistry, S. K. Banerjee*
5. *The NALCO Water Handbook, Kemmer, McGraw Hill*
6. *Environmental Microbiology Elsevier– AP, Maier R.M, Pepper I.L and Gerba C.P, New York 2009.*
7. *Microbiology, Pelczar Jr, M.J., Chan E.C.S., Krieg R.N., and Pelczar M.F, Tata McGraw–Hill, New Delhi, 1996.*
8. *Process Chemistry for Water and Wastewater Treatment, Benefield, Judkins and Weand, Prentice Hall, New Delhi.1996.*
9. *Environmental Biotechnology: Principles and Applications, Rittman B., McCarty P.L. and McCarty P, McGraw–Hill, New Delhi, 2000.*

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6221	Environmental Chemistry and Microbiology	4-0-0	4	2015

Module	Contents	Hours Allotted	% of marks in End Semester Examination
I	Types of chemical reactions – stoichiometric calculations – solutions – chemical equilibrium. Acid-base equilibria – alkalinity, acidity, buffers and buffer index - Chemical thermodynamics – Oxidation–Reduction Fundamentals of surface and colloidal chemistry- Colloids and their classification, Properties and their stability – Colloidal dispersions – Zeta potential – destruction of colloids – basic method of coagulation, different colloidal dispersions.	10	25
II	Mass transfer and transport of impurities in water and air –diffusion, dispersion – Physical and chemical interactions due to various forces, suspensions and dispersions. Chemistry of water and waste water – Introduction to physico-chemical water quality parameters	6	25
FIRST INTERNAL EXAMINATION			
II	Microorganisms – Classification, prokaryotic and eukaryotic cells, structure, characteristics, nucleic acids, DNA and RNA, Viruses, their detection and quantification – Microscopy Measurements and Isolation of Microorganism – Different Cultures – Media and Techniques of Staining and Enumeration of microorganism- Importance of sterilization, factors influencing sterilization, principles and methods	7	

III	Microbial Metabolism And Growth: Metabolic classification of microorganisms: phototrops, chemotrops, Applications in Environmental Engineering. Enzyme and enzyme kinetics – Metabolism – Respiration – Fermentation – Glycolysis – Kreb's cycle – Carbohydrate – Protein, lipids, significance of energetic – Chemical composition of cell and nature of organic matter used by microorganisms – Biogeochemical cycling.	15	25
SECOND INTERNAL EXAMINATION			
IV	Distribution of microorganisms in natural water – Indicator organisms – Coliforms – Fecal coliforms – E.*coli*, *Streptococcus fecalis* – Differentiation of coliforms – Significance – MPN –Membrane Filtration techniques – Microbiology of wastewater treatment processes such as Activated Sludge process – Trickling filter – Anaerobic processes. – Introduction to Microbiology of Soil, Air And Industry– Microbiology of bioremediation and solid waste treatment.	12	25
END SEMESTER EXAMINATION			

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 60 marks

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6231	Physicochemical methods in Environmental Engineering	4-0-0	4	2015

Course Objective

To make the students understand the principles of physico-chemical treatment methods in Environmental Engineering.

Syllabus

Process dynamics- Sedimentation-Coagulation and flocculation- Floatation and aerosol separation-Filtration-Disinfection-Adsorption-Ion exchange- Membrane process- Sludge treatment

Expected Outcome

Upon successful completion of this course, the student will be having a thorough knowledge about the various physical and chemical operations taking place in waste water treatment plant.

References

1. *Wastewater Engineering – Treatment and Reuse, Metcalf & Eddy, Inc., Revised by G. Tchobanoglous, F. L. Burton, and H. D. Stensel. Tata McGraw-Hill Publishing Company Limited, New Delhi, 2011.*
2. *Unit Operations and Processes in Environmental Engineering, T. D. Reynolds, P. Richards. PWS Series in Engineering, Boston, 2010.*
3. *Environmental Pollution and its Control, S. A. Abbasi, DPH, New Delhi 2010.*
4. *Manual on Water Supply and Treatment. CPHEEO, Ministry of Urban Development, GoI, New Delhi, 1999.*
5. *Physico-chemical processes for water quality control, Weber W. J, Wiley Inter-science,1972*
6. *Unit operations of sanity engineers, Rich L. G, Wiley Topan*

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6231	Physicochemical methods in Environmental Engineering	4-0-0	4	2015

Module	Contents	Hours Allotted	% of marks in End Semester Examination
I	Process dynamics-Reactions and Reactors-Mechanics of mass transport-reactions and energetics-kinetics and reaction rates-reactor engineering and process design. Screenings-types of screens-head loss in screens Equalization process-types of equalization process-volume of equalization basins	10	20
II	Sedimentation-sedimentation processes- types of settlings- tube settlers-design of sedimentation tanks. Coagulation and flocculation- coagulation processes-stability of colloids-destabilization of colloids in water and wastewater treatment-transport of colloidal particles	8	30
FIRST INTERNAL EXAMINATION			
II	Floatation and aerosol separation-methods of floatation-gas particle contact-dissolved air floatation. Filtration-filtration processes-filter media- types of filters-mechanisms of filtration-hydraulics of filtration-filter problems -effluent quality-design of filters	8	
III	Disinfection-processes-methods of disinfection-factors influencing-nonchemical methods-details of chlorination-other disinfectants. Adsorption-adsorption process-adsorption isotherm-adsorption kinetics-factors influencing-design of adsorption units Ion exchange- process-materials-exchange reactions-application in water and wastewater treatment-design of units Membrane process - Reverse Osmosis-electro dialysis- ultrafiltration- membrane properties-	16	30

	process design Chemical oxidation-principles and theories-generation and application of chemical methods		
SECOND INTERNAL EXAMINATION			
IV	Sludge treatment-characteristics of sludge-dewatering methods-conversion process-anaerobic and aerobic digestion-combustion-disposal, of sludge.	10	20
END SEMESTER EXAMINATION			

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 60 marks

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6241	Solid and Hazardous Waste Management	3-0-0	3	2015

Course Objective

To provide information regarding different elements of land pollution, various hazardous wastes, their origin, characteristics and treatment.

Syllabus

Legal and Organizational foundation- storage and handling of solid waste- Separation and Processing and Transformation of Solid Waste- Energy recovery-Landfills- Hazardous waste management- Hazardous waste treatment and design

Expected Outcome

Upon successful completion of this course, the student will be aware about the solid wastes that are generated from various sources and its management techniques, which will be useful as an Environmental Engineer.

References

1. *Hazardous Waste Management, M. D. LaGrega, P. L Buckingham, J. C. Evans, 2nd edition. McGraw-Hill, 2011.*
2. *Handbook of Solid Waste Management, F. Kreith, G. Tchobanoglous, 2009.*
3. *CPHEEO, Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organization, Government of India, New Delhi, 2000.*
4. *Hazardous Waste Management, Charles A. Wentz, McGraw- Hill,1995*
5. *Integrated solid waste management: engineering principles and management issues, George Tchobanoglous, Hilary Theisen, S. A. Vigil, McGraw-Hill,1993*

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6241	Solid and Hazardous Waste Management	3-0-0	3	2015

Module	Contents	Hours Allotted	% of marks in End Semester Examination
I	Types and Sources of solid and hazardous wastes - Need for solid and hazardous waste management - Legislations on management and handling of municipal solid wastes, hazardous wastes, and biomedical wastes. Determination of composition of MSW- storage and handling of solid waste- Future changes in waste composition. Collection and transport of solid waste: Collection of Solid waste: type of waste collection systems, analysis of collection system- alternative techniques for collection system.	10	25
II	Separation and Processing and Transformation of Solid Waste: unit operations used for separation and processing, Materials Recovery facilities, Waste transformation through combustion and anaerobic composting, anaerobic methods for materials recovery and treatment- Recycling of plastic materials and metals.	6	30
FIRST INTERNAL EXAMINATION			
II	Energy recovery – Incinerators. Transfer and Transport: need for transfer operation, transport means and methods, transfer station types and design requirements. Landfills: Site selection, design and operation, drainage and leachate collection systems – requirements and technical solutions, designated waste landfill remediation – Integrated waste management facilities.	6	
III	Hazardous waste management: Definition and identification of hazardous wastes- sources and characteristics- hazardous wastes in Municipal Waste- Hazardous waste regulations –	8	20

	minimization of Hazardous Waste – compatibility, handling and storage of hazardous waste- collection and transport.		
SECOND INTERNAL EXAMINATION			
IV	Hazardous waste treatment and design: Hazardous waste treatment technologies – Design and operation of facilities for physical, chemical and thermal treatment of hazardous waste – Biomedical waste disposal. Solidification, chemical fixation and encapsulation, incineration. Hazardous waste landfills: Site selection, design and operation – remediation of hazardous waste disposal sites.	9	25
END SEMESTER EXAMINATION			

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 60 marks

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6215	Industrial Water Pollution Control and Waste Management	3-0-0	3	2015

Course Objective

To provide information regarding different elements of water pollution and methods of treatment. Also to expose students to the various industrial processes and the origin, characteristics and treatment of waste water generated.

Syllabus

Sources of wastes- Study of some typical problem caused by industrial pollution in India- Prevention Vs Control of Industrial Pollution-Removal of suspended and colloidal solids- Individual and common effluent treatment plants- Industrial manufacturing process description

Expected Outcome

Upon successful completion of this course, the student will get a basic idea about the industrial waste and pollution caused which will be essential for waste disposal and management studies.

References

1. *Industrial Waste Treatment, Nemerow N.L, Elsevier Science & Technology Books, 2006*
2. *Industrial Waste Treatment Handbook , Frank Woodard,Butterworth–Heinemann, 2001.*
3. *Wastewater Treatment, Rao M.N. and Datta A.K , Oxford and IBH Publishing Co. Pvt. Ltd.*
4. *Industrial Water pollution Control, Eckenfelder, McGraw Hill Company, New Delhi, 2001.*

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6215	Industrial Water Pollution Control and Waste Management	3-0-0	3	2015

Module	Contents	Hours Allotted	% of marks in End Semester Examination
I	Sources of wastes – Industrial and domestic – Nature and characteristics of wastewater – Industrial wastewater and environmental impacts- Effects of industrial waste on streams and sewage treatment plants- Study of some typical problem caused by industrial pollution in India – Need for environment impact assessment for major industries.	8	20
II	Prevention Vs Control of Industrial Pollution – Benefits and Barriers – Waste minimization – Source reduction – Techniques – Waste Audit – Mass balance – Evaluation of pollution prevention options – waste volume reduction – Waste strength reduction – Neutralization – equalization and proportioning	6	25
FIRST INTERNAL EXAMINATION			
II	Removal of suspended and colloidal solids – Removal of inorganic and dissolved solids – Disposal of sludge solids. Discharge of treated waste to municipal sewers- Stream protection measures.	4	
III	Individual and common effluent treatment plants – Zero effluent discharge systems – Wastewater quality requirements for its reuse – Residuals of industrial wastewater treatment – Quantification and characteristics of Sludge – Thickening, digestion, conditioning, de-watering and sludge disposal.	12	30
SECOND INTERNAL EXAMINATION			

IV	Industrial manufacturing process description– Wastewater characteristics– Source reduction options and waste treatment flow sheet for Textiles, Tanneries, Pulp and paper, metal finishing, Petroleum Refining, Pharmaceuticals, Sugar and Distilleries, Food Processing, fertilizers, fishing industry, Dairy plant, Oil refineries, Rubber industry, Steam power plant.	9	25
END SEMESTER EXAMINATION			

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 60 marks

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6225	Analytical Methods For Environmental Monitoring	3-0-0	3	2015

Course Objective

Students are expected to know the various analytical methods used in Environmental Engineering

Syllabus

Instrumental methods- Conductivity- Colorimetry- Analysis of Acidity, Alkalinity, BOD, COD, Hardness, Sulphides, chlorides- Spectrophotometry- Chromatography- Material characterization techniques

Expected Outcome

Upon successful completion of this course, the students will have a fundamental knowledge about the analytical methods used in Environmental Engineering.

References

1. *Principles of Instrumental Analysis, D.A. Skoog, D.M. West and T.A. Nieman, ,5th Ed. Thomson Asion (P) Ltd. Singapore, 2004*
2. *Instrumental Methods of Analysis, H.H, Willard, L.L. Merit, J.A. Dean and F.A. Settle, 7th Ed. CBP Publishers and Distributors, New Delhi, 1986*

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6225	Analytical Methods For Environmental Monitoring	3-0-0	3	2015

Module	Contents	Hours Allotted	% of marks in End Semester Examination
I	Classification of instrumental methods- Performance characteristics of instruments (static and dynamic)- errors and uncertainties in performance parameters- noise reduction- Sensitivity and detection limit Errors-types- expression of errors- Precision and accuracy- Calibration of instrumental methods	4	25
II	Analysis of water quality parameters – Conductivity meter-electrolytic conductivity, specific equivalent and molar conductance- colorimetry and its applications. Working principles of pH, EC, TDS meters.	5	25
FIRST INTERNAL EXAMINATION			
II	Determination of Acidity, Alkalinity, BOD, COD, hardness, sulphides, chlorides, Ca, Mg, and analysis of minerals Fe, Mn, Ca, Mg in water	9	
III	Spectrophotometry - Electromagnetic radiation - Atomic absorption and emission spectrometry - Ultraviolet-visible spectrophotometry principle and instrumentation- Atomic adsorption spectroscopy principle and instrumentation- Flame photometer Dispersion and scattering: turbidimetry and nephelometry, fluorimetry.	10	25
SECOND INTERNAL EXAMINATION			
IV	Chromatography- principle and classification- column efficiency and resolution- quantitative determination- Column Chromatography- Thin Layer Chromatography- Principle and application-Ion chromatography-Gas	11	25

	Chromatography(GC)- High precision liquid chromatography (HPLC)- Mass Spectroscopy-GC-MS. Material characterization techniques- SEM, TEM, XRD, FTIR, thermal analysis- working principles and applications.		
END SEMESTER EXAMINATION			

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 60 marks

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6235	Transport of Water and Wastewater	3-0-0	3	2015

Course Objective

To make the students able to design various water and waste water distribution systems

Syllabus

Fluid flow- Water transmission and distribution- Wastewater collection and conveyance- Storm water drainage

Expected Outcome

Upon successful completion of this course, the student will be able to design water and waste water distribution system as an environmental engineer.

References

1. *Practical Hydraulics Hand Book, B.A. Hauser. Lewis Publishers, New York, 2011.*
2. *Water and Wastewater Technology, M.J. Hammer. Regents/Prentice Hall, New Jersey, 2011.*
3. *Water Supply Engineering (Vol 1), S K Garg, Khanna Publishers, 2010*
4. *Manual on water supply and Treatment. CPHEEO, Ministry of Urban Development, GOI, New Delhi, 1999.*
5. *Manual on Sewerage and Sewage Development. CPHEEO, Ministry of Urban Development, GOI, New Delhi, 1993.*

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6235	Transport of Water and Wastewater	3-0-0	3	2015

Module	Contents	Hours Allotted	% of marks in End Semester Examination
I	Fluid flow: Continuity, energy and momentum principles; frictional head losses in free and pressure flow, major and minor head losses and their estimation. Pumping of fluids and selection of pumps. Flow measurement.	10	25
II	Water transmission and distribution**:** Planning factors. Water transmission main design. Pipe material and economics	4	25
FIRST INTERNAL EXAMINATION			
II	Water distribution pipe networks and methods for their analysis and optimization. Laying and maintenance of pipelines; in situ: lining, appurtenances and corrosion prevention	5	
III	Wastewater collection and conveyance**:** Design of sanitary sewer; partial flow in sewers, economics of sewer design; sewer appurtenances; material, construction, inspection and maintenance of sewers; design of sewer outfalls: mixing conditions; conveyance of corrosive wastewaters.	10	25
SECOND INTERNAL EXAMINATION			
IV	Storm water drainage**:** Run-off estimation, rainfall data analysis, and storm water drain design. Rainwater harvesting.	10	25
END SEMESTER EXAMINATION			

Internal Continuous Assessment: 40 Marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 60 marks

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6251	Research Methodology	0-2-0	2	2015

Course Objectives

- To impart knowledge about various methodologies followed in engineering research, formulation of research problems and to apply the same in project work.
- To make students aware of the problems faced by Indian researchers.

Syllabus

Research Methodology: An Introduction-Formulating a Research Problem -Conceptualizing a research design-Processing and Analysis of Data-Methods of Data Collection-Writing a Research Report- Interpretation of Data and Paper Writing -A study of the use of the following tool: Matlab / Simulink , Software for paper formatting like LaTeX/ MS Office

Expected Outcome

Upon successful completion of this course, the student will get an idea about carrying out research in engineering field, and the problems that are faced during the course of research.

References

1. *Digital Signal Processing Laboratory Using MATLAB, Sanjit K. Mitra, , McGraw-Hill College, ISBN-13: 978-0073108582*
2. *Research Methodology: Methods and Techniques, C. R. Kothari, New Age International, 2004*
3. *Getting Started with MATLAB: Version 6: A Quick Introduction for Scientists and Engineers , Rudra Pratap, ,2001, Oxford University Press*
4. *Research Methodology : An Introduction, Wayne Goddard and Stuart Melville, 2nd Edition, 2001, Juta & Co Ltd*

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6251	Research Methodology	0-2-0	2	2015

Module	Contents	Hours Allotted	% of marks in End Semester Examination
I	Research Methodology: An Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Applications of Research, Definition of Research, Characteristics of Research ,Types of Research, Steps in Research Process Formulating a Research Problem : Reviewing the Literature, Formulating a Research Problem, Identifying Variables, Constructing Hypothesis	7	25
II	Conceptualising a research design: Definition of a Research Design, Need for Research Design, Functions of Research Design, Features of a Good Design	3	25
FIRST INTERNAL EXAMINATION			
II	Methods of Data Collection: Collection of Primary Data, Observation Method, Interview Method, Collection of Data through Questionnaires, Collection of Data through Schedules	4	
III	Processing and Analysis of Data: Processing Operations, Elements/Types of Analysis, Statistics in Research, Measures of Central Tendency, Measures of Dispersion, Measures of Asymmetry (Skewness) Writing a Research Report: Research writing in 5general, Referencing, Writing a Bibliography, Developing an outline, Writing about a variable	7	25
SECOND INTERNAL EXAMINATION			

IV	Interpretation of Data and Paper Writing – Layout of a Research Paper, Journals in Environmental Engineering, Impact factor of Journals, When and where to publish ? Ethical issues related to publishing, Plagiarism and Self-Plagiarism A study of the use of the following tool Matlab / Simulink , Software for paper formatting like LaTeX/ MS Office	5	25
END SEMESTER EXAMINATION			

Internal Continuous Assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests. The assessment details are to be announced to the students, right at the beginning of the semester by the teacher.

Mid Term Internal Test	40 Marks
Assignment I	10 Marks
Assignment II	10 Marks
Final Internal Test	40 Marks
Total	**100 Marks**

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6261	Seminar		2	2015

Course Objectives

- To assess the debating capability of the student to present a technical topic
- To impart training to students to face audience and present their ideas
- To create self-esteem and courage that is essential for engineers.

Individual students are required to choose a topic of their interest from Environmental Engineering related topics preferably from outside the M.Tech syllabus and give a seminar on that topic about 30 minutes. A committee consisting of at least three faculty members (preferably specialized in Environmental Engineering) shall assess the presentation of the seminar and award marks to the students. Each student shall submit two copies of a write up of his/her seminar topic. One copy shall be returned to the student after duly certifying it by the chairman of the assessing committee and the other will be kept in the departmental library. Internal continuous assessment marks are awarded based on presentation skill, quality of the report and participation.

Internal Continuous Assessment: 100 marks

The percentage distribution of marks is as given below

Marks for the report:	30%
Presentation	40%
Ability to answer questions on the topic	30%

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6271	Environmental Quality Measurement Laboratory	0-0-2	1	2015

Course Objective

To analyze the characteristics of water/wastewater samples

Syllabus

- Physical and chemical characteristics of water – pH, Electrical conductivity, Turbidity, Alkalinity, Acidity, Hardness, Sulfates, Fluorides, Nitrates.
- Analysis of solids content of water: Total solids, suspended solids, volatile solids, non-volatile solids, Residual chlorine analysis, Optimum coagulant dose, Break point Chlorination.
- Test on dissolved oxygen, BOD and COD
- Analysis of soil for organic content, chloride, sulphate, pH, conductivity

References

1. *Standard Methods for the Examination of Water and Wastewater, American Public Health Association, 2011.*

2. *Fundamentals of Environmental Sampling and Analysis, Z. Chunlong, Wiley Interscience, 2011*

Internal Continuous Assessment: 100 marks

Practical Records/Output	Regular Class Viva Voce	Final Test (Objective)
40%	20%	40%

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6212	Biological Methods in Environmental Engineering	3-1-0	4	2015

Course Objective

To familiarize the students with collection and characterization of wastewater samples, their treatment and disposal and advanced wastewater treatment process and their applications

Syllabus

Objectives of biological treatment -Microbiological treatment kinetics and flow regimes - Aerobic biological treatment -Sequencing Batch Reactor -Trickling filter- Aerated lagoons - Stabilization ponds -Advanced biological treatment processes

Expected Outcome

Upon successful completion of this course, the student will have knowledge about the basics of biological waste water treatment process and their applications.

References

1. *Waste Water Engineering: Treatment, disposal and reuse, Metcalf and Eddy Inc., McGraw Hill, 26-Mar-2002*
2. *Biological Process Design for waste water treatment, Benefield and Randall–Prentice Hall of India, New Jersey, 1980*
3. *Unit Operations and Processes in Environmental Engineering, T. D. Reynolds, P. Richards. PWS Series in Engineering, Boston, 2010.*
4. *Biological Waste Treatment. W.W. Eckenfelder, Jr., and D.J. O'Connor, Pergamon Press, 1964*

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6212	Biological Methods in Environmental Engineering	3-1-0	4	2015

Module	Contents	Hours Allotted	% of marks in End Semester Examination
I	Objectives of biological treatment – Role of microorganisms in waste water treatment – Types of biological processes for waste water treatment – Different microbial metabolisms – Bacterial growth patterns – Microbiological treatment kinetics and flow regimes – Michaelis-Menten and Monod models – Rate of biomass growth with soluble substrates – Kinetic coefficients – Effect of temperature – Oxygen requirements – Biomass yield – Observed yield – Kinetic constants evaluation of biological treatment.	16	30
II	Aerobic biological treatment – Attached growth and suspended growth treatment systems – Modeling suspended growth treatment process – Activated sludge process – Description – Various types – Methods of aeration – Microbiology – Process analysis – Process design considerations – Operational difficulties – Modifications.	8	30
FIRST INTERNAL EXAMINATION			
II	Sequencing Batch Reactor – Process description and operation. Trickling filter – Filter classifications – Microbiology – Process design considerations – Design of physical facilities – Recirculation – NRC Equation – Operational difficulties.	8	
III	Aerated lagoons – Types – Process design considerations. Stabilisation ponds – Classification – Design considerations. Sludge treatment and disposal – Characteristics of sludge – Sludge processing – Preliminary	10	20

	operations – Thickening – Stabilizatio - Aerobic digestion - Anaerobic digestion – Composting – Conditioning – Dewatering - Heat drying - Incineration- Wet air oxidation – Land application		
SECOND INTERNAL EXAMINATION			
IV	-Aerated lagoons -Stabilisation ponds Advanced biological treatment processes – Nitrogen removal – Nitrification and Denitrification -Stoichiometry – Process analysis – Operational and environmental variables. Economics of biological treatment – Constructional cost, capital cost, operational cost – Total cost.	10	20
END SEMESTER EXAMINATION			

Internal Continuous Assessment: 40 Marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 60 marks

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6222	Air Quality Management and Meteorology	3-0-0	3	2015

Course Objective

To familiarize the students with collection and characterization of ambient and stack air samples, their treatment and control, importance of mathematical models and meteorology in air pollutant dispersion and its concentration.

Syllabus

Air pollution – sources and effects- Meteorological aspects of air pollutant dispersion- Air pollution sampling and measurement- Air pollution control methods and equipment- Control of specific gaseous pollutants

Expected Outcome

Upon successful completion of this course, the student will have basic knowledge of air pollution and its important parameters that are essential for monitoring and control.

References

1. *Air Pollution Control Engineering, Noel de Nevers, Waveland Press, McGraw-Hill, 2010*
2. *Environmental Pollution Control Engineering, C.S.Rao, New Age International, Wiley Eastern Ltd, Delhi, 2007*
3. *Air pollution its origin and control, Wark Kenneth and Warner C.F,. Harper and Row Publishers, New York, 1981*
4. *Air pollution Control vols 1, 2, 3, Stern A. C, Academic press, Newyork, 1968*
5. *Air pollution hand book, Magill. P. L, McGraw -Hill.*
6. *Encyclopedia of Environmental Pollution and Control Vol 1,2,3, Chhatwal G.R, Anmol Publications*

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6222	Air Quality Management and Meteorology	3-0-0	3	2015

Module	Contents	Hours Allotted	% of marks in End Semester Examination
I	Air pollution – sources and effects – Definition and concentrations, classification and properties of air pollutants, emission sources, major emissions from global sources, importance of Anthropogenic sources, behavior and fate of air pollutants. Photochemical smog, Effects of air pollution on health, vegetation and materials damages. Meteorological aspects of air pollutant dispersion – Temperature lapse rates and stability, wind velocity and turbulence, plume behavior, dispersion of air pollutants, solutions to the atmospheric dispersion equation, The Gaussian plume model.	12	30
II	Air pollution sampling and measurement – Types of pollutant sampling and measurement, ambient air sampling, collection of gaseous air pollutants, collection of particulate pollutants	6	25
FIRST INTERNAL EXAMINATION			
II	Stack sampling, Ambient air quality and emission standards - Air pollution indices - Air Act	4	
III	Air pollution control methods and equipment – Control methods, source correction methods, cleaning of gaseous effluents, particulate emission control – gravitational settling chambers, cyclone separators, fabric filters, electrostatic precipitators, wet scrubbers, selection of a particulate collector, control of gaseous emissions, absorption by liquids,	9	25

	adsorption by solids, combustion, Biological air pollution control technologies - bioscrubers, biofilters, and Indoor air quality.		
SECOND INTERNAL EXAMINATION			
IV	Control of specific gaseous pollutants – Control of sulphur dioxide emission, desulphurization of flue gases, Dry methods, wet scrubbing methods, control of nitrogen oxides, Modification of operating conditions, modification of design conditions, effluent gas treatment methods, Carbon monoxide control, control of hydrocarbons, mobile sources.	8	20
END SEMESTER EXAMINATION			

Internal Continuous Assessment: 40 Marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 60 marks

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6232	Environmental Impact Assessment	3-0-0	3	2015

Course Objective

To make the students aware about the ecological and social costs of unrestrained technological progress and the importance of protection of environment through environmental impact assessment.

Syllabus

Evolution of EIA – Concepts- Components- Importance assessment techniques- Prediction and assessment of impacts- Trends in EIA practice and evaluation criteria- Concepts of environmental audit, objectives of audit- Life cycle assessment – EMS - Case studies in EIA.

Expected Outcome

Upon successful completion of this course, the student will have basic knowledge about environmental impact assessment and its necessity for future.

References

1. *Complete Guide to ISO 14000, R. B. Clements. Simon & Schuster, 2011.*
2. *Environmental Impact Assessment, L. W. Canter, Mc Graw Hill, New York, 2010.*
3. *Handbook of Environmental Impact Assessment Vol I and II, J. Petts, Blackwell Science, London, 2010.*
4. *Environmental Impact Assessment (EIA) notification 2006, Ministry of Environment and Forests,GOI.*
5. *The Theory and the Practice of Environmental Impact Assessment, S. A. Abbasi and N. Ramesh, DPH, New Delhi, 2003.*

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6232	Environmental Impact Assessment	3-0-0	3	2015

Module	Contents	Hours Alloted	% of marks in End Semester Examination
I	Evolution of EIA – Concepts –Environmental Impact Statement (EIS), Environmental Risk Assessment (ERA). Legal and Regulatory aspects of EIA in India. Types and limitations of EIA. Terms of Reference in EIA. Issues in EIA; national, cross sectoral, social, and cultural.	7	20
II	Components: screening, setting, analysis, prediction of impacts - mitigation. Matrices - Networks - Checklists. Importance assessment techniques - cost benefit analysis - analysis of alternatives - methods for Prediction and assessment of impacts - air - water - soil - noise - biological - cultural - social - economic environments.	4	20
FIRST INTERNAL EXAMINATION			
II	Standards and guidelines for evaluation. Public Participation in environmental decision making: public hearings.	2	
III	Trends in EIA practice and evaluation criteria - capacity building for quality assurance. Expert System in EIA - use of regulations and AQM. Document planning - collection and organization of relevant information - use of visual display materials – team writing - reminder checklists. Preparation of environmental Management Plan.	8	20
SECOND INTERNAL EXAMINATION			
IV	Concepts of environmental audit, objectives of audit. Management of audits: waste management contractor audits. Introduction to environmental management system (EMS). Principles & elements of successful environmental	18	40

	management; ISO principles; creating an environmental management system in line with ISO: 14000. Benefits of an environmental management system. Principles and elements of successful environmental management: leadership, environmental management planning, implementing an environmental management system, measurement & evaluations required for an environmental management system, environmental management reviews & improvements. Legal and regulatory concerns; Integrating ISO 9000 & ISO 14000. TQM. Life cycle assessment – EMS - Case studies in EIA.		
END SEMESTER EXAMINATION			

Internal Continuous Assessment: 40 Marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 60 marks

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6266	Environmental Geology	3-0-0	3	2015

Course Objective

To learn the fundamentals of geology in environmental planning and analysis of systems

Syllabus

Fundamental concepts of environmental geology-Geology and urban planning-problems of urbanization-Disposal of waste from nuclear and thermal stations and factories-Natural resources utilization and the environment- Definition and scope of medical geology

Expected Outcome

Upon completion of this course, the student will learn the fundamentals of geology in environmental planning and analysis of systems

References

1. Environmental geosciences, Wiley International, Strahler A.N and Strahler A.H.
2. Control and fate of atmospheric trace metals, Pacyna J.M. and Ohar B
3. Environment and health, Raiz Akhtar
4. Textbook of preventive and social medicine, Park J.E. and Park K

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6266	Environmental Geology	3-0-0	3	2015

Module	Contents	Hours Allotted	% of marks in End Semester Examination
I	Fundamental concepts of environmental geology-concepts of ecology-flood and impact on environment-Nydel projects and environment-depositional environments-resources and silting-lakes-lagoons and estuarine environments-coastal erosion and impact on beach environment-Aeolian deposits and their environmental consequences-wind erosion and related environmental problems	9	25
II	Geology and urban planning-problems of urbanization. Environmental analysis in planning of rural and urban areas. Environmental consequences of natural calamities like volcanic activity, earth quakes and landslides	5	25
FIRST INTERNAL EXAMINATION			
II	Disposal of waste from nuclear and thermal stations and factories. Impact of waste disposal in the quality of ground water. Vulnerability of ground water to pollutants. Ecologist's role in management of waste disposal.	5	
III	Natural resources utilization and the environment. Greenhouse effect and global warming. Chlorofluorocarbons and holes in the ozone layer. Problems in mining environment. Environmental legislation in India. Marine pollution-marine base sources-oil spills-processes of oil water interface-effects of ecosystems.	10	25
SECOND INTERNAL EXAMINATION			

IV	Definition and scope of medical geology-environmental and health. Heavy metal pollutants (Cd,Hg,Pb,Re,Ra,As).Problems relating health and geology. Man-environment relationship. Trace elements in human biology. Goiter and iodine, fluorosis, fluorite, multiple sclerosis and Pb, As poisoning, Cesium and heart disease, radiation hazards.	10	25
END SEMESTER EXAMINATION			

Internal Continuous Assessment: 40 Marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 60 marks

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6276	Environmental Biotechnology	3-0-0	3	2015

Course Objective

Students are expected to know the principles of biotechnology and its application in environmental engineering

Syllabus

Past, present and Future of Environmental Biotechnology – Biotechnological Pollution Control Techniques

Expected Outcome

Upon successful completion of this course, the student will be aware of the principles of biotechnology and it's applications in environmental engineering

References

1. Environmental Biotechnology theory and application, G. M. Evan, J. C. Furlong, John Wiley & Sons, Ltd,-/2503

2. Environmental Biotechnology Principles and Applications, B. E. Rittmann, P. L. Mc Carty, Mc Craw-Hill International Editions/Singapore, 2011.

3.Environmental Biotechnology, B. C. Bhattacharrya, and R. Banerjee, Oxford University Press, India, 2011.

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6276	Environmental Biotechnology	3-0-0	3	2015

Module	Contents	Hours Allotted	% of marks in End Semester Examination
I	Environmental biotechnology down the ages: historical methods of biotechnological waste treatment and resource recovery, modern and post-modern developments in environmental biotechnology, future trends. Bioreactors: batch, semi-batch, plug-flow, continuously stirred, packed bed, expanded/fluidized bed and hybrid reactors. Immobilization. Aseptic and septic bioreactors.	6	20
II	Biotechnological Pollution Control Method I- Desulphurization of coal and oil. Pest control with whole organism and semiochemical approaches. Biosubstitution.	4	20
FIRST INTERNAL EXAMINATION			
II	Bioremediation: *in situ and ex situ t*echniques- biosparging, bioventing, injection recovery, land farming, soil banking, and soil slurry reactor techniques. Biotechnological approaches to hazardous waste treatment.	5	
III	Biotechnological Pollution Control Method II- Phytotechnoloty: Plants as bioreactors. Phytoremediation: phytoextraction, rhizofiltration, phytostabilisation, phytodegradation and phytovolatilisation. Phytomining. Macrophyte-based wastewater treatment systems. Algal effluent treatment systems and their limitations. Microbiology of various waste water treatment processes.	12	30
SECOND INTERNAL EXAMINATION			

IV	Biotechnological Pollution Control Method III-Composting: mechanism, operation, monitoring, and control of composting process. Animal-based solid-waste treatment systems: vermicomposting and termigradation. Genetic manipulation for developing pollution monitoring and control systems. Transgenic plants.	12	30
END SEMESTER EXAMINATION			

Internal Continuous Assessment: 40 Marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 60 marks

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6286	Numerical Methods	3-0-0	3	2015

Course Objective

To use mathematical knowledge in solving problems like optimization, correlation of data etc. and for modeling

Syllabus

Solution of algebraic and transcendental equations- Solution of simultaneous equations- Numerical differential-Numerical integration- Solution of ordinary differential equations

Expected Outcome

Upon successful completion of the course, the student will have basic knowledge about the numerical methods and its application environmental engineering

References

1. Numerical methods for Scientific and Engineering Computation, M. K Jain, New Age International, 01-Jan-2003
2. Elementary Numerical Analysis, Conte and Carl DeBoor
3. Introduction to Numerical Analysis, Gupta A and Bose S C
4. Introduction to Numerical Analysis, Hilderbrand FB
5. Introduction to Numerical Analysis, Fjorberg C E
6. An Introduction to Numerical Analysis, Kendall E Atkinson
7. Statistics, Murrey R Spiegel
8. Numerical Mathematical Analysis, James B. Scarborough
9. Applied Numerical Analysis, C F Gerald & P O Wheatley
10. Numerical algorithms ,E V Krishnamurthy & S K Sen

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6286	Numerical Methods	3-0-0	3	2015

Module	Contents	Hours Allotted	% of marks in End Semester Examination
I	Solution of algebraic and transcendental equations- Review and comparison of various iterative methods, convergence- Generalized Newton- Raphson method for multiple roots- Higher order methods- Newton's method for non-linear systems.	9	25
II	Solution of simultaneous equations-Direct & indirect methods-Gauss elimination and Gauss Jordan methods- ill conditioning- pivoting – Jacobi, Gauss-Seidel and relaxation methods-convergence-Eigen value problems-Vector iteration method	5	25
FIRST INTERNAL EXAMINATION			
II	Interpolation- Newton's Divided difference, Lagrange, Aitken, Hermite and Spline techniques – Inverse interpolation –Error estimates-Double interpolation-Trigonometric interpolation.	5	
III	Numerical differential-Numerical integration-Newton–Cote's integration formula-Gauss quadrature –Error estimates-Double integration. Curve fitting-method of least squares – non-linear relationships – Correlation and Regression – Linear Correlation – Measure of correlation – Standard error of estimate – Coefficient of correlation – Multiple linear regression	10	25
SECOND INTERNAL EXAMINATION			
IV	Solution of ordinary differential equations-Single step & multi step methods-stability of solution – simultaneous first order differential equations - higher order different equations. Numerical solution of integral equations. Partial differential equations – classification – Laplace equation, ID wave equation, ID heat	10	25

	equation – Finite difference method – Relaxation methods. Stability and convergence of solution.		
END SEMESTER EXAMINATION			

Internal Continuous Assessment: 40 Marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 60 marks

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6218	Advanced Hydrology and Water Resources Engineering	3-0-0	3	2015

Course Objectives

To make the knowledge base of the student in hydrology stronger and broader so that they can handle the design and analysis of the environmental systems with confidence.

Syllabus

Fundamental hydrology-Water losses-Ground water flow and well hydraulics-Aquifer parameters Open wells -Tube wells -Test holes-Yield estimation-Floods-estimation-Modeling

Expected Outcome

On completion of this course, the student will be capable of handling the design and analysis of the environmental systems

References

1. *Groundwater, Raghunath H.M, New Age International, 2007*
2. *Elementary Hydrology, Singh, V.P, Prentice Hall of India, New Delhi, 1994.*
3. *Engineering Hydrology, Subramanya, K., Tata Mcgraw Hill, New Delhi,1994*
4. *Hydrologic analysis and design, McCuen, R.H, Prentice Hall, Eaglewood Cliffs, New Jersey, 1989.*
5. *Applied Hydrology, Chow , V.T, D.R. Maidment and L.W. Mays, McGraw Hill Book company, Singapore, 1988.*
6. *Hydrology, Raghunath H.M, Wiley Eastern Ltd New Delhi,1985*

7. Mathematical models for surface water hydrology, Ciriani T.A

8. Ground water hydrology, Tood D. K, Wiley Eastern

9. Introduction to hydrology, Viessman L and Knapp

10. Elements of Water Resources Engineering, Duggal and Soni, New Age International, 1996

11. Ground water and tube wells, Garg S.P, Oxford &IBH New Delhi, 1982.

12. Numerical methods for Engineers, Chapra, S.C and Canale, R .P, McGraw Hill Int.1990.

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6218	Advanced Hydrology and Water Resources Engineering	3-0-0	3	2015

Module	Contents	Hours Allotted	% of marks in End Semester Examination
I	Fundamental hydrology-Hydrological cycle-components of hydrologic cycle –Rainfall-atmospheric circulation –types and forms of precipitation-Rainfall data and its processing-frequency analysis-probability distribution and its application hydrology.-IDF Curves and DAD curves and its derivation and uses. Water losses-Infiltration-Hortans' and Green Ampt model runoff-Indices. Hydrograph-components- base flow separation- unit hydrograph- S and synthetic hydrograph.	9	25
II	Ground water flow and well hydraulics-Aquifer parameters-land subsidence due to over pumping-steady radial flow in to a well-well in uniform flow-steady flow with uniform charge-and steady flow in to a well confined, unconfined and leaky aquifers-well near aquifer boundaries-multiple well systems-partially penetrating wells –-pumping tests. Non equilibrium for pumping test-Theis method.-Jacob's method-Chow's method.	6	25
FIRST INTERNAL EXAMINATION			
II	Salt water intrusion, ground water basin development, and Artificial recharge. Rainwater harvesting	3	

III	Open wells – Design of open well –yield test.- Methods of construction-dug wells. Tube wells –design-screened wells-gravel packed wells- -selection of screen size-yield of a well. Well loss- determination of well loss by step pumping method. Test holes-well logs - shallow tube wells -deep wells - -drilling in rocks-screen installation-well completion- well development-testing wells for yield-failure of tube wells.	8	15
SECOND INTERNAL EXAMINATION			
IV	Yield estimation: flow duration curve and mass curve –reservoir capacity and design. Hydrologic equation and water balance studies- flood routing studies. Floods-estimation: Empirical -Rational formula-hydrograph method- flood frequency analysis-Gumbel's and Log-pearson type III. Regression – Linear and non-linear - correlation- Methods of assessing error in hydrologic data and hydrologic computation. Modelling – Classification of models based various criteria – Physically based models – Classification of PDEs- Methods for solution – FDM –Explicit and Implicit equation -solution procedure for Laplace and Unsteady ground water flow equation- and FEM (Basic concepts only)	13	35
END SEMESTER EXAMINATION			

Internal Continuous Assessment: 40 Marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carries 10 marks. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 60 marks

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6228	Global Climatic changes and Disaster Management	3-0-0	3	2015

Course Objective

To make the base of the student more stronger on the subject and to relate its application in Environmental Engineering

Syllabus

Climate, weather and Climate Change-Modelling of Climate Change-Overview of disaster, major natural disasters -Factors for disaster-Techniques of monitoring and design against the disasters-Water supply preparedness and protection

Expected Outcome

Upon successful completion of this course, the student will have an idea about the various aspects that relate global climatic changes and disaster management in environmental engineering which can further be used for research purpose.

References

1. *Disaster Management, H.K. Gupta, , Universiters Press, India, 2003*
2. *Principles of emergency planning and management, Alexander D, Oxford University Press, 2002.*
3. *Introduction to Emergency Management, Hallow G. and Bullock J, Elsevier, 2002.*
4. *Climate Change and Sustainable Development: Prospects for Developing Countries, Anil Markandya, Routledge, 2002.*
5. *Manuals on Natural Disaster management in India, M.C. Gupta, National Centre for Disaster Management, IIPA, New Delhi, 2001*

6. *Disaster Management, R.B. Singh, Rawat Publication, New Delhi, 2000*
7. *Climate Change Policy - Facts, Issues and Analysis, Jepma, C.J, and Munasinghe, M, Cambridge University Press, 1998.*

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6228	Global Climatic changes and Disaster Management	3-0-0	3	2015

Module	Contents	Hours Allotted	% of marks in End Semester Examination
I	Climate, weather and Climate Change; – Overview of Earth's Atmosphere; Layers of Atmosphere; – Temperature, Radiation and Variation; – Heat- Balance of Earth Atmosphere System; – Temporal Variation of Air temperature; – Temperature Change in Soil; – Thermal Time and Temperature Extremes, – Hydrologic cycle. – Climate Variability like Floods, Droughts, Drought Indicators, Heat waves, Climate Extremes Causes of Climate Change; – Modelling of Climate Change, Kyoto Protocol Montreal protocol and IPCC Scenarios, difference between climate change and climate variability Carbon trading and clean development mechanism Role of countries and citizens in containing in global warming	10	25
II	Overview of disaster, major natural disasters – flood, tropical cyclone, droughts, landslides, heat waves, earthquakes, fire hazards, tsunami, etc.	4	20
FIRST INTERNAL EXAMINATION			
II	Factors for disaster – climatic change and global sea rise, erosion, environmental degradation, large dams and earthquakes, road building and landslides, Chemical and Biological weapons – case studies.	4	

III	Techniques of monitoring and design against the disasters. – Management issues related to disaster; – Mitigation through capacity building, legislative responsibilities of disaster management; – Disaster mapping, assessment, pre-disaster risk and vulnerability reduction, post disaster recovery and rehabilitation; disaster related infrastructure development. – Disaster management plan, national crisis management committee, state crisis management group.	10	25
SECOND INTERNAL EXAMINATION			
IV	Water supply preparedness and protection, emergency water supply strategy, rural and urban emergencies. – Assessment of damage. – Emergency water supply schemes – Sources, quality, treatment, storage and distribution, operation and maintenance. Sanitation – Human waste and health, strategy for excreta disposal in emergencies, techniques for excreta disposal, disposal of wastewater, management of refuse.	11	30
END SEMESTER EXAMINATION			

Internal Continuous Assessment: 40 Marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 60 marks

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6238	Water Pollution Control and Stream Sanitation	3-0-0	3	2015

Course Objective

To make the students aware about the sources of surface water pollution, their control and stream quality standards

Syllabus

Introduction-importance of water sources-socio-economic importance-Water quality and stream quality standards-Eutrophication-Organic self –purification-Microbial self-purification-Classification of streams-Rational stream sanitation practices-Purification in estuaries-Impacts of river developments on waste assimilation capacity

Expected Outcome

Upon successful completion of this course, the student will have good knowledge about the sources of pollution, control and stream quality standards.

References

1. Stream Sanitation , Phelps E.

2. Applied stream sanitation, Viez

3. Water pollution, causes, effects and control, P. K. Goel

4. Applied Groundwater hydrology, Todd G. K

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6238	Water Pollution Control and Stream Sanitation	3-0-0	3	2015

Module	Contents	Hours Allotted	% of marks in End Semester Examination
I	Introduction-importance of water sources-socio-economic importance-sources of pollution-types of waste-waste products of man's activities-sources of stream pollution-types of waste products-location and management of waste loads-projecting waste loadings Water quality and stream quality standards	8	20
II	Eutrophication-organic pollution-oil pollution-radioactive pollution-marine pollution-thermal pollution-pesticide pollution-heavy metal pollution	4	25
FIRST INTERNAL EXAMINATION			
II	Organic self -purification-quantitative definition-reoxygenation-oxygen balance and stream dissolved oxygen profile-oxygen sag curve-Streeter Phelp's equation-Critical deficit-problems Microbial self-purification-pathogenic microorganisms of sewage origin-indices of contamination-enumeration-percapita contribution-seasonal variations-death rate survival in the stream environment	6	
III	Classification of streams-natural self purification process-disposal of wastewater-	12	30

	Rational stream sanitation practices-dual objectives of stream sanitation practices-the science and art of applied stream sanitation-stream survey-types of stream survey-execution of stream surveys Purification in estuaries-evaluation of self purification in estuaries-tides and currents-distribution of waste loads by tidal translation-sea water intrusion-waste assimilation capacity of estuaries-bacterial contamination-stable wastes		
SECOND INTERNAL EXAMINATION			
IV	Impacts of river developments on waste assimilation capacity-detrimental and beneficial effects-hydroelectric power-navigation works-flood control works-irrigation and other diversions	9	25
END SEMESTER EXAMINATION			

Internal Continuous Assessment: 40 Marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 60 marks

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6262	Mini Project	0-0-4	2	2015

Course Objective

- To help students develop practical ability and knowledge about practical tools / techniques in order to solve real life problems related to the industry, academic institutions and computer science research.

The students can be divided into groups consisting of maximum of 2 members. The students should report their progress of work regularly to their guides. The selection of topics can be in any field of environmental engineering based on their interest and the guide's area of work. Copies of the report should be submitted to the guide, department library and the college library and one copy can be kept with the student.

Internal Continuous Assessment: 100 Marks

The marks of internal continuous assessment will be based on two interim reviews/evaluations by the guide along with evaluation committee consisting of two other internal faculty members.

	Attendance/Regularity	Evaluation committee	Guide
Evaluation 1	10	30	10
Evaluation 2	10	30	10

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6272	Environmental Microbiology and Engineering Laboratory	0-0-2	1	2015

Course Objective

To analyze the various microbial constituents in wastewater

Syllabus

1. Microscopic Examination of Microorganisms: Preparation of bacterial smear - staining - Hanging drop technique - plate count test, MPN tests and MFT Tests.
2. Determination of MLSS and MLVSS in ASP
3. Coagulation and flocculation of water – Optimization of dose / pH / time of flocculation.
4. Color removal from wastewater by adsorption - Estimation of suspended particulate matter / SPM, NOx, SOx.

References

1.Standard methods for the examination of water and waste water, American public health association 1996, NewYork.

2.F.W. Fifield and P.J. Haives Blackie, Environmental Analytical Chemistry, Academic and professional glasgow.

Internal Continuous Assessment: 100 marks

Practical Records/Output	Regular Class Viva Voce	Final Test (Objective)
40%	20%	40%

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6217	Remote Sensing and GIS	3-0-0	3	2015

Course Objective

To make the students understand the basics of emerging fields -remote sensing principles and Geographic Information System- so that they can utilize it for environmental system modeling

Syllabus

Introduction to remote sensing -Sensors- Satellite system parameters-Different types of data products and their characteristics-Geographic Information system-Data input and data editing-Input methods- Integration of RS and GIS

Expected Outcome

Upon successful completion of this course, the student will have basic knowledge about the applications of Remote Sensing and GIS in Environmental Engineering

References

1. Remote sensing and Image Interpretation, Lillesand T.M. and Kiefer R.W, Second Edition, John Wiley and Sons, 1987.

2. Remote Sensing and Geographical Information System, AnjiReddy, M, BSP Publications, 2001.

3. Introduction to Geographic Information Systems, Chang, K, Tata McGraw Hills Edition, New Delh, 2005

4.Manual of Remote Sensing, American Society of Photogrammetry and Remote Sensing, 1993.

5. Principles of Remote Sensing, Paul Curran P.J, ELBS, 1983.

6. Remote Sensing Principles and Interpretation, Sabins F.F. Jr., W.II. Freeman and Company, 1978.

7.Geo Information Systems – Applications of GIS and Related Spatial Information Technologies, ASTER Publication Co., Chestern (England), 1992.

8. Principles of GIS for Land Resources Assessment, Burrough P.A , Oxford Publication, 1980.

9. Geographical Information System – An Introduction, Jeffrey Star and John Estes, Prentice – Hall Inc., 1990.

10. Basic Readings in Geographic Information System, Marble D.F., Galkhs H.W. and Pequest, Sped System Ltd., New York, 1984.

11. Geographic Information systems and environmental modeling- PHI of India, Clarke K.C. Parks B.O., and Crane M.P, New Delhi, 2006

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6217	Remote Sensing and GIS	3-0-0	3	2015

Module	Contents	Hours Allotted	% of marks in End Semester Examination
I	Introduction to remote sensing – Electromagnetic spectrum – Physics of remote sensing – Effects of atmosphere – Atmospheric windows – Interaction of earth surface features with EMR – Spectral characteristics of vegetation, water, soil, etc. – Various types of platforms– Airborne and space based platforms - Different types of aircraft – Manned and unmanned spacecraft used for data acquistion – Characteristics of different types of platforms – Characteristics of Remote Sensors – Multi spectral sensors – Multi Spectral Scanners – Microwave remote sensing- Factors affecting Microwave measurement-Radar wave bands- SLAR and SAR.	10	25
II	Sensors- Satellite system parameters- sensor parameters-spatial, spectral and radiometric resolution – False colour composite (FCC) – Multi spectral photographs – Thermal and microwave imaging system-Earth Resources satellite and Meteorological satellites	5	25
FIRST INTERNAL EXAMINATION			
II	Different types of data products and their characteristics – Image Interpretation - Basic principles of visual interpretation – Elements of image interpretation - Equipment for visual interpretation – Activities of image interpretation – Ground truth - Basic principles of digital image processing – filtering	5	

III	Geographic Information system – History and development of GIS – GIS definitions and Terminology -Architecture– System concepts – Coordinate systems – Standard GIS packages Type of data – Spatial and non- spatial data – Data structure – Points – Lines – Polygon – Vector and raster – Files and data formats – Spatial data modeling –Raster GIS model and Vector GIS models.-GIS data file management and Database models	9	25
SECOND INTERNAL EXAMINATION			
IV	Data input and data editing-Input methods –GPS as data capture-data editing. Spatial analysis – Data retrieval – Query – Simple analysis – Record – Buffering and Overlay – Vector data analysis – Raster data analysis – Modelling in GIS – Digital elevation model – DTM – Modelling Networks Integration of RS and GIS – Need and Facilities for integration. Application of these to water resources and environmental engg-Cadestral records and LIS	10	25
END SEMESTER EXAMINATION			

Internal Continuous Assessment: 40 Marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 60 marks

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6227	Environmental System Analysis	3-0-0	3	2015

Module	Contents	Hours Allotted	% of marks in End Semester Examination
I	Significance of Systems Engineering: Systems Analysis, Systems Design and system synthesis. Scope of applications to environmental engineering Systems addressing to specific environmental problems. Water pollution and transport and atmospheric processes.	9	25
II	Role of optimization models: Deterministic models/Linear programming,	5	25
FIRST INTERNAL EXAMINATION			
II	Dynamic programming, separable and nonlinear programming models.	5	
III	Formulation of objective functions and constraints for environmental engineering planning and design. Applications to environmental systems analysis.	10	25
SECOND INTERNAL EXAMINATION			
IV	Introduction to modern tools: Expert systems, Neural networks, Genetic Algorithm	10	25
END SEMESTER EXAMINATION			

Internal Continuous Assessment: 40 Marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carries 10 marks. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 60 marks

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6237	Groundwater Contamination and Pollution Transport	3-0-0	3	2015

Course Objective

To learn the principles of pollution transport, and estimation of extent of contamination by modelling

Syllabus

Ground water and the hydrologic cycles- Physical properties and principles-steady state flow and transient flow- Resource evaluation- Chemical properties and principles- Solute transport- USGS-Moc model

Expected Outcome

Upon successful completion of this course, the student will have thorough knowledge about pollution transport and estimation by modeling.

References

1. Ground water Hydraulics and Pollutant Transport, Randall J. Charbeneau
2. Ground water, Allen Freeze R. and John A. Cherry, Prentice Hall.Inc

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6237	Groundwater Contamination and Pollution Transport	3-0-0	3	2015

Module	Contents	Hours Allotted	% of marks in End Semester Examination
I	Ground water and the hydrologic cycles-Ground water as a resource-Ground water contamination-Ground water as a geotechnical problem-Ground water and geologic processes. Physical properties and principles-Darcy's law-Hydraulic head and fluid potential-piezometers and nests. Hydraulic conductivity and permeability-homogenicity and anisotropy-porosity and voids ratio-Unsaturated flow and the water table-steady state flow and transient flow-compressibility and effective stress-transmissivity and storativity-Equations of ground water flow -Limitations of Darcian Approach-hydro dynamic dispersion.	10	25
II	Resource evaluation: development of ground water resources-Exploration of Aquifers-the response of ideal aquifers to pumping	5	25
FIRST INTERNAL EXAMINATION			
II	Measurement of parameters-Laboratory tests-Numerical simulation for aquifer yield prediction-Artificial recharge and induced infiltration-land subsidence - sea water intrusion	5	
III	Chemical properties and principles: constituents - chemical equilibrium-association and dissociation of dissolved species-effects of concentration gradients-mineral dissolution and solubility-Oxidation and reduction process-Ion exchange and adsorption-environmental isotopes-field measurement of index parameters. Chemical evolution: ground water in carbonate terrain-ground water in crystalline rocks-ground water in	9	25

	complex sedimentary systems -geotechnical interpretation of 14C dates-process rates and molecular diffusion.		
SECOND INTERNAL EXAMINATION			
IV	Solute transport: water quality standards-transport process-non reactive constituents in homogeneous media-transport in fracture media-hydrochemical behaviour of contaminants-trace metals-nitrogen-trace non -metals-organic substances-measurement of parameters – velocity-dispersivity-chemical partitioning- sources of contamination-land disposal of solid waste-sewage disposal on land. USGS-Moc model: modelling principles-MOC modelling.	10	25
END SEMESTER EXAMINATION			

Internal Continuous Assessment: 40 Marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 60 marks

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6267	Planning and Design of Environmental Facilities	3-0-0	3	2015

Course Objective

Students are expected to know in detail the various water and wastewater treatment systems and their layout and design.

Syllabus

Environmental Engineering hydraulic design- Design of various sewer appurtenances – Design of surface and subsurface drainage ,water treatment units ,waste water treatment units

Expected Outcome

Upon successful completion of this course, the student will have basic knowledge about the wastewater treatment systems, its design and layout.

References

1. Waste water Engineering: Treatment, disposal & reuse, Metcalf and Eddy Inc.,Tata McGraw Hill
2. Environmental Engineering, Peavy, McGraw Hill
3. Water supply Treatment and distribution, Rodger Walker
4. Environmental Engineering: A Design Approach, Sinero- Prentice Hall of India, Delhi
5. Design calculations in waste water treatment, Wilson, McGraw Hill Kogakusha

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6267	Planning and Design of Environmental Facilities	3-0-0	3	2015

Module	Contents	Hours Allotted	% of marks in End Semester Examination
I	Environmental Engineering hydraulic design: Water distribution systems- Design of distribution systems- Hydraulic analysis – Distribution system components – Storage tanks -Analysis – Hardy Cross method – Equivalent Pipe method – Computer Programmes. Pumps – Design of water and waste water pumping system.	10	25
II	Types of sewerage system – Hydraulics of sewers –Design of various sewer appurtenances - Design of sanitary and storm water sewers	5	25
FIRST INTERNAL EXAMINATION			
II	Structural requirement of sewer under various conditions – Design of surface and subsurface drainage – Roadways and Airport drainage.	5	
III	Design of water treatment units – Design of sedimentation tanks, Mixing basins, Flash Mixer, Clariflocculator, Slow sand filter, Rapid sand filter, Spray and Cascade aerator, Chlorinator.	9	25
SECOND INTERNAL EXAMINATION			
IV	Design of waste water treatment units – Design of screens, Grit chamber, Sedimentation tank, Activated sludge process, Trickling filter, Aerated lagoons, Stabilization ponds, Oxidation ditch, Septic tank, Imhoff tank, Sequencing batch reactor, Sludge digestion tank.	10	25
END SEMESTER EXAMINATION			

Internal Continuous Assessment: 40 Marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 60 marks

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6277	Bioremediation Principle and Applications	3-0-0	3	2015

Course Objective

Students are expected to know the principles of bioremediation and in situ treatment practices.

Syllabus

Bioremediation practices and applications- response of microorganisms to the presence of pollutants and their application in waste management- Microbial detoxification - Microbial cleaning of gases - bioremediation project.

Expected Outcome

Upon successful completion of this course, the student will know more about the bioremediation and treatment practices

References

1. Microbiology for sanitary engineers, Rose E Mckanney.
2. Microbiology for waste water and sewage, Gamey and Lord.
3. Text book of microbiology, Pelczhar and Reid..
4. General Microbiology, Roger T Stainer and Michael Dandroff.

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6277	Bioremediation Principle and Applications	3-0-0	3	2015

Module	Contents	Hours Allotted	% of marks in End Semester Examination
I	Current bioremediation practices and applications, Microbial systems of bioremediation, Factors influencing bioremediation (Environmental, physical and chemical factors).	9	25
II	Genetic response of microorganisms to the presence of pollutants (plasmid coded inducible degradative enzymes	5	25
FIRST INTERNAL EXAMINATION			
II	Applications of genetically engineered microorganisms for hazardous waste management, microbial transformation reactions (aerobic and anaerobic biotransformations).	5	
III	Microbial detoxification of specialty chemicals (insecticides, herbicides, fungicides, polychlorinated biphenyls, heavy metals), Bioremediation systems and processes (solid, liquid and slurry phase remediation)	12	30
SECOND INTERNAL EXAMINATION			
IV	Microbial cleaning of gases (biofiltration and bioscrubbing), in situ bioremediation, laboratory scale biotreatability studies for bioremediation, management of bioremediation project.	8	20
END SEMESTER EXAMINATION			

Internal Continuous Assessment: 40 Marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 60 marks

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6287	Environmental Systems Modelling	3-0-0	3	2015

Course Objective

To introduce new models and study their application in the environmental engineering field

Syllabus

Introduction to mathematical modeling-models for transport and fate of contaminants, activated sludge process, anaerobic processes- introduction to soft computing techniques

Expected Outcome

Upon successful completion of this course, the student will have knowledge about new models and application in environmental engineering field.

References

1. Integrated Environmental Modeling – Pollutant Transport, Fate, and Risk in the Environment, Ramaswami A., Milford J.B., Small M.J., John Wiley & Sons, 2005.
2. Principles of Geographical Information Systems, Burrough P.A. and McDonnell R.A., , Oxford University Press, 1998.
3. Dynamics of environmental bioprocesses, modelling and simulation, Snape J.B., Dunn I.J., Ingham J. and Prenosil J., Weinheim: VCH, 1995.
4. International Water Association – Activated sludge modelling ASM1 and ASM2
5. Surface Water Quality Modeling, Chapra S.C, McGraw–Hil, Inc., New York, 1997.

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE6287	Environmental Systems Modelling	3-0-0	3	2015

Module	Contents	Hours Allotted	% of marks in End Semester Examination
I	Introduction: Mathematical modelling and simulation – Defining systems and its components – Types of models and their applications – Evaluation of models – Graphical analysis – Quantitative analysis – Sensitivity analysis – Uncertainty analysis.	10	25
II	Models for transport and fate of contaminants: Mass and energy balance – Advection – Molecular diffusion – Dispersion – Their application in modelling of rivers-lakes, sediments, wetlands, subsurface flow and transport – Air pollution modelling.	6	30
FIRST INTERNAL EXAMINATION			
II	Modelling of volatilization, Chemical transformations, sorption/desorption, Photochemical transformations and Biological transformations.	6	
III	Models for activated sludge process – Anaerobic processes – Aquasim – Ginafit.	8	20
SECOND INTERNAL EXAMINATION			
IV	Introduction to soft computing techniques: Analytic hierarchy process – Fuzzy set theory, Neural networks, Simple applications in environmental engineering.	9	25
END SEMESTER EXAMINATION			

Internal Continuous Assessment: 40 Marks

Internal continuous assessment is in the form of periodical tests and assignments/tutorials. Two internal tests each carrying 15 marks will be conducted. Assignments/tutorials carry 10 marks. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 60 marks

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE7263	Seminar	0-0-2	2	2015

Course Objectives

- To assess the debating capability of the student to present a technical topic.
- To impart training to students to face audience and present their ideas
- To create self-esteem and courage that is essential for engineers.

Individual students are required to choose a topic of their interest from Environmental Engineering related topics preferably from outside the M.Tech syllabus and give a seminar on that topic about 30 minutes. A committee consisting of at least three faculty members (preferably specialized in Environmental Engineering) shall assess the presentation of the seminar and award marks to the students. Each student shall submit two copies of a write up of his/her seminar topic. One copy shall be returned to the student after duly certifying it by the chairman of the assessing committee and the other will be kept in the departmental library. Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and participation.

Internal continuous assessment: 100 marks

The percentage distribution of marks is as given below

Marks for the report:	30%
Presentation	40%
Ability to answer questions on the topic	30%

Kerala Technological University

Master of Technology- Curriculum, Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE7283	Project (Phase I)	0-0-12	6	2015

Course Objectives

- To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes.
- To develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.

In the phase I of the Masters Research project, the student have to interact with someone to identify a research need that is important to them and to use the library to inform themselves on the topics related to the research need. He/she should discuss their topics of interest with their guide and finalize their area of research work. The culmination of this phase is to write a literature review that also includes a statement of the problem, information about the potential significance to social work, and research questions and (if appropriate) hypotheses.

Internal continuous assessment: 50 marks

The marks of internal continuous assessment will be based on interim reviews/evaluations by the guide along with evaluation committee consisting of two other internal faculty members.

Progress Evaluation by the Project Supervisor: 20 marks

Presentation & Evaluation by the Committee: 30 marks

Course No.	Course Name	L-T-P	Credits	Year of Introduction
09CE7284	Project (Phase II)	0-0-21	12	2015

Course Objectives

- To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes.
- To develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.

Master Research project phase II is a continuation of project phase 1 started in the third semester. Towards the end of the semester there would be a pre submission presentation before the evaluation committee to assess the quality and quantum of the work done. This would be a pre-qualifying exercise for the students for getting approval by the departmental committee for the submission of the thesis. At least one technical paper is to be prepared for possible publication in journal or conference. The technical paper is to be submitted along with the thesis. The final evaluation of the project will be external.

Internal continuous assessment: 100 marks

The marks of internal continuous assessment will be based on the evaluation by the guide along with evaluation committee consisting of two other internal faculty members, and an external examiner.

Project Evaluation by the Supervisor: 30 marks

Evaluation by the External Expert : 30 marks

Presentation & Evaluation by the Committee: 40 marks